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The Production of Estimated Levels of Fuel Poverty in Wales: 2012-2016



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Views expressed in this report are those of the researcher and not necessarily those of the Welsh Government

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Glossary of acronyms

Acronym/Key word	Definition
ASHP	Air Source Heat Pump
COA	Census Output Area
CERT	Carbon Emissions Reduction Target
CESP	Community Energy Saving Programme
CH	Central Heating
CPI	Consumer Price Index
CWI	Cavity Wall Insulation
DECC	Department of Energy & Climate Change
DG	Double Glazing
ECO	Energy Company Obligation
EHS	English Housing Survey
ERDF	European Regional Development Fund
FIT	Feed in Tariff
HEES	Home Energy Efficiency Scheme
HHCRO	Home Heating Cost Reduction Obligation
HRP	Household Reference Person
HW	Hot Water Cylinder
LA	Local Authority
LI	Loft insulation
LIHC	Low Income High Costs fuel poverty indicator
LIW	Living in Wales survey
LSOA	Lower Super Output Area
Ofgem	Office of the Gas and Electricity Markets
PG	Priority Group
PV	Photo-voltaic panels
RHI	Renewable Heat Incentive
RPI	Retail Price Index
RSL	Registered Social Landlord
SAP	Standard Assessment Procedure for Energy Rating of Dwellings

SHW	Solar Hot Water
SWI	Solid Wall Insulation
WHD	Warm Homes Discount scheme

1. Summary

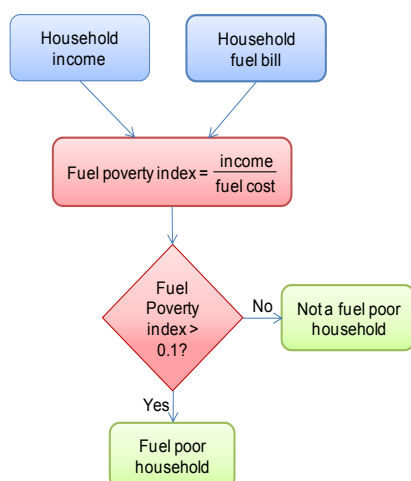
- 1.1 The Welsh Government has a responsibility to report on the level of fuel poverty (10% indicator) in Wales and a statutory obligation to do everything reasonable to reduce the number of fuel poor households, with the aim of eradicating fuel poverty in Wales by 2018. This report presents the findings from research undertaken by BRE to develop a model to predict overall levels of fuel poverty, severe fuel poverty, fuel poverty amongst vulnerable households and levels of fuel poverty amongst social housing tenants in Wales for the years 2012 to 2016.
- 1.2 The 2008 Living in Wales dataset was used as the base dataset and estimates of the fuel poverty levels were derived by modelling the installation of reported numbers of energy efficiency improvement measures, along with changes to fuel prices and household incomes and recalculating the fuel poverty indicator for each household in the dataset. Projections of energy efficiency installations, fuel prices and income changes for 2015 to 2016 were used to predict the 2016 fuel poverty levels. A Monte-Carlo method was used to simulate the application of the reported numbers of energy efficiency improvements to the Welsh housing stock.
- 1.3 In 2012, 29% of all households (364,000 households) were predicted to be in fuel poverty, decreasing slightly in 2013 to 28% (351,000 households) and peaking in 2014 at 30% (376,000 households). The combination of (moderately) rising household incomes, reduction in household energy consumption due to energy efficiency improvements, and decreasing gas and oil prices since 2014, have led to fuel poverty levels across all Welsh households decreasing since 2014 to a projected level of 23% (291,000 households) in 2016.
- 1.4 Levels of severe fuel poverty (defined as any household having to spend more than 20% of household income on household fuel costs) were calculated to remain broadly level between 2012 and 2014, followed by a decrease in 2015, resulting in a projected level of severe fuel poverty of 3% (43,000 households) in 2016.

- 1.5 A vulnerable household is defined by the Welsh Government as one with any member aged 60 years or over, with a child/young person under the age of 25 years or with any long-term limiting condition or disabled member. A similar pattern of changes in the levels of fuel poverty were seen for vulnerable households, although a slightly higher proportion of vulnerable households are calculated to be in fuel poverty, decreasing from a level of 31% in 2012 (328,000 vulnerable households) to 24% in 2016 (261,000 vulnerable households).
- 1.6 Amongst social housing tenants, 33% (73,000 social sector households) were predicted to be in fuel poverty in 2012, decreasing to 27% (61,000 social sector households) in 2016. Compared to all households, a similar pattern in the changes of fuel poverty levels between 2012 and 2016 was seen for social housing tenants although a higher proportion of social housing tenants were calculated to be fuel poor compared to all households.
- 1.7 The predicted national levels of fuel poverty for Wales are higher than in England but lower than in Scotland or Northern Ireland (as a percentage of all households).
- 1.8 Under the Low Income High Costs (LIHC) definition, 141,000 households (11%) were predicted to be in fuel poverty in 2012, decreasing to 132,000 (10%) in 2016. The LIHC indicator comprises a second indicator relating to the depth of fuel poverty amongst fuel poor households, measured through a fuel poverty gap which represents the difference between the required fuel costs for each household and the median required fuel costs. The aggregated fuel poverty gap of the fuel poor households was estimated to be £78 million in 2012, decreasing to a projected £60 million in 2016. The average fuel poverty gap reduced from £552 in 2012 to £453 in 2016.

2. Introduction

- 2.1 The Welsh Government has a responsibility to report on the level of fuel poverty in Wales and a statutory obligation to do everything reasonable to reduce the number of fuel poor households, with the aim of eradicating fuel poverty in Wales by 2018.
- 2.2 A fuel poor household (under the definition used in Wales) is one which needs to spend more than 10% of its income on fuel to maintain a satisfactory heating regime. Households who spend more than 20% are considered to be in severe fuel poverty. In 2004 and 2008, Living in Wales (LiW) data were used to calculate each household's energy requirement using the BREDEM methodology¹. Fuel prices were calculated using data from DECC and the Sutherland Tables and the 'full' and 'basic' household incomes were calculated using data from the LiW household questionnaire². These three components were combined to produce the fuel poverty statistics (see Figure 1).

Figure 1: Determining the fuel poverty status of a household



- 2.3 The estimated number of fuel poor households in 2008 was 332,000. The most recent published data on fuel poverty in Wales comes from

¹ BRE Domestic Energy Model – current version is BREDEM-2012

<http://www.bre.co.uk/page.jsp?id=3176>

² See the 'Methodology' annex in the report 'Fuel Poverty statistics' for further details.

<http://gov.wales/statistics-and-research/fuel-poverty-reports-living-in-wales-survey/?lang=en>

the Fuel Poverty Projection Tool, which used data modelled on the 2008 Living in Wales Property Survey to estimate fuel poverty levels in 2012. Fuel price, income and energy efficiency changes, applied to the 2008 data, suggested that the level of fuel poverty increased to 386,000 households in 2012. The estimated number of vulnerable households in fuel poverty in 2012 was 328,000, and the estimated number of fuel poor households in social housing was 70,000.

2.4 The aims of this research were to:

- Estimate the levels of fuel poverty for the whole population in Wales for each year from 2012 to 2016.
- Estimate the distribution of fuel poverty at a local level across Wales as an aid to informing the targeting of funding in future fuel poverty schemes.

2.5 The Welsh Government has not conducted a property survey since the 2008 Living in Wales survey and since this time has published a new Fuel Poverty Strategy in July 2010 and a Fuel Poverty Evidence Plan in 2012. Considerable efforts to improve the energy efficiency of the Welsh housing stock have been made since 2008; fuel prices have fluctuated and household incomes generally increased; therefore a modelling approach is required to evaluate the impact of these changes on the fuel poverty levels in Wales.

3. Methodology

3.1 Fuel poverty under the 10% methodology is determined by three factors: fuel prices, household income and energy consumption (which relates to the energy efficiency of the home). The objectives of this work are to predict overall levels of fuel poverty, severe fuel poverty, fuel poverty amongst vulnerable households and levels of fuel poverty amongst social housing tenants in Wales for the years 2012 to 2016.

3.2 The 2008 LiW data was used the base dataset and the fuel poverty statistics were calculated in a way that is consistent with that used for

the 2004 and 2008 LiW surveys (and for the 2012 Projection Tool). There have been three significant updates to the calculation of fuel poverty statistics in Wales. One requirement, driven by an update to the official Fuel Poverty Methodology, has been to re-calculate the fuel consumption at the 2008 base position using the latest version of the BREDEM methodology (BREDEM-2012). In addition to this, the Welsh Assembly Government published its 'Fuel Poverty Strategy' in 2010 in which it re-defined the definition of a vulnerable household and what is considered to be a 'satisfactory heating regime'. The effect of these changes to the 2008 base fuel poverty statistics, together with a summary of the changes to the Bredem-2012 model, are reported in Annex A.

- 3.3 Using the 2008 LiW data as a base, fuel prices and household incomes have been adjusted and the installation of projected energy efficiency improvement measures has been simulated; all to 2016 levels. The changes used in the Fuel Poverty Projection Tool (i.e. applied to the 2008 data to project to the 2012 position have been updated slightly to provide consistency in the method and use the data that wasn't currently available at the time of the original work.

Fuel price changes

- 3.4 Changes to fuel prices over the period 2008 to 2015 have been derived from the statistics published by the Department of Energy and Climate Change (DECC) on their domestic energy price indices page. The monthly indices for gas, electricity, liquid fuels and solid fuels, published in Table 2.1.3³, have been used to calculate annual changes for the individual fuels, based on a calendar year. These are shown in Table 1. It can be seen that whereas fuel prices for all types increased substantially between 2008 and 2012, increases since then have been more moderate and reversed in trend between 2014 and 2015. Gas, electricity and solid fuels decreased slightly (or remained static) and oil prices decreased considerably. Projected fuel prices at

³ Consumer prices index: fuel components, monthly figures Table 2.1.3
<https://www.gov.uk/government/statistical-data-sets/monthly-domestic-energy-price-stastics>

2016, published by DECC in their 'Energy and Emissions projections' series⁴, have been used.

Table 1: Fuel price adjustments applied to the 2008 Living in Wales data to project to 2016 levels

	2008-2012	2012-2013	2013-2014	2014-2015	2015-2016 (projected)
Gas	+31.2%	+7.7%	+4.7%	-4.5%	-2.8%
Electricity	+15.5%	+7.4%	+5.5%	-0.3%	+3.0%
Oil	+19.3%	+0.3%	-11.3%	-29.5%	+8.4%
Solid fuels (coal)	+27.8%	+1.5%	+2.8%	+0.3%	-0.9%

Warm Homes Discount

3.5 The Warm Homes Discount Scheme (WHD) requires participating domestic energy suppliers to provide support to those who are in, or at risk of fuel poverty, predominantly in the form of a direct rebate on electricity bills. The scheme came into operation in April 2011 and although it has altered slightly in eligibility criteria and amount of the rebate in successive years, the main objectives are that a 'Core Group' of less well-off pensioners receives an automatic, direct electricity bill rebate (£140 in 2014/15) and a 'Broader Group' of households who are fuel poor or at risk of fuel poverty are identified by the energy suppliers and targeted for a rebate of the same value as the Core Group following successful applications. Data collected in the interview component of the LiW 2008 survey have been used to model 'Core Group' and 'Broader Group' eligibility flags for all the households in the 2008 fuel poverty dataset. The actual numbers of households in each group receiving the WHD was calculated from data provided by DECC on the numbers of customers receiving the rebates in Great Britain (Wales is assumed to account for 5% of these). These are shown in Table 2.

⁴ Accessed at: <https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2015>

Table 2: Estimated numbers of ‘Core’ and ‘Broader’ Group Warm Homes Discounts to apply in Wales

	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016 (projected to be same as previous year)
Core group	35,070	57,894	61,839	71,355 ⁵	71,355
Broader group	11,715	24,475	30,274	37,907	37,907

Income changes

3.6 Households receive income from different sources, the main ones being employment income and state benefits. The working status and age of the household members will determine what proportion of their income comes from each source. Detailed data on these income streams was collected in the 2008 LiW survey and modelled by BRE to produce the ‘fuel poverty full income’ variable required in the calculation of the fuel poverty indicator. To project the 2008 household incomes to 2016 levels, the household income has been separated into two components, the ‘Earned’ income and ‘Other’ income. ‘Earned’ income is the income earned from private employment sources for the Household Reference Person (HRP) and any partner, not including any income earned from savings. ‘Other’ income includes income from all the other components of the fuel poverty full income i.e. income from state benefits, income from any savings, any income from winter fuel payments, housing benefit, council tax benefit, income from any additional benefit units⁶ and a deduction for council tax. The method for calculating the adjustments applied to the two components are summarised in Table 3 and the actual rates applied are shown in Table 4.

⁵ In 2014-2015, eligibility for the core group was expanded to include those in receipt of Guarantee Credit and Savings Credit and between the ages of 65-74.

⁶ Note that in the 2008 Living in Wales survey, data from incomes from additional benefit units was not collected and was imputed using a ‘hot decking’ technique in order to calculate the fuel poverty incomes.

Table 3: Income adjustments applied to the 2008 Living in Wales data to project to 2016 levels

Data sources for fuel poverty income projections	
Estimated ' earned ' income for the HRP and any partner	Using data from the Annual Survey of Hours and Earnings (ASHE)⁷, Table 3.7a 'Annual pay - Gross (£) - For all employee jobs: United Kingdom', which includes a regional breakdown, the percentage change in the median income between April 2008 and April 2016 was determined for Wales. Separate factors were calculated from the change from 2008-2012, then annual changes until 2015. As the latest available published data is for April 2015, a projection was made to obtain the 2016 position. For the last 4 years the annual change in earned income has been stable at around 2%, therefore it was assumed to remain the same for 2015-2016.
Estimated ' other ' income	Significant changes have been made to the amounts, and types, of state benefits received since the original 2008 LiW survey, making it difficult to project the changes in 'other' income. State benefits have historically been uprated in line with prices using the Retail Price Index (RPI), until April 2011, then the Consumer Price Index (CPI) from April 2011 onwards. Increases in working-age benefits were limited to 1% for 3 years from April 2013, however a 'triple lock' is in place for the state pension which guarantees the state pension amount to increase by the highest of earnings, prices (CPI) or 2.5%. For these projections, the price indexed percentage change has been applied, with the relevant changes being obtained from the annual 'Benefit Up-rating' documents published by the House of Commons Library⁸.

3.7 The projected changes to both components of income differ to those used in the Fuel Poverty Tool as ASHE data up to 2012 has been used for this work. This was not available in time for the previous tool, for which the Average Weekly Earnings (AWE), Great Britain only, data was used.

⁷ ASHE data can be found on the Office for National Statistics website:

<http://www.ons.gov.uk/ons/rel/ashe/annual-survey-of-hours-and-earnings/index.html>

⁸ Available at <http://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN06172>

Table 4: Projected changes to the fuel poverty income components between 2008 and 2016

	2008-2012	2012-2013	2013-2014	2014-2015	2015-2016 (projected)
'Earned' income	+5.9%	+2.1%	+2.1%	+2.0%	+2.0%
'Other' income	+10.9%	+5.2%	+2.2%	+2.7%	+1.2%

Energy efficiency upgrades

- 3.8 Every household would have been effected by changes in fuel prices and incomes that have occurred since 2008 but only a proportion of households would have installed energy efficiency upgrades to their home e.g. cavity wall insulation or loft insulation. Quantifying the estimated effect of energy efficiency improvements in this time to the levels of fuel poverty has involved a three stages.
- 3.9 Firstly, an assessment of all the energy efficiency grant schemes available to Welsh households during the period 2008-2016 was carried out, to ascertain the types of energy efficiency measures installed. Over this time period there have been a succession of central Government funded energy efficiency programmes: CERT (Carbon Emissions Reduction Target) and CESP (Community Energy Saving Programme), followed by ECO (Energy Company Obligation). These programmes required certain gas and electricity suppliers to meet various carbon emission reduction obligations through the provision of a variety of energy efficiency measures in domestic properties. The programmes' administrator, Ofgem, reports regularly on the measures installed. There are also several subsidy schemes through which the UK Government has provided support to measures which reduce households' fuel costs: the Feed in Tariff (FIT) supports those generating their own electricity, predominantly through solar photovoltaic installations, the Renewable Heat Incentive (RHI) supports the installation of renewable heat technologies (ground and air source heat pumps, biomass and solar hot water systems). Energy efficiency improvements made through the Green Deal scheme are also relevant to this work.

3.10 In addition to the national funding streams, the Welsh Government has provided funding through three programmes: HEES (Home Energy Efficiency Scheme), ARBED, designed to bring environmental, social and economic benefits to Wales through the coordination of investment into the energy performance of Welsh homes⁹, and NEST, designed specifically to support low income households in fuel poverty through a package of free home energy improvement measures¹⁰. Data on the numbers and types of measures installed under ARBED and NEST have been provided by the Welsh Government for this work. Table 5 shows the timescales of the energy efficiency funding streams considered in this work.

Table 5 Timeline of energy efficiency funding schemes

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Government schemes									
<i>CERT</i>	Apr08-Dec12								
<i>CESP</i>		Oct09-Dec12							
<i>ECO</i>						ECO1 and ECO2			
<i>Green Deal</i>						Jan13-Jul15			
<i>FIT</i>			Apr10 onwards						
<i>RHI</i>		Legacy accreditations Jul09-Apr14					Apr14 onwards		
Welsh funding schemes									
<i>HEES</i>	Nov 2000-Mar11								
<i>Arbed2 ERDF</i>		Phase I Apr09-Apr12			Phase II May12-Jun15				
<i>Arbed (LA + RSL)</i>					2012 onwards				
<i>NEST</i>				Apr11-2017					
Background activity									

3.11 An assessment of the predominant types of energy efficiency upgrades installed under each scheme was made and eleven measures were selected to model for this work. These are listed in Table 6. It should be noted that less mainstream measures were applied by some funding streams, for example, voltage optimisers were installed in South Wales under the Arbed Phase 2 scheme, but

⁹ <http://gov.wales/topics/environmentcountryside/energy/efficiency/arbed/?lang=en>

¹⁰ <http://gov.wales/statistics-and-research/evaluation-nest-energy-efficiency-scheme/?lang=en>

due to modelling constraints the impact of these has not been quantified.

Table 6: Modelled energy efficiency improvement measures

	Description of the energy efficiency measure applied
Loft insulation (LI)	Applied 250mm of loft insulation to all pitched roofs with an accessible loft, or insulation at ceiling level where currently $\leq 150\text{mm}$ exists.
Cavity wall insulation (CWI)	Added insulation to all unfilled cavity walls and improved insulation levels to cavity walls that are only partly insulated. Assumed all walls post-1995 are insulated due to building regulations, even if reported as uninsulated.
Hot water cylinder insulation (HW)	If tank has a jacket with less than 80mm added a full 80mm on top of the existing jacket. If tank has foam insulation added 40mm of extra insulation. If tank has no foam or jacket then added an 80mm jacket.
Solid wall insulation (SWI)	Added insulation to all unfilled solid walls and improved insulation levels to solid walls that are only partly insulated. Assume all walls post-1996 are insulated due to building regulations, even if reported as uninsulated. Also included 'other' wall types as ECO funding now covers these.
Double glazing (DG)	Upgraded to full double glazing if currently less than 100%. All single glazed window areas replaced by double glazed windows.
Central heating installation (CH)	For room heaters and 'other' heaters: installed gas Central Heating to all dwellings on the gas network, installed air source heat pump if off the gas network.
Boiler upgrades	Applied to gas, oil and LPG boilers. Upgraded non-condensing boilers with a tank to condensing boilers. Upgraded non condensing boilers with no tank to condensing combi boilers. No fuel switch.
Fuel switching	Fuel switch non-gas central heating to gas if on the gas network. Fuel switch for dwellings not on the gas network. Switch to ASHP if boiler is not condensing. Fuel switch electric storage heaters to gas CH if on the gas network.
Air source heat pumps (ASHP)	See fuel switching and CH installation.
Solar hot water (SHW)	Installed solar hot water in houses or bungalow (not flats) where not already present.
Solar Photovoltaics (PV)	No solar PV recorded in in the LiW 2008 survey. Orientation information is not available in the LiW 2008 data. PV added to houses only, on front face unless not applicable.

- 3.12 The second stage of the process was to quantify the numbers of each measure installed per year. Detailed statistics published by DECC as part of its Green Deal and Energy Company Obligation (ECO) statistics¹¹ were used to derive the number of measures applied through the central Government funded programmes. 5% of the Great Britain total was assumed to have been installed in Wales (Table T1.11c) and the projected number of installations for September 2015 through to December 2016 was derived from a trend line¹² fitted to the previous two years of data.
- 3.13 The numbers of installations funded by the Arbed and NEST programmes were provided by the scheme managers. For both schemes, funding for some measures installed was also leveraged from ECO and therefore care had to be taken to avoid double counting the numbers of installations. For Arbed, only the measures installed using ERDF (European Regional Development Fund) funding were included in the assessment. For NEST, information provided by the Welsh Government suggested that 44% of installations leveraged ECO funding, therefore 56% of the installations recorded was included in this work.
- 3.14 Ofgem publishes detailed statistics on the solar PV installations via its Feed In Tariff (FIT) reporting and statistics (at the country level) for air source heat pumps (ASHP) and solar thermal hot water (SHW) systems via its Renewable Heat Incentive (RHI) quarterly reports. For both ASHP and SHW, a projection for the number of installations to the end of 2016 were derived assuming the same rate of installation recorded in the latest published figures (Q2 2015). For PV installations, a predicted rate of installation for 2016 was published by Ofgem for Great Britain, and 5% was assumed to occur in Wales.

¹¹ <https://www.gov.uk/government/statistics/green-deal-energy-company-obligation-eco-and-insulation-levels-in-great-britain-detailed-report-to-june-2015> (published Sept 2015) Tables T1.11c and T2.2A used.

¹² A linear trendline was fitted to the data for cavity wall insulations and a polynomial (order=2) trendline was fitted to the loft insulation and solid wall insulation data.

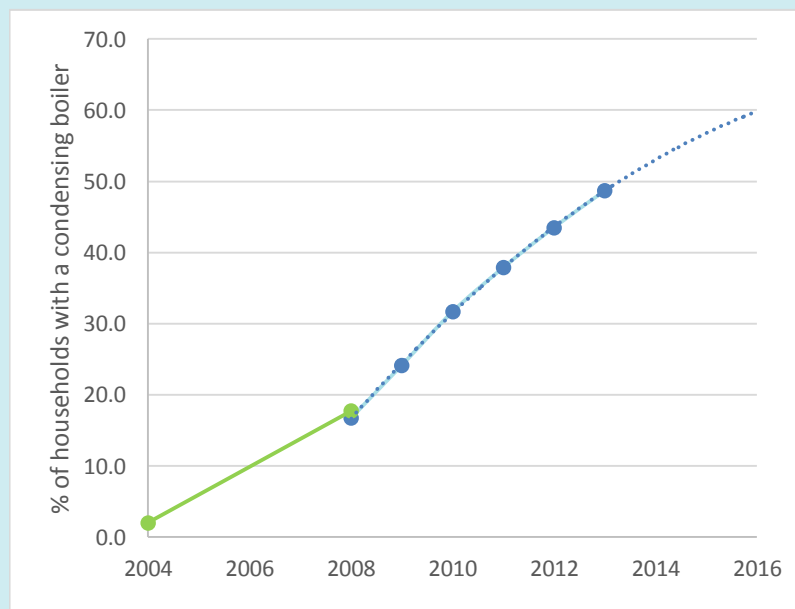
3.15 Alongside these funded schemes, for some energy efficiency improvements there is also a level of background activity, which is not particularly easy to estimate. For example there is a background level of new boiler installations, due to breakdown of older models, which is not necessarily done through a funding scheme. The installation of double glazing is also a measure which is not generally supported by any funding stream, but which is still carried out by homeowners for various reasons. To estimate this background activity, data from the English Housing Survey (EHS) has been used. Figure 2 shows an example of how the estimation of the background activity for condensing boiler upgrades has been carried out; a similar procedure was done for double glazing installations and hot water cylinder insulation.

Figure 2: Condensing boiler background activity

The most recent published data (2013) for the English Housing Survey reports that 49

% of dwellings in England have a condensing boiler. Projecting forwards to 2016, using a polynomial trendline, suggests that this figure will have risen to 60% of all dwellings in England. It is assumed that the same level of activity has occurred in Wales as has for England, therefore in 2016 it is estimated that there will be 783,000 dwellings with condensing boilers in Wales, based on a projected total number of dwellings of 1,309,309 (GOV live tables for house building completions). Figure 2 shows the trend in the percentage of dwellings with a condensing boiler in England and Wales.

Figure 2: Percentage of homes in England and Wales with a condensing boiler



- 3.16 The final stage in estimating effect of energy efficiency improvements was to derive targeting flags so that the measures described above could be applied to the relevant households. CERT required 40% of overall target to be achieved in the Priority Group (PG), defined as those in receipt of certain income-related benefits or those over 70 years of age. ECO has three main obligations, of which the Home Heating Cost Reduction Obligation (HHCRO) has a requirement to focus measures on vulnerable consumers on certain types of benefits. The eligibility criteria for the Arbed and NEST schemes were reviewed and data in the Living in Wales survey used to derive the flags. For Arbed, improvements were targeted at households in the most

deprived areas of Wales, living in 'Hard to Treat' homes (homes with solid or non-traditional walls or homes off the gas network) or having a low income. NEST funding was targeted at households in receipt of a means tested benefit (MTB) and living in a privately owned or rented home that has a SAP rating of less than 38.

3.17 Table 7 shows the numbers of energy efficiency measures estimated to have been installed to households in Wales in the years up to 2016, along with the derived household targeting flags used to apply the measures across the housing stock.

Table 7: Numbers of energy efficiency measures installed and the associated household targeting flags¹³

	<i>Eligibility flag</i>	2008-2012	<i>Eligibility flag</i>	2012-2013	2013-2014	2014-2015	2015-2016
LI	40% to PG	254,000	None	8,000	10,000	8,000	8,000
LI			NEST	370	370	370	0
LI			ArbedERDF	130	130	130	0
CWI	40% to PG	110,000	None	9,000	16,000	13,000	14,000
CWI			NEST	88	88	88	0
SWI	40% to PG	7,000	None	2,000	3,000	2,000	1,000
SWI			NEST	63	63	63	0
SWI			ArbedERDF	712	712	712	0
DG	None	100,000	None	27,021	26,021	24,021	22,000
HW insulation	None	101,600	None	25,002	2	2	0
CH		0	NEST	1,701	1,701	1,701	0
CH			ArbedERDF	460	460	460	0
Fuel Switch	40% to PG	1,339	ArbedERDF	144	144	144	0
Boiler upgrade	None	336,000	ECO_HHCRO	5,549	5,549	5,549	0
Boiler upgrade			None	433	433	433	0
Boiler upgrade			NEST	1,961	1,961	1,961	0
Boiler upgrade			ArbedERDF	134	134	134	0
Boiler upgrade			None	59,923	59,923	59,923	43,000
ASHP	None	282	None	282	166	248	273
SHW	Arbed	1,100	None	191	120	141	106
SHW			ArbedERDF	11	11	11	0
PV	None	23,176	None	6,289	5,636	6,299	8,430

¹³ To avoid double counting of certain measures, the numbers reported under the NEST and ARBED schemes do not represent the total number of measures installed under these funding streams as a proportion will have been included under the ECO funding stream, with the 'None' eligibility flag.

Simulating the projections

3.18 A Monte-Carlo method was used to simulate the application of energy efficiency improvements to the Welsh housing stock. The method is as follows:

- A LiW survey case (i.e. household) requiring loft insulation was selected at random in the dataset for improvement. Further cases were randomly selected until the required number of households (i.e. the total number of households reported/projected to have had loft insulation installed as reported in Table 7) had been assigned the improvement measure in the dataset. The same procedure was performed for all the energy efficiency improvement measures, accounting for any household targeting requirements where applicable.
- Once all of the identified improvement measures had been assigned, the energy consumption of the household was re-calculated where applicable to take into account the energy efficiency upgrades. The change in energy consumption for each household, for each energy efficiency measure independently, was calculated using the BREDEM 2012 energy model. For households in which several measures were installed, a combined energy savings factor, based on the relative savings from all the individual measures, was applied to the base energy consumption.
- The fuel poverty status for each case was re-calculated based upon the required year's projected incomes, fuel prices and projected energy consumption (incorporating the energy improvement upgrades) and an overall level of fuel poverty was determined.
- The procedure is repeated a specified number of times (5,000) to simulate the random application of the energy efficiency measures, with the average result of all the outcomes being taken as the best estimate of the fuel poverty statistic.

Caveats

- 3.19 It is important to note for the methodology described above, it was assumed that the number and make-up of the housing stock has not changed between 2008 and 2016 e.g. no account has been made for demolitions, new build, extensions etc. It was also assumed that the number and make-up of households has not changed between 2008 and 2016 e.g. that there has been no change in household composition, the employment status of individuals remained constant etc. The 2008 dwelling grossing factor was used for all analysis in this report.

4. Results

- 4.1 The estimated levels of fuel poverty for the years 2012, 2013, 2014 and 2015, along with a projected fuel poverty level for 2016, have been produced and national estimates of fuel poverty in all households, vulnerable households, and for households living in social housing, along with the predicted level of severe fuel poverty, are shown in Table 8 to Table 11.

National estimates of fuel poverty – all households

- 4.2 The combination of (moderately) rising household incomes, reduction in household energy consumption due to energy efficiency improvements, and decreasing gas and oil prices since 2014, have led to fuel poverty levels across all Welsh households decreasing since 2014 to a projected level of 23% in 2016.

Table 8: Projected number of households in fuel poverty, 2012 to 2016

	Number of households in fuel poverty (000s)	Percentage of households in fuel poverty (%)
2012	364	29
2013	351	28
2014	376	30
2015	305	24
2016	291	23

National estimates of severe fuel poverty

- 4.3 Severe fuel poverty is defined as any household having to spend more than 20% of household income on household fuel costs. The projected levels of severe fuel poverty remains broadly level between 2012 and 2014, followed by a decrease in 2015, resulting in a projected level of severe fuel poverty of 3% in 2016.

Table 9: Projected number of households in severe fuel poverty, 2012 to 2016

	Number of households in severe fuel poverty (000s)	Percentage of households in severe fuel poverty (%)
2012	64	5
2013	61	5
2014	63	5
2015	46	4
2016	43	3

National estimates of fuel poverty – vulnerable households

- 4.4 The definition of a vulnerable household has been widened by the Welsh Government to one with any member aged 60 years or over, with a child/young person **under the age of 25 years**¹⁴ or with any long-term limiting condition or disabled member. The estimated levels of fuel poverty in vulnerable households follows the same trend as for all households (vulnerable households comprise 84% of all households), with a broadly level rate of fuel poverty between 2012 and 2014, followed by a decrease to a projected 24% in 2016.

¹⁴ The definition of vulnerable used in the 2004 and 2008 fuel poverty estimates included households with a child/young person aged 16 or under.

Table 10: Projected number of vulnerable households in fuel poverty, 2012 to 2016

	Number of vulnerable households in fuel poverty (000s)	Percentage of vulnerable households in fuel poverty (%)
2012	328	31
2013	315	29
2014	337	32
2015	274	26
2016	261	24

National estimates of fuel poverty – social housing

- 4.5 The 2008 Living in Wales survey showed that 18% of households (224,000) live in social housing. The estimated levels of fuel poverty in households living in social housing follows the same trend as for all households. An estimated 12,000 households living in social housing are estimated to be removed from fuel poverty between 2012 and 2016.

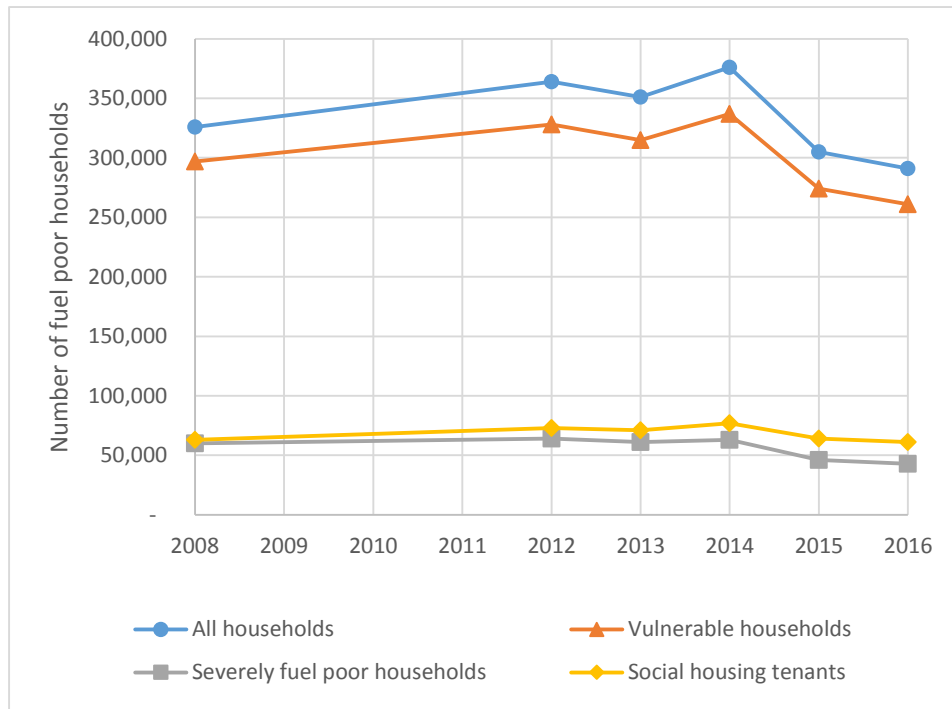
Table 11: Projected number of social housing tenants in fuel poverty, 2012 to 2016

	Number of social housing tenants in fuel poverty (000s)	Percentage of social housing tenants in fuel poverty (%)
2012	73	33
2013	71	32
2014	77	34
2015	64	28
2016	61	27

- 4.6 Figure 3 shows the timeline for the fuel poverty estimates for the different groups between 2004 and 2016. The 2004 and 2008 estimates are the published estimates derived from the respective

year's Living in Wales survey data, the projections for 2012 onwards are those developed in this work.

Figure 3: Timeline showing the change in the levels of fuel poverty for all households, vulnerable households, severely fuel poor households and households living in social housing



4.7 Including energy efficiency measures in these projections is important. The estimated fuel poverty levels in 2016 that would occur if no energy efficiency improvements had been made (i.e. only changes in incomes and fuel prices were implemented) are shown in Table 12. The impact of the energy efficiency measures has been to reduce the projected levels of fuel poverty in all households by approximately 80,000 households (6 percentage points) and to reduce the projected levels of fuel poverty in vulnerable households by approximately 73,000 households (7 percentage points).

Table 12: Projected number of fuel poor households in 2016 if energy efficiency measures were not implemented

Fuel Poverty levels, 2016	<i>Without</i> energy efficiency measures (income and fuel price changes only)		<i>With</i> energy efficiency measures	
	Number of fuel poor households (000s)	% of fuel poor households	Number of fuel poor households (000s)	% of fuel poor households
Fuel poor, all households	371	29	291	23
Severely fuel poor	60	5	43	3
Fuel poor in vulnerable group	334	31	261	24
Fuel poor in social housing	77	34	61	27

Validation of the model

Comparison of the results with the Wales Fuel Poverty Projection Tool 2012

- 4.8 A previous estimate of the numbers of households in fuel poverty was derived using the Wales Fuel Poverty Projection Tool 2012¹⁵. This tool, developed by BRE, used a slightly different methodology to simulate the application of energy efficiency measures into the stock, but was based on the BREDEM energy modelling methodology, albeit the previous version to the one used in this work. Additionally, the 2010 Welsh Government's Fuel Poverty Strategy re-defined the satisfactory heating regime – the updated version has been used in this work but was not used in the 2012 Projection Tool. Annex A provides an assessment of the different outcomes due to the BREDEM model update. Table 12 provides a comparison of the projected number of households in fuel poverty in 2012 as calculated by the two methods.

¹⁵ See <http://gov.wales/statistics-and-research/wales-fuel-poverty-projection-tool/?lang=en>

4.9 It can be seen that the estimated levels of fuel poverty in all households at 2012 are slightly lower in this work than those predicted by the 2012 Projection Tool. This arises from a combination of the methodological changes discussed above, but it is also likely that some of the reduction is explained by an improved targeting of the energy efficiency measures to the stock, to households more at risk of fuel poverty.

Table 13: Comparison of the projected number of households in fuel poverty at 2012

	Wales Fuel Poverty Projection Tool 2012	Current model
	Number and percentage in fuel poverty @ 2012	Number and percentage in fuel poverty @ 2012
All households	386,000 (30%)	364,000 (29%)
Vulnerable households	328,000 (33%)	328,000 (31%)
Social housing tenants	70,000 (31%)	73,000 (33%)

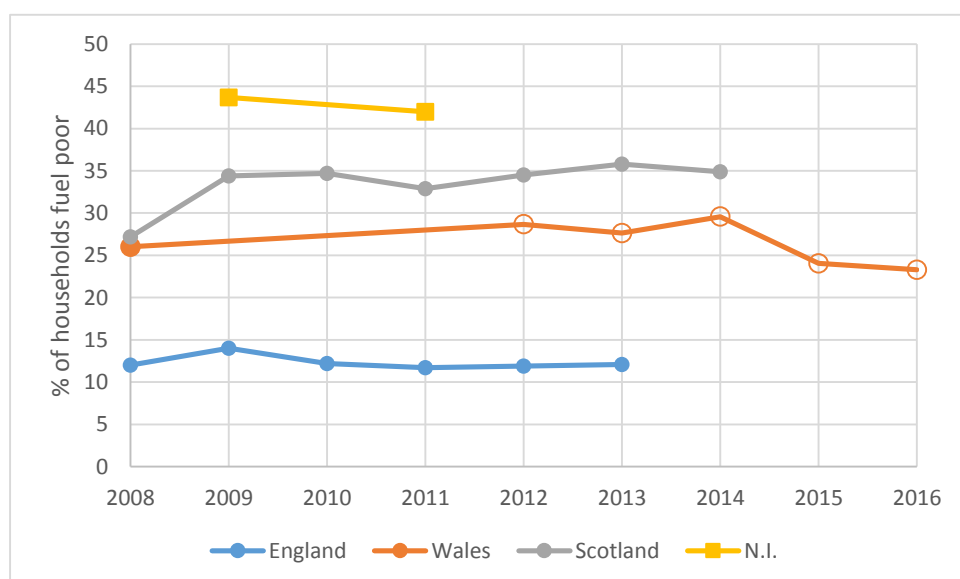
National comparisons

4.10 Figure 4 shows the percentage of households in fuel poverty (10% indicator) for each country in the UK¹⁶. The projected Welsh fuel poverty levels for 2012 to 2016 are shown in open circles, all other figures are taken from data published by the respective governments¹⁷. It can be seen that Wales has the second lowest level of fuel poor households in the four nations after England.

¹⁶ Fuel poverty in England is now measured by the Low Income High Costs indicator, however data to enable the calculation of the 10% indicator are still published to enable comparison between nations.

¹⁷ Scottish Government, 2015. Scottish House Condition Survey: 2014 Key Findings. The 10% fuel poverty indicator for England is available from the UK Data Archive. Northern Ireland Housing Executive, Northern Ireland House Condition Survey, 2001 to 2011.

Figure 4: National comparisons of the percentage of households in fuel poverty in the UK

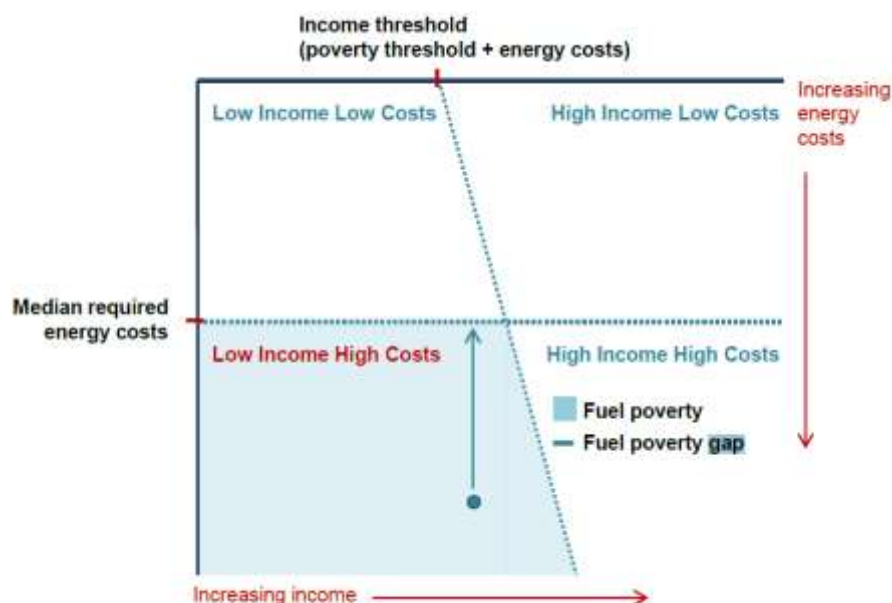


Fuel Poverty in Wales under Low Income High Costs.

4.11 Under the Low Income High Costs (LIHC) definition of fuel poverty, a household is considered to be fuel poor if they have required fuel costs that are above average (the national median level) and, were they to spend that amount, they would be left with a residual income below the official poverty line (shown by the shaded area in bottom left hand quadrant in Figure 5). Unlike the 10% indicator, the LIHC indicator is a relative measure as it compares households to the national median bill and income¹⁸. The LIHC definition results in a lower number of households being classed as fuel poor because to be so, they have to have both high energy costs and low incomes relative to the stock.

¹⁸ See DECC 'Annual Fuel Poverty Statistics Report, 2015' for further information on the LIHC definition. Access at <https://www.gov.uk/government/collections/fuel-poverty-statistics>

Figure 5: Fuel poverty under the Low Income High Cost indicator



Source: Figure extracted from the Annual Fuel Poverty Statistics Report, 2015, DECC.

4.12 Table 14 shows the number of all households, vulnerable households and social housing tenants projected to be in fuel poverty under the LIHC definition. For comparison, the latest published data for England shows that in 2013, 10.4% of all households were estimated to be fuel poor under this definition¹⁷.

Table 14: Projected number of households in fuel poverty under the LIHC definition, 2012-2016.

	Number of households in fuel poverty (000s) and (%)	Number of vulnerable households in fuel poverty (000s) and (%)	Number of social housing tenants in fuel poverty (000s) and (%)
2012	141 (11%)	129 (12%)	27 (12%)
2013	140 (11%)	129 (12%)	29 (13%)
2014	137 (11%)	127 (12%)	28 (12%)
2015	128 (10%)	119 (11%)	28 (12%)
2016	132 (10%)	123 (12%)	27 (12%)

4.13 The LIHC indicator comprises a second indicator relating to the *depth* of fuel poverty amongst fuel poor households, measured through a fuel poverty gap which represents the difference between the required fuel costs for each household and the median required fuel costs (shown by the vertical arrow in Figure 5). The fuel poverty gap for each individual household is then aggregated across all fuel poor households to produce an overall aggregate fuel poverty gap which gives a sense of the depth of fuel poverty on a national level. The aggregate and average fuel poverty gap across all fuel poor households for the years 2012 to 2016 are shown in Table 15.

Table 15: Projected aggregate and average fuel poverty gap for households in fuel poverty in Wales, 2012-2016.

	Aggregate fuel poverty gap (£ million)	Average fuel poverty gap (£)
2012	78	552
2013	79	562
2014	71	520
2015	58	455
2016	60	455

5. Local Area Fuel Poverty Estimates

Introduction

5.1 To supplement the updated 2015 estimates of fuel poverty levels in Wales, further modelling was undertaken to produce estimated fuel poverty data at local area level. This used additional data sources alongside the Living in Wales 2008 data to model the proportion of fuel poor households at Lower Super Output Area (LSOA) and Local Authority level. The results have been presented in a separate database, whilst this report gives a brief outline of the estimated local authority results.

Modelling summary

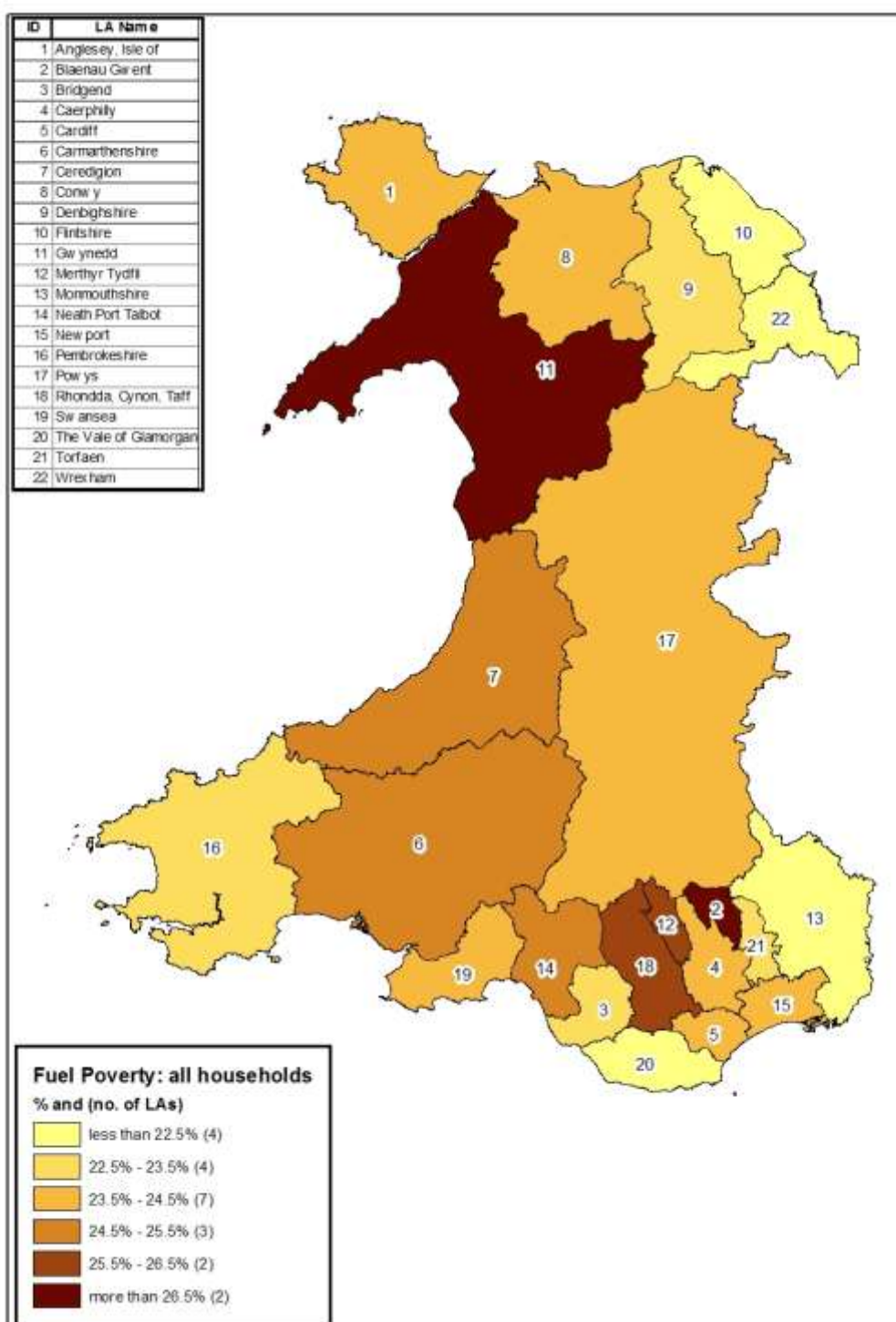
- 5.2 The local area fuel poverty model was based on national data drawn from the Living in Wales 2008 dataset. Application of the model requires specific local area data on a variety of demographic factors drawn from detailed datasets produced by Experian, and aggregate data from the 2011 Census.
- 5.3 The model was created in SPSS and used multiple regression analysis on a range of demographic variables, to select those which were statistically most useful in predicting whether a particular case was fuel poor. Those selected (see section 5.6) formed the final model which was applied at a dwelling level before being aggregated to Census Output Area (COA) level using household totals from the 2011 Census. The fuel poor and household totals were then benchmarked and adjusted to reflect the 2015 national fuel poverty figures presented in the main report¹⁹. Finally, the data were aggregated to LSOA and Local Authority levels.

Local Authority results

- 5.4 The Local Authority level results have been displayed in Figure 6, with each Local Authority coloured to reflect the average proportion of fuel poverty in that area. Lighter colours indicate lower overall fuel poverty proportions and darker colours show higher proportions. The values in brackets give the number of Local Authorities in each category.

¹⁹ 'The Production of Estimated Levels of Fuel Poverty in Wales: 2012-2016'.

Figure 6: Proportion of households in fuel poverty (10% definition), by local authority, 2015



5.5 We can see that the highest number of Local Authorities were found in the 24% category, reflecting the overall 2015 national estimate. The highest proportion of fuel poverty (above 26% fuel poor) can be found

in Gwynedd in the north and concentrated in the south around Merthyr Tydfil, Rhondda and Blaenau Gwent. The lowest proportions were found in the far north-eastern and south eastern areas. Local Authorities containing cities such as Cardiff, Swansea and Newport fall in the middle of the range of percentages, however a closer examination of the accompanying database shows a wide range of estimated fuel poverty at LSOA levels. For example, the proportions of fuel poor in the Cardiff LSOAs range from 12% to 44%.

Model inputs

5.6 The key input variables²⁰ to the local area fuel poverty model were:

- Household type, categorised into:
 - Couples with no dependent children; couples with dependent children; lone parents; single females; single males; other multi-person households.
- Dwelling age, categorised into:
 - Homes built pre-1919; homes built between 1919 and 1944; homes built between 1945 and 1980; homes built post-1980.
- Typical property type for each postcode, categorised into:
 - Detached houses; semi-detached houses; bungalows; terraced houses; flats.

5.7 Other variables were also subjected to the regression analysis but discarded from the final model including the following postcode dominant demographics:

- Tenure; number of bedrooms; property value; household composition; financial stress on the household and household affluence.

²⁰ The variables were drawn from the 2015 Experian Marketing Services UK Household Database and the 2011 Census aggregate data.

Annex A

Wales 2008 “baseline” fuel poverty statistics

The fuel poverty statistics reported for Wales in 2008 were calculated by BRE, following the official Fuel Poverty Methodology, using the BREDEM 12 model to calculate the energy consumption for each surveyed dwelling. The definition of a vulnerable household was a household with a member aged 60 years or over, with any children aged under 16 or with any long-term sick or disabled member. The resulting estimates, using the fuel poverty full income definition are shown in line 1 of Table 16.

The fuel poverty calculation methodology is under continuous review and has evolved since the original calculations. A major change has been to update to the energy consumption methodology to use the BREDEM 2012 energy model. The 2008 LiW survey data was re-run through the new model and the resulting estimates, using the original income and fuel prices, are shown in line 2 of Table 16.

The Welsh Government now defines a vulnerable household as one with any member aged 60 years or over, with a child/young person **under the age of 25 years** or with any long-term limiting condition or disabled member. The fuel poverty statistics, using the BREDEM 2012 energy model, recalculated for the change in definition of vulnerability are shown in line 3 of Table 16.

In addition, the Welsh Government’s Fuel Poverty Strategy, published in 2010, re-defines the ‘satisfactory heating regime’ as being 23°C for the living room and 18°C in other rooms, to be achieved for 16 hours in every 24 for households with older people or people with disabilities or chronic illness. All other households used a heating regime of 21°C in the living room and 18°C in other rooms, for a period of 9 hours in every 24 (or 16 in 24 over the weekend). The published 2008 fuel poverty statistics were calculated using a heating regime of 21°C in the living room and 18°C in other rooms, for a period of 9 hours in every 24 (or 16 in 24 over the weekend) for all

households. The 2008 fuel poverty statistics have been recalculated (using the BREDEM 2012 model), using the updated definition of vulnerable households and are shown in line 4 of Table 16.

Table 16: Impact of methodological changes to the 2008 baseline fuel poverty statistics

		Number of households in fuel poverty	Number of vulnerable households in fuel poverty	Number of households in severe fuel poverty
1	Published 2008 fuel poverty statistics	332,000 (26% of all households)	285,000 (29% of all vulnerable households)	60,000 (5% of all households)
2	2008 data using updated BREDEM 2012 energy consumption model	300,000 (24% of all households)	259,000 (26% of all vulnerable households)	52,000 (4% of all households)
3	2008 data using updated BREDEM 2012 energy consumption model, with the updated definition of 'vulnerable' household		272,000 (26% of all vulnerable households)	
4	2008 data using updated BREDEM 2012 energy consumption model, updated definition of 'vulnerable' household, and updated heating regime	326,000 (26% of all households).	297,000 (28% of all vulnerable households).	60,000 (5% of all households).

Summary of changes to the BREDEM-2012 model²¹ – extracted from DECC's Annual Fuel Poverty Statistics Reports, 2014 and 2015.

The key methodological updates from the BREDEM-2012 model include:

- An update to the climate data
- Alterations to the calculation and effect of energy gains
- Changes to the cooking, lights and appliances algorithms
- Introduction of the provision for electric showers
- Updates to the hot water energy requirement and loss calculations.

The adoption of BREDEM-2012 is estimated to produce a slight reduction in the overall energy consumption for the average household. Space heating requirements are likely to reduce slightly as outdoor temperatures are revised to show an increase of 1°C – resulting in less heat loss through the thermal fabric of properties. Conversely, energy use for lights and appliances now show a slight increase, as each of the key elements within this category is now individually modelled.

The key methodological updates which affect the calculation of the fuel poverty statistics include:

- A change to the calculation of the inter-zone heat transfer coefficient
- Small reduction in the energy content of heated water
- Alteration to the procedure for calculating the water heating efficiency from a central heating boiler
- Small reduction in heat gains produced by warm air heating system pumps.

These changes are estimated to produce a small reduction in the overall energy consumption for the average household. Households classed as under-occupying (few occupants in a large dwelling) are most affected because of the change to the inter-zone heat transfer coefficient, which controls the heat loss from living room to unheated parts of the dwelling.

²¹ Extracted from the Annual Fuel Poverty Statistics Reports, 2014 and 2015 published by the Department of Energy and Climate Change (DECC). Accessed at <https://www.gov.uk/government/collections/fuel-poverty-statistics>