



Department for  
Energy Security  
& Net Zero



## Fuel Poverty Methodology Handbook (Low Income Low Energy Efficiency)

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Statistical Methodology

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# 1. Introduction

This methodology handbook is a guide for all users of the Department for Energy Security & Net Zero (DESNZ) fuel poverty statistics. Within it, the user will find descriptions of the methodology used to calculate the 2023 fuel poverty estimates for England under the Low Income Low Energy Efficiency (LILEE) indicator and the yearly fuel poverty time series produced back to 2010. Information on the fuel poverty datasets available and where to find them is also included in Section 8.

Users should note that the detailed methodological descriptions found from Chapter 2 onwards relate to the English fuel poverty statistics only (information on the other devolved nations are provided in Section 1.3).

This document sets out the measurement of fuel poverty under the Low Income Low Energy Efficiency metric as set out in [Sustainable warmth: protecting vulnerable households in England strategy](#) published on 11 February 2021. Further documentation outlining the methodology for calculating the Fuel Poverty Energy Efficiency Rating (FPEER) is published [here](#).

## 1.1 What is fuel poverty

The metric for Fuel poverty in England is the Low Income Low Energy Efficiency (LILEE) indicator. A household is considered to be fuel poor if it meets two key criteria:

- i) Low energy efficiency. This includes all households with a Fuel Poverty Energy Efficiency Rating (FPEER) of band D or below
- ii) Low income. This includes all households whose residual household income would be below the official poverty line if they were to spend their modelled energy costs

The LILEE definition is a relative indicator with regards to income but an absolute measure regarding energy efficiency.

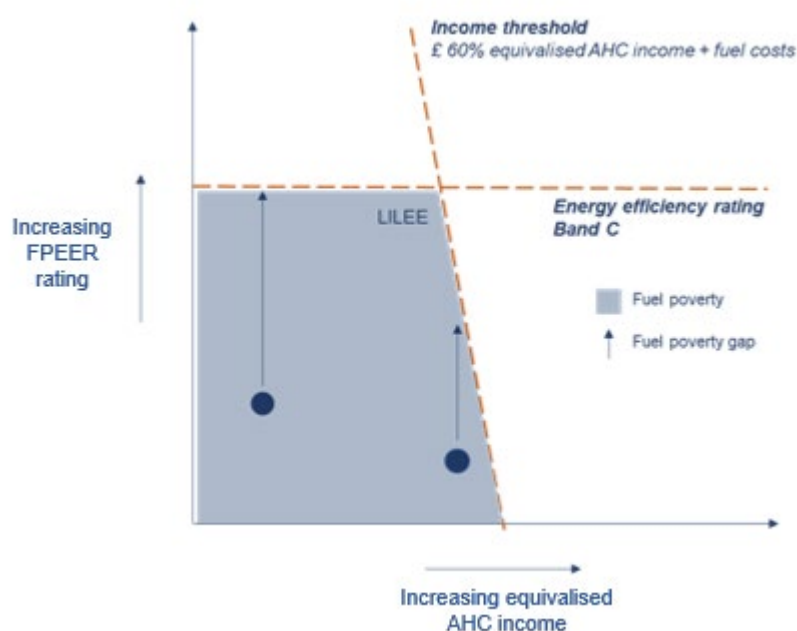
The LILEE indicator is a *dual* indicator which estimates both:

- i) The number of households that have both low incomes and low energy efficiency (shown by the shaded area in the bottom left-hand quadrant in Figure 1)

- ii) The depth of fuel poverty among these fuel poor households. This is measured through a fuel poverty gap (shown by the vertical arrows in Figure 1), which represents the difference between the required fuel costs for each household and the nearest fuel poverty threshold.

For a detailed explanation of how to calculate the Low Income Low Energy Efficiency indicator, see Chapter 6.

**Figure 1: Fuel poverty under the Low Income Low Energy Efficiency indicator**



There are three key elements which determine whether a household is fuel poor under LILEE:

- Household income (after housing costs);
- Fuel Poverty Energy Efficiency Rating (FPEER) (in addition to building energy performance factors this is adjusted for direct energy cost interventions, e.g., Warm Home Discount); and
- Fuel costs.

### Household Income After Housing Costs (AHC income)

Household income after housing costs includes income from employment, benefits, government income support or other sources such as rental income for each member of the household. Housing costs which include rent or mortgage payments are deducted from this to calculate a household's AHC income. Data are collected from the English Housing Survey (EHS). Where data are missing, it is modelled where appropriate to a plausible

value. A more detailed explanation for how AHC income is calculated can be found in Chapter 3.

### **Fuel Poverty Energy Efficiency Rating (FPEER)**

The Fuel Poverty Energy Efficiency Rating is based primarily on the Government's [Standard Assessment Procedure](#) (SAP) for assessing the energy performance of domestic properties. Building on SAP, the FPEER methodology also accounts for the impact of policy interventions that directly affect household energy costs (e.g. Warm Home Discount). In the same way as SAP, the methodology generates an energy efficiency rating from 0 (lowest) to 100 (highest). This rating is then translated into an energy efficiency 'Band' from G (lowest) to A (highest). This is analogous to the SAP rating methodology which is used to generate an overall energy efficiency Band (also from G to A) for Energy Performance Certificates. A house is considered to be fuel poor if it has a FPEER rating of D or below and is classified as low income. Further details regarding FPEER can be found in the [Fuel Poverty Energy Efficiency Rating Methodology handbook](#).

### **Fuel Costs**

The cost of energy is modelled using a fuel poverty specific version of the [BRE Domestic Energy Model](#) (BREDEM) rather than basing fuel costs on actual household spending. BREDEM combines the fuel requirements of the household with corresponding fuel prices. These costs capture four areas of energy requirements:

- Space heating;
- Water heating;
- Lights and appliances; and
- Cooking.

The modelling ensures that the household achieves the adequate level of warmth (as set out in the definition of fuel poverty and explained in more detail in Section 5.7), subject to a range of characteristics concerning the dwelling and its occupants. The household energy requirements are modelled based on several factors including:

- The size of the property;
- The number of people who live in the dwelling and their occupancy pattern;
- The energy efficiency of the dwelling; and
- The mix of different fuels used by each household.

It is important that calculations use a modelled energy consumption, as fuel poverty is a measure of whether a household is able to afford to heat their home to an adequate level. This recognises that by their nature those households assessed as being fuel poor may in reality actively limit their energy use (for example, by reducing the temperature their home is heated to) due to the cost.

## 1.2 What are the uses of fuel poverty statistics?

Fuel poverty data has a wide range of uses both within and outside of Government. As well as being used to track objectives against targets, it is used to help develop, focus and target policies. Whilst it is not possible to use the dataset to identify individual and specific households that are in fuel poverty, within Government it is used to provide an understanding of the demography and geography of the fuel poor, and to indicate which groups are particularly susceptible to fuel poverty.

In addition, the wider English Housing Survey (EHS) dataset can provide detail around the heating and energy requirement of different types of households and homes. This information can be used to form an understanding of the role and impact of energy efficiency measures on fuel poverty and help to target policies to improve the energy efficiency of the housing stock.

Detailed demographic and dwelling-level splits of fuel poverty in England are available for users, published as part of the [annual fuel poverty reporting](#). In addition to the current year figures, a workbook showing [long term trends in fuel poverty](#) amongst different types of households is updated and published annually. A set of Detailed Tables for 2010-2023 and Trends Tables for those years are available on a consistent basis using the LILEE metric.

DESNZ also publish the full fuel poverty dataset each year at the household level. This is made available from the [UK Data Service](#) after the full EHS datasets are made available. This is helpful for users who want to extend their analysis of fuel poverty.

DESNZ continues to meet user requirements for sub-regional estimates of fuel poverty. This data is used particularly by local authorities, who combine this data with information they hold themselves to help target schemes at a local level. Annual [sub-regional fuel poverty data](#) are only available on a LILEE basis since 2019. Estimates for 2022 will be published on 25 April 2024.

## 1.3 Why are fuel poverty statistics reported separately for England, Wales, Scotland and Northern Ireland?

Fuel poverty is a devolved matter, with each separate administration having individual policy targets, measurement and outputs. The main reason for the devolution is that the separate administrations have the power to affect certain aspects of fuel poverty policies (such as energy efficiency programs), but not others (such as incomes and market conditions, which impact fuel prices). As a result, different indicators of fuel poverty are used that are based on different methodological assumptions.

Fuel poverty in Wales, Scotland and Northern Ireland is currently calculated using 10% indicators, as opposed to the LILEE indicator in England, to determine the proportion of fuel poor in these nations.

Under the 10% indicator, a household is considered to be fuel poor if it is required to spend more than 10% of its income on fuel, to maintain an adequate standard of warmth. The fuel poverty ratio, used under this method, is defined as:

$$\text{Fuel Poverty Ratio} = (\text{Modelled fuel costs (i.e. modelled consumption} \times \text{price)}) / \text{Income}$$

Where this ratio has a value greater than 0.1 (10%), the household is considered to be fuel poor.

The 10% definition of fuel poverty was previously used to calculate the fuel poverty statistics in England, from 2001 - 2011. In 2012, an [independent review was published by Professor John Hills](#) which recommended a new method to calculate fuel poverty, with separate indicators to calculate both the extent and depth of fuel poverty. This was the LIHC method which was used from 2013 but was replaced with LILEE in 2021 as the measure of fuel poverty in England.

The underlying assumptions used in the modelling of fuel poverty statistics varies for each country, as detailed below.

- In England fuel poverty is now modelled from the English Housing Survey (EHS) using the LILEE indicator, and this document explains the methodology underpinning the English calculation.
- In Scotland, the Scottish Housing Survey is used to model fuel poverty. The most recent statistics measure fuel poverty according to the definition set out in the Scottish Fuel Poverty Statement 2002 using a 10% indicator. The underlying assumptions to calculate theoretical energy consumption are similar to those used in England. The main differences in the Scottish definition are alternative interpretations of:
  - a satisfactory heating regime for pensioners, long-term sick and disabled households;
  - the adequate standard of warmth is achieved at a higher temperature for these groups (23°C compared with English 21°C); and
  - a different approach to under-occupancy.
- The [Fuel Poverty \(Targets, Definition and Strategy\) \(Scotland\) Act 2019](#), which received Royal Assent on 18th July 2019, includes a new definition of fuel poverty in Scotland based on advice from an independent panel of experts and further



scrutiny and amendment by the Scottish Parliament. Please see Annex C in the main [fuel poverty report](#) for further detail on the new definition.

- The Welsh Housing Conditions Survey is used to estimate fuel poverty in Wales under a 10% measure. Figures for Wales are also updated less frequently, as the fuel poverty module of questions are not asked every year. [The most recent estimates of fuel poverty in Wales](#) are measured using the Welsh Housing Conditions Survey 2017-18.
- The last Housing Condition Survey for Northern Ireland was run in 2016. [Fuel poverty statistics](#) were produced using both a 10% and LIHC definition and published in 2023. It should be noted that Northern Ireland has no statutory requirement relating to fuel poverty.

As a result of both definition and methodological differences in fuel poverty for each devolved nation, the figures are non-additive (i.e. cannot be combined) in relation to a UK total. The latest fuel poverty figures for each of the devolved nations can be found at Annex C in the annual [fuel poverty report](#). More details of the devolved surveys and fuel poverty in each of the nations can be found at the links below.

**Scotland:**

<https://www.gov.scot/publications/scottish-house-condition-survey-2021-key-findings/>

**Wales:**

<https://gov.wales/fuel-poverty-estimates-wales>

**Northern Ireland:**

<https://www.nihe.gov.uk/Working-With-Us/Research/House-Condition-Survey>

## 2. What are the key data sources for modelling fuel poverty?

### 2.1 The English Housing Survey

The source of data for housing and the household members, essential for estimating fuel poverty figures under the LILEE definition of fuel poverty, is the English Housing Survey (EHS). The EHS is currently an annual survey commissioned by the Department for Levelling Up, Housing & Communities (DLUHC). For the purposes of producing the fuel poverty statistics, two years of the survey are combined. The EHS data collected April 2021 to March 2022 (21-22 single year dataset) is combined with the data collected April 2022 to March 2023 (22-23 single year dataset) in order to produce the fuel poverty dataset used to estimate 2022 fuel poverty figures.

In the fuel poverty annual statistics published in 2024, new figures have been published for 2022, 2023 and 2024. The 2022 revised data are taken directly from the detailed modelling described in section 3-5 of this handbook using the EHS data and energy prices for that period. The headline figure in the 2024 report is for 2023 which represents a one-year ahead projection from the 2022 EHS data. The methodology used for the one and two-year ahead projections is described in section 7. While the methodology for both projected years is very similar, the one-year ahead projection is considered more robust as the projections drivers are largely based on observed or announced data, for example the energy price cap.

The EHS covers all tenures and includes a household interview and a physical inspection of properties by a surveyor. The information obtained through the survey provides an accurate picture of the type and condition of housing in England, the people living there, and their views on housing and their neighbourhoods. The survey is a random sample of housing and householders in England. The sample is clustered, with half of England being sampled each survey year, meaning that two consecutive years of the survey provide a national sample, which is what is used to derive the fuel poverty statistics.

The two key components of the EHS used in the estimation of fuel poverty are:

- Interview Survey: An interview is conducted with the householder. The interview covers a wide range of topics that include household characteristics, satisfaction

with the home and the area, disability and adaptations to the home, and income. Currently, each year around 13,300 interviews are conducted with householders<sup>1</sup>.

- Physical Survey: around 6,200 dwellings (approximately 6,000 households and 200 vacant properties<sup>2</sup>) have a follow-up physical survey of their dwelling.

Fuel poverty calculations use paired sample data, where both a physical and interview survey have been conducted on the same property. Vacant properties are not included in fuel poverty calculations as these are not classed as households.

Further information for users of the English Housing Survey datasets include: technical advice notes for the [EHS](#), the [EHS headline reports and survey forms](#), and the different levels of access for the EHS datasets that are available from the [UK Data Service](#). Analysts who use the EHS data are recommended to use derived files where required variables exist, as these data are validated and reconciled with other data across the survey and are without missing values.

### Calculating the main components of fuel poverty

Most of the information used to calculate the main components of fuel poverty (income, energy prices and energy requirements) can be obtained from the interview and physical EHS surveys:

#### Income

- The EHS interview survey collects detailed information about the income of the Household Reference Person (HRP)<sup>3</sup> and any partner from different sources (wages, pensions, benefits, savings and investments, and other sources, e.g. rent from property).
- Less detailed income information is collected on behalf of other household members aged over 16 (who are not the HRP or partner).
- The EHS interview survey also collects information on housing related benefits and Council Tax support, Mortgage Payment Protection Insurance (MPPI) and housing costs (rent and mortgage payments).

#### Energy prices

The EHS interview survey collects information on the method of payment of gas and electricity, and the household's location in the country. This is combined with average fuel

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<sup>1</sup> Since the 2020/21 survey year the achieved sample size for the interview survey been lower than this due to ongoing impacts of the COVID-19 pandemic. This has also resulted in a smaller sample size for the physical survey.

<sup>2</sup> In the 2020/21 survey no vacant properties were surveyed because of changes in the survey methodology due to the COVID-19 pandemic.

<sup>3</sup> The Household Reference Person (HRP) is the person in whose name the dwelling is owned or rented or who is otherwise responsible for the accommodation. In the case of joint owners or tenants, the person with the highest income is taken as the HRP. Where incomes are equal, the older occupant is taken as the HRP.

price data from DESNZ and other sources, as well as price regional variations to estimate the energy bills for each household (see section 4.2).

### Energy requirements

Data on the occupancy characteristics and region, is provided by the interview survey. The physical survey then provides information about the physical characteristics of the home, which are used to inform the modelling of household energy use for fuel poverty, including:

- Detailed information about the dimensions
- Dwelling type and age
- Heating and hot water systems
- Dwelling fabric and exposure/shading
- Energy efficiency measures

Further information required for the modelling of fuel poverty is obtained from other data sources. These are detailed in section 2.2 below, and within the chapters for each component of fuel poverty.

## 2.2 Energy price information

Fuel prices used in the modelling of fuel poverty are produced using information gathered from a variety of external sources, as the EHS does not collect detailed information on energy suppliers and tariffs. Details of these sources are given below:

- [The Quarterly Energy Prices publication](#) is used to provide the average annual fuel prices for mains gas and electricity. From the 2021-22 EHS survey year onwards the methodology was altered to use prices based on the financial year (i.e. April – March instead of January - December) to align the prices more closely with the survey period. Specifically, the prices are published within the following DESNZ published tables:
  1. Average variable unit costs and fixed costs for electricity for UK regions (QEP 2.2.4); and,
  2. Average variable unit cost and fixed cost for gas for regions in Great Britain (QEP 2.3.4).

The quarterly survey used to produce the tables for this official statistical<sup>4</sup> publication covers around 90 per cent of the energy suppliers and records specific details of the price of each tariff, and the number of customers on each tariff in each region of the UK, splitting this by payment type. DESNZ then makes assumptions for the proportion of the market that is not surveyed in order to produce an estimate

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<sup>4</sup> See Chapter 10

of the entire energy market. Prices take the form of unit costs, fixed costs and any discounts that are given (e.g. discount for paperless billing).

- [The Consumer Price Index](#) (CPI), published by the ONS, is used to obtain fuel prices for heating oil and smokeless fuels. The prices are collected monthly and split regionally. Coal prices are estimated from prices of smokeless fuel.
- [The Sutherland Tables](#) provide fuel price data for Liquefied Petroleum Gas (LPG) and bottled gas. Fuel prices from the Sutherland Tables are available quarterly and are split regionally to show comparative heating costs across the UK. The prices are converted to p/kWh using the calorific values from the [Digest of UK Energy Statistics \(DUKES\)](#).
- Finally, [SAP 2012 fuel prices](#) (from the Government's Standard Assessment Procedure for the energy rating of dwellings) are used for other fuels and tariffs (where their use is relatively minor), including biofuels, communal heating, and Economy 10 and 24 electricity tariffs. These prices are then inflated to the survey year using the CPI.

The fuel prices are used in conjunction with the predicted energy consumptions for space heating, water heating, lighting, appliances and cooking to determine the fuel costs for each household.

## 3. How is household income modelled?

This chapter details the income methodology used for LILEE, including the calculation of the final fuel poverty income variables, validation of income, and changes in the income methodology. A list of the acronyms used in the description of the income methodology can be found in Chapter 12. The household income is combined with fuel costs to determine whether a household falls under the income threshold in the calculation of the LILEE indicator.

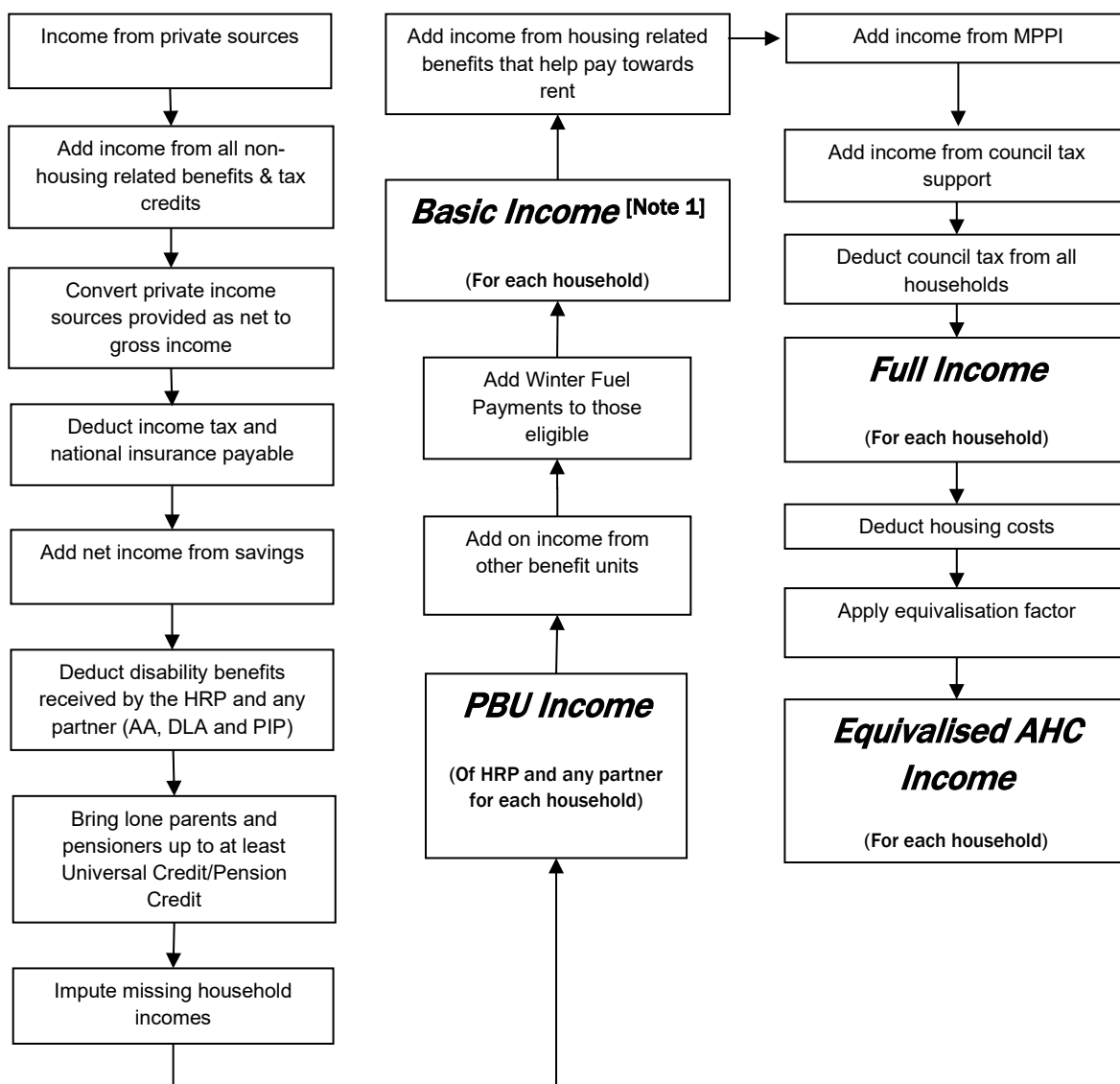
### 3.1 Overview

The equivalised After Housing Costs (AHC) income is used to define the number of households living in fuel poverty under the LILEE indicator and calculate the fuel poverty gap. It is produced by:

- Adding the personal incomes of the Household Reference Person (HRP) and any partner together, plus any benefit payments received by the HRP and any partner (from private sources, state benefits, and savings) to provide the 'Primary Benefit Unit (PBU) income'. Benefit payments made specifically to the HRP and any partner to cover the additional costs of living with a disability including Disability Living Allowance (DLA), Personal Independence Payments (PIP), and Attendance Allowance (AA) are excluded from the household income.
- Income from independent children and other adult members of the household, known as Other Benefit Units (OBU), and the Winter Fuel Payment (WFP), if applicable, is then added to give the household 'Basic income'. For 2022/23, the basic income also accounts for government income support packages, which include the means tested Cost of Living Payment paid to households on a low income benefit/tax credit (a payment of £650 in 2022/23) and the pensioner Cost of Living Payment paid to households entitled to Winter Fuel Payment (a payment of £300 for winter 2022/23).
- Addition of income related directly to housing, including housing related benefits (HB), Mortgage Payment Protection Insurance (MPPI), Council Tax Support (CTS), and the deduction of Council Tax payable. This is referred to as the household 'Full income'.
- Deduction of housing costs (total mortgage repayments and net rent payments).
- The division by the relevant income equivalisation factor (see Table 11) to reflect the fact that different households have different spending requirements. This creates the final 'Equivalised AHC income'.

The EHS interview survey collects detailed information about income sources for the PBU, and less detailed income information for the OBU. Figure 2 outlines the main steps involved in this process and the sections to follow, detail the procedures involved in each step.

**Figure 2: The main steps in calculating equivalised AHC income**



[Note 1] For 2022/23, the basic income also accounts for government income support packages.

### 3.2 Missing data

The Computer Assisted Personal Interviewing (CAPI) used to conduct the EHS interview survey contains many ‘soft checks’ to clarify values with the householder where extreme amounts are initially provided, particularly around state benefits/allowances and tax

credits<sup>5</sup>. Thus, the EHS income calculation method assumes that the details given by the respondent are correct unless there is a strong reason to suggest otherwise. Such cases are assessed on a case-by-case basis. If income amounts from individual income sources provided are deemed implausible, a method of imputation is required for these cases, and (more commonly) for cases where information on income sources/amounts is either refused or unknown. Within the 2022 combined year fuel poverty dataset, just over three-fifths of the cases (60.3 per cent) had no imputations for the Primary Benefit Unit (PBU) income data. Of the remaining 39.7 per cent of cases with PBU imputations, some cases had private sources (21.5 per cent) or benefits (6.8 per cent) imputed where the information was missing, refused or unknown. An additional 4.5 per cent of cases had some private sources and some benefits imputed or changed. The remainder of cases had the following imputations: household income imputed using group median (2.2 per cent), pension imputed to basic State Pension where the original income provided is below basic State Pension (2.6 per cent), pension imputed using group median where the original income provided is above basic State Pension (1.6 per cent) and basic income imputed where below a minimum income threshold (0.5 per cent). Table 1 summarises the type and method of income imputations carried out.

**Table 1: Income imputation procedures**

Type of income	Type of missing data	Method of imputation
<b>Private incomes</b>	Sources of private income are refused or unknown	Sample median imputed at a later stage
Self-employed	Amounts missing	Uses data from the Annual Survey of Hours and Earnings (ASHE) based on age, sex, part-time/full-time, social economic classification and from 2010 data, also geographical location
Regular employment	Amounts missing	
Occupational pension	Amounts missing	Sample median based on sex and social economic classification
Private pension	Amounts missing	
Other sources	Amounts missing	Sample median based on working status
<b>State benefits</b>	Benefits received are refused or unknown	Sample median imputed at a later stage
<ul style="list-style-type: none"> <li>- Universal Credit (excluding Universal Credit housing element) [note 1]</li> <li>- Income Support</li> <li>- Jobseekers Allowance</li> <li>- Pension Credit</li> <li>- State Pension</li> <li>- Employment and Support Allowance</li> <li>- Child Benefit</li> <li>- Working Tax Credit [note 2]</li> </ul>	Benefit amount is refused or unknown	Where the rates vary greatly depending on household characteristics (notably means tested benefits) individual benefit assessments are carried out. More general methods are used for benefits where fewer rates apply.

<sup>5</sup> For EHS 2020/21 and EHS 2021/22 data collection, due to the COVID-19 pandemic face-to-face EHS interviews were replaced with telephone interviews. The soft checks to clarify responses/values within the data collection tool remained in place for the telephone based interview survey.



<ul style="list-style-type: none"> <li>- Child Tax Credit</li> <li>- Maternity Allowance</li> <li>- Widows Pension</li> <li>- War Disablement Pension</li> <li>- Severe Disability Allowance</li> <li>- Industrial Injuries Disablement Benefit</li> <li>- Carers Allowance</li> <li>- Statutory Sick Pay</li> <li>- Attendance Allowance [note 3]</li> <li>- DLA (mobility and care component) [note 3]</li> <li>- PIP (mobility and daily living component) [note 3]</li> </ul>		
Other disability benefit	Benefit amount is refused or unknown	Theoretical amount of DLA (mobility) modelled
Savings	Amount of savings refused or unknown	Imputed using CHAID analysis using various input household and dwelling characteristics to build a decision tree
Primary Benefit Unit (PBU) income	Overall net household income missing or in households with a partner, HRP only missing/partner only missing	Median sample income imputed based on the HRP and any partner using the variables working status and social economic classification or using HRP/partner information only
Other Benefit Units (OBU)	Income amount missing for additional adults (on an individual basis)	Hot-decking (see section 3.4 for more information) based on sex, age, social economic classification, working status, (from 2010 data) grouped geographical location for additional adults in work and (from 2015 data) presence of an income source.
Winter Fuel Payment (WFP)	No information collected on whether household receives WFP	Modelled based upon eligibility of all household members. The amount depends upon the age profile of the household members.
Housing related benefits that help pay towards rent (including Universal Credit housing element)	Amounts missing	Full housing benefit – set as the net rent amount Partial housing benefit, don't know if full or partial or in receipt of the housing element of Universal Credit – individual housing benefit assessment carried out
MPPI	No information given as to amount (applies to all MPPI cases)	Imputed using mortgage information
Council Tax Support (CTS)	Modelled for all CTS cases	Full CTS – set as the council tax due Partial CTS/don't know if full or partial – individual CTS assessment carried out

[Note 1] In the 2021/22 modelling, the Universal Credit rates used for imputation of missing amounts varied depending on the date that the EHS interview survey was conducted due to mid-year Universal Credit policy changes.

[Note 2] The childcare element is not modelled for Working Tax Credit.

[Note 3] Benefit payments made specifically to the HRP and any partner to cover the additional costs of living with a disability including Disability Living Allowance, Personal Independence Payments and Attendance Allowance are excluded from the household income under the LILEE income metric.

### 3.3 EHS Primary Benefit Unit (PBU) income methodology

Initial checks on the interview survey input data are carried out to ensure the dataset is as clean as possible in preparation for the calculations. This involves checking household characteristic data to identify any implausible values and editing (e.g. replacing with modelled values) where necessary.

After the initial checks, a series of key indicators about the household are created at the person and household level (for example, age/sex of the HRP and any partner, working status of HRP and any partner and the presence and number of dependent children etc.), which are subsequently checked for completeness/plausibility. These indicators are used to compute theoretical entitlement to benefits and are used in the process of imputing missing values and validation.

#### **Income from private sources**

Separate calculations are made for the annual income for the HRP and any partner from regular employment (including income from Government training schemes), self-employment, occupational pensions, private pensions and other private sources. For each private income source selected the respondent is asked to provide a banded gross/net amount. If provided, the income is then set at the mid-point of the band.

Where respondents state receipt of private income sources (e.g. employment, self-employment income), but are unable/refuse to specify an amount; then an estimated amount is assigned according to the methods outlined in Table 1.

The same amounts are used to impute employed and self-employed income. For these two private income sources, the amount of income assigned depends upon the number of hours worked. The Annual Survey of Hours and Employment (ASHE) data used for imputation is based on full-time employment. Therefore, if the hours worked are less than or equal to 15 per week, the amount imputed is one-third of the full-time income amount. Part-time work greater than 15 hours per week is set to two-thirds of the full-time income amount.

For the small number of cases where the HRP/partner selected working in terms of their employment status, stated as being in receipt of paid work, but did not select any employment or self-employment income under their income sources (nor responded refused to their income sources) and is not in receipt of any 'other' private income, then the HRP/partner is assigned an employment income and an employment income amount is imputed based upon the method outlined above (Table 1). In this situation it is assumed that the HRP/partner unintentionally omitted employment income as an income source in the EHS interview survey.

For student households, if the HRP/partner is in full-time education (and not studying for A-Levels), with no reported income sources, modelled to be living in a university household,

then the HRP/partner income is set to in receipt of 'other' private income, rather than 'no income' and an estimated amount is assigned according to the methods outlined in Table 1. Also, each year, there are a few private income sources coded as £0 in the EHS interview survey. These cases are individually assessed and where deemed implausible; an amount is estimated using the standard imputation routines.

Respondents predominantly provide gross private income amounts. However, where net amounts are given for income from private sources, the gross amount for that source is approximated. Due to mid-year changes to National Insurance rates, depending on the date of interview survey in 2022/23, the net amount is increased by either 47 per cent or 50 per cent if the individual is under pension age and in receipt of earnings/self-employment income (to replicate Income Tax and National Insurance). Otherwise, 25 per cent is applied (to replicate Income Tax only), unless the combined private net and gross income is less than the Income Tax threshold, in which case it is assumed that no tax is paid, and the net amount is set to the gross amount. The total gross private income for the HRP and any partner for all sources is calculated. This is required to enable the total tax amount to be deducted. It is not possible to simply calculate the tax on the gross part and then add the gross-taxed to the net, as the rate of tax is dependent on income thresholds. Where imputation has taken place, this is recorded against the data. On-going validation of the amounts of income from private sources is carried out throughout the calculation.

### **Income from state benefits<sup>6</sup>**

The EHS interview survey asks about benefits received by the HRP and any partner (combined as a benefit unit) and the amounts and time periods of the payments. For PBUs that contain a partner, for most benefit sources it is unknown whether it is the HRP and/or partner who are in receipt of the selected benefit, except for State Pension, Child Benefit, Income Support, Pension Credit and Universal Credit where the individual recipient (whether HRP and/or partner) is known. As this information is required for the purpose of Income Tax deduction, benefit receipt is estimated based on the eligibility criteria of each person in the couple. Using this information, non-housing related benefit amounts for the HRP and any partner are calculated.

Missing benefit amounts are imputed for cases where the respondent has answered 'yes' to receiving a particular benefit but did not provide the amount received. For means tested benefits, such as Income Support, the rate varies greatly depending on the circumstances of the HRP and any partner and for these benefits individual benefit assessments are carried out. For other benefits based on rates, such as Carer's Allowance, the prescribed rates are imputed.

Questions were introduced into the EHS 2010 interview survey to ascertain whether the missing individual benefit amounts were due to the inclusion of the missing amounts with

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<sup>6</sup> See section 3.8 for changes to Universal Credit (2016 dataset and 2018 dataset)

other specified benefits. From 2010 modelling onwards, use of this data has been incorporated into the assessment of missing benefit incomes to avoid double counting of benefit income where it is deemed that the missing benefit income has already been accounted for.

The total benefit income is derived for the HRP and any partner separately, split between taxable and non-taxable benefit income.

Benefit payments made specifically to the HRP and any partner to cover the additional costs of living with a disability including Disability Living Allowance, Personal Independence Payments and Attendance Allowance are excluded from the household income under the LILEE income metric as these are aimed at supporting recipients with quality of life measures independent of fuel payments (see section 'Deduction of PBU disability benefits').

### **Income deductions**

The final income variables are presented in terms of net income, which is the income net of Income Tax and National Insurance. At this stage in the income calculation process, the private income is presented in terms of gross income and the benefit income is presented in terms of gross and/or net income depending on the selected benefit receipt.

The private income and taxable benefit income are added together separately for the HRP and any partner. This information is used in conjunction with the rates and allowances for Income Tax, including applicable tax relief from property rental, to derive the income tax payable for the HRP and partner. Based on the [rates and allowances for National Insurance](#), Class 1, 2 and 4 contributions are calculated. The total net income for HRP and partner are computed separately by the following formula:

$$\text{Net income} = \text{Non taxable income} + \text{Taxable income} - (\text{National Insurance payable} + \text{Income Tax payable})$$

For the EHS 2022/23, some policy changes associated with National Insurance came in mid-survey year; primary threshold for Class 1 insurance increased on 6<sup>th</sup> July 2022 from £9,880 to £12,570, and the Class 1 NI rates dropped back to 0.12 and 0.02 on 6<sup>th</sup> November 2022, after a previous increase to 0.1325 and 0.0325 respectively at the start of the financial year. As the EHS data collection is a snapshot point in time, for the 2022/23 modelling, the start date of the EHS Interview Survey was used to select the appropriate National Insurance thresholds/rates for each case in the dataset.

### **Income from savings interest**

The EHS interview survey asks the HRP and any partner their combined total amount of savings, provided as banded amounts. The mid-point of the reported band is taken as their savings amount.

Prior to the EHS 2020-21 interview survey, the savings module referred to savings and investments. However, the reference to investment was removed from the EHS savings module to avoid any potential double counting of investment interest income, as interest from investment is included under income from other private sources.

Where the amount of savings has not been provided, a method based on Chi squared Automatic Interaction Detection (CHAID) analysis is used to estimate the combined savings of the HRP and any partner. The banded savings question from the interview survey is used as the dependent variable in the analysis and a variety of household and dwelling characteristics such as tenure and age/sex of HRP are used as the predictor variables for estimating the savings amount. Once all the cases have a savings amount, income from savings interest is then calculated using a gross interest rate of 3.75 per cent. Income from savings is modelled as a gross amount and converted (if applicable) to a net amount using an interest rate of 3 per cent net of tax<sup>7</sup>. As well as the personal tax allowance, the personal savings allowance is also incorporated into the gross to net conversion of savings income. The modelled net savings interest amount is added onto the net private and benefit income.

### **Deduction of PBU disability benefits**

As confirmed in the Sustainable Warmth strategy published in February 2021, benefit payments made specifically to cover the additional costs of living with a disability including Disability Living Allowance, Personal Independence Payments and Attendance Allowance are excluded from the income calculation for the LILEE fuel poverty indicator. The combined annual amount of disability benefits from Disability Living Allowance, Personal Independence Payments and Attendance Allowance is primarily based upon the benefit amount(s) that the householder provided in the EHS interview survey, with missing amounts imputed according to the methods outlined in Table 1. The removal of the specified disability benefit amounts from the PBU income takes place before the low income imputation. This acts to lower the PBU income for households that selected receipt of the main disability benefits in the EHS interview survey.

### **Low incomes**

The next stage in the income calculation is the imputation of low incomes. This is where the PBU net private and benefit income, including income from savings, is assessed for certain groups to ascertain if it is below a theoretical minimum amount.

In 2007/2008 this area was the focus for development and was reviewed by the Fuel Poverty Methodology Group (FPMG) who recommended some improvements to imputing low incomes in 2008. Analysis showed that two household groups are more likely to under-report their income: lone parents; and pensioners (although the reasons for this were not

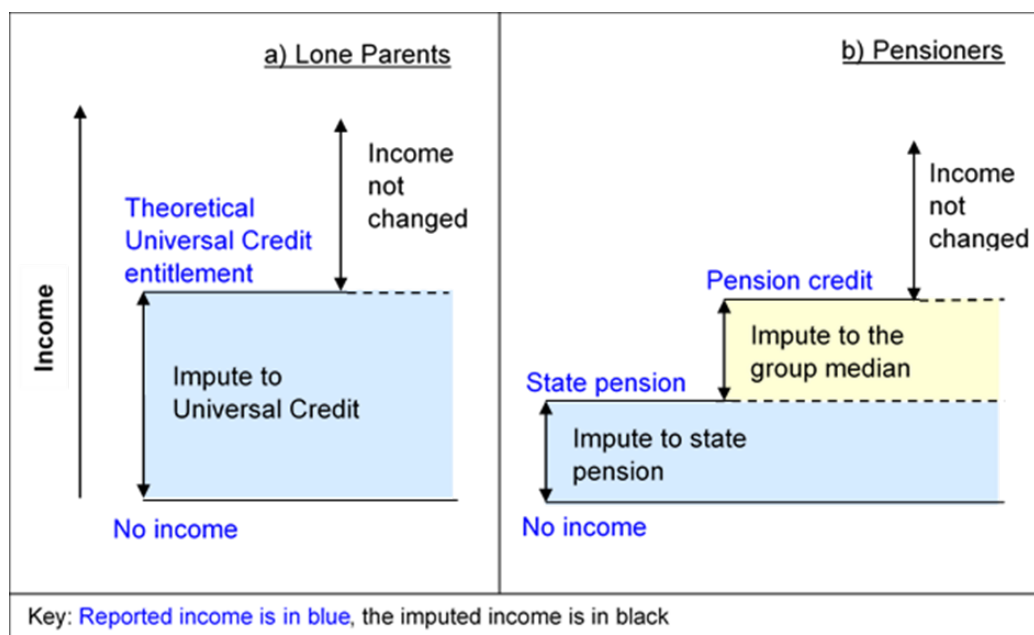
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<sup>7</sup> No information is collected on the type of savings account, the term of the account or the rate of interest. A net rate of 3% (3.75% gross) is fixed for all householders and has been used for all years of the fuel poverty income calculation regardless of whether interest rates are higher or lower than this.

investigated at this time). For these two groups, if their income is less than a minimum amount, their income is imputed, using a different method for each group.

For lone parents, using the LILEE income metric, if their total net income is below theoretical Universal Credit entitlement then their income is uplifted to their theoretical Universal Credit level (Figure 3a)<sup>8</sup>. Where the HRP or any partner are over pension age, if their total income is lower than State Pension, their income is imputed up to State Pension (Figure 3b). If their income is greater than State Pension but lower than their Pension Credit entitlement their income is set to missing and later in the calculation procedure it is imputed to the group median based on working status and social economic group. A flag is created to identify cases which are changed in the fuel poverty low income imputation routine and the original values are kept for later checking.

**Figure 3: Imputation of low incomes**



### Imputing missing income data

At this stage there are three scenarios in which the total PBU income could still be missing:

- i) If the respondent answered ‘don’t know’ or ‘refused’ at the beginning of the income section for the HRP and any partner;
- ii) If the benefit sources received are reported as unknown or refused; or

<sup>8</sup> Prior to 2020 modelling, Income Support was used as the theoretical minimum income threshold for working age lone parents.

- iii) If, in the case of pensioners, their income is greater than State Pension but lower than their Pension Credit entitlement, their income is set to missing in the fuel poverty low income imputation routine.

Where the HRP has a partner, it is possible that only one of the individual incomes is unknown or refused. In this situation, or if there is no partner of the HRP, the income of the individual with the missing amount is imputed to the group median based on their working status and socio-economic classification. Where the income of both the HRP and partner are missing, their income is imputed to the group median based on a combined employment status and socio-economic classification for both HRP and partner.

### Output

Each PBU in the dataset has a net private and benefit income, including income from savings interest.

$$PBU\ income = Net\ private\ income + Net\ benefit\ income + Net\ savings\ income$$

(all based on the HRP and any partner and excludes the benefit income from DLA, PIP and AA)

## 3.4 Fuel poverty basic income methodology

The fuel poverty basic income is the household net income, including winter fuel payment for those eligible. For 2022/23, the basic income also accounts for government income support packages, which include the means tested Cost of Living Payment paid to households on a low income benefit/tax credit (a payment of £650 in 2022) and the pensioner Cost of Living Payment paid to households entitled to Winter Fuel Payment (a payment of £300 for winter 2022/23). The annual basic household income is then capped at £100,000 to maintain the confidentiality of respondents with an income above this level and to comply with the [data disclosure control guidance issued by the Government Statistical Service](#).

### Other Benefit Units (OBU)

The PBU is made up of the HRP, their partner (if applicable) and any dependent children. Other Benefit Units (OBU) are made up of other household members that are not part of the PBU, e.g. a grown-up child living with their parents or two or more people sharing a house. Each OBU can include up to two adults, but only if they are a couple, otherwise each adult makes up their own separate OBU. For the fuel poverty calculations, the income of these additional adult household members is considered as part of the household income<sup>9</sup>.

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<sup>9</sup> Additional adult household members reported during the EHS interview survey to be living in Halls of Residence are excluded from the analysis and their income is not considered to be part of the household income.

Data on the total gross income of other household members aged over 16 (who are not the HRP or partner) are collected at the person level. Household members aged 16 or over that are not in the same benefit unit as the HRP are considered as additional adults and form the OBU (if the household member is a child of the HRP/partner, aged between 16 and 18<sup>10</sup> and in full-time education then they will be included in the same benefit unit as the HRP and therefore not considered as an additional adult).

If a gross income is provided for the additional adult, then this value is used for the income of the household member. If no income sources are selected, apart from a small group of cases (see below), the income of the additional adult is assigned as £0. If the additional adult has selected income sources but has not provided an amount for their income, then an income value is imputed based on a 'hot-decking approach'.

If an additional adult is a full-time student, with no reported income sources, living in a house where the HRP is also a full-time student in further education, then the additional adult income is set to missing as opposed to no income (as it is highly likely that they have misreported presence of an income source), and an income amount is imputed for the individual based upon the hot-decking approach as described below. Also, where an additional household member selected working in terms of their employment status, stated in receipt of paid work, but provided a gross income value of £0, then their gross income is also set to missing and an income amount imputed.

The process of hot-decking involves finding cases in the dataset that provided an income amount, which are similar in other parts of their responses to the cases with the missing value. For imputing missing additional adult income values, a specification to find similar cases is created for each case based on age (banded), sex, working status, socioeconomic classification (where applicable), grouped geographical location for those in work and presence of an income source. The case with the missing value has a precise specification and it is matched at random to a case with an income value with the same specification, this income value is then used for the missing case. If the additional adult selected receipt of an income source, with a missing income value, then it is only hot-decked against cases with an income greater than zero.

There are two situations where not all missing cases are matched:

- i) If a case with a missing value has a specification which is not matched by a case with a non-missing value; or
- ii) When there are more cases with missing values than with non-missing values of the same specification.

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<sup>10</sup> Dependent children aged 19 that are studying for A-Levels or equivalent are also deemed to be in the same benefit unit as the HRP and therefore not considered as an additional adult.



Missing cases that are not matched during the hot-decking process are imputed to a sample median based on working status, and for some working status categories with large samples, age (banded) and sex.

Once all the additional adults have a gross income assigned, it is converted to a net amount by deducting the applicable Income Tax and National Insurance. The net income of the additional adults is aggregated up to the household level to provide the total net income from Other Benefit Units (OBU) in the household.

Benefit payments made specifically to the HRP and any partner to cover the additional costs of living with a disability including Disability Living Allowance, Personal Independence Payments and Attendance Allowance are excluded from the household income. However, due to insufficient income data collected in the EHS interview survey on additional adults in the household, it is unknown whether an additional adult is in receipt of the disability benefits DLA, PIP or AA. Therefore, in the income calculation, no attempt is made to remove potential disability benefit payments received by additional adults in the household.

### **Winter Fuel Payments**

Winter Fuel Payments (WFP), introduced in 1998, are a payment given once a year to help older people with their cost of heating. They are available to households with at least one resident aged over state pension age and most payments are made automatically to eligible persons who have either received the payment before or who are in receipt of certain state benefits. Those who do not automatically receive the WFP have to claim the payment. There are no questions on the EHS interview survey as to whether anyone in a household receives WFP. The applicable amount of WFP for the household is modelled using the age profile of household members and the specified rates are assigned to the household income. Additional one-off payments<sup>11</sup> for household members aged over state retirement age are sometimes provided alongside WFP. For example, in 2009/2010, in addition to the WFP payment there was an additional one-off payment of £100 for households over 80 or £50 for those age 60 – 79. If applicable for the year of the dataset, these payments will also be included in the WFP amount.

### **Government income support packages in 2022**

In the 2022/23 data the modelled basic income also accounts for several government income support packages. These packages include:

- The means tested Cost of Living Payment paid to households on a low income benefit/tax credit (a payment of £650 in 2022/23).

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<sup>11</sup> See page 26 of following document for more examples of additional payments made: [Winter Fuel Payments update, Briefing Paper Number 06019, 24<sup>th</sup> March 2016](#)

- The pensioner Cost of Living Payment paid to households entitled to Winter Fuel Payment (a payment of £300 for winter 2022/23).

The EHS 2022/23 interview survey was modified in multiple places to make it clear to respondents not to include these one-off Cost of Living Payments in their response to income amounts. Therefore, these payments were modelled according to eligibility and added to the household basic income.

The means tested Cost of Living Payment of £650 in 2022/23 is allocated to households based upon modelled eligibility using the fuel poverty derived theoretical benefit eligibility flags. These derived variables delivered as part of the fuel poverty dataset, indicate whether anyone in the household is likely to receive a range of means tested benefits. An income payment of £650 is added to the basic household income if the household is modelled as being eligible for theoretical Pension Credit, Child Tax Credit, Working Tax Credit, Income Support, income-related Employment and Support Allowance, income-based Jobseekers Allowance or Universal Credit.

The pensioner Cost of Living Payment of £300 in 2022/23 is added to the basic household income if the household is eligible for WFP.

These government income support packages were applied to all applicable cases for the 2022 dataset (surveyed between April 2022 to March 2023).

## Output

The Fuel Poverty Basic Income variable (*fpbasinc*) is created by adding the income from the OBU in the household and the WFP to the PBU income variable.

$$\text{Fuel poverty basic income (fpbasinc)} = \text{PBU income} + \text{OBU income} + \text{WFP}$$

As noted in the section above, in 2022, the modelled basic income also accounts for several government income support packages.

There are a small proportion of cases with a fuel poverty basic income of zero. This occurs where:

- i) the HRP and any partner select that they have no sources of income, with no savings or, the HRP and any partner selects disability benefits (DLA, PIP and AA) as their only income sources with no savings; and
- ii) there is no OBU income; and
- iii) where there are no household members over state pension age and therefore not modelled to be in receipt of WFP.

At this stage of the modelling, for these cases the income is left unchanged.

### 3.5 Fuel poverty full income methodology

The Fuel Poverty full income variable is created by adding the income received related to housing costs, notably housing related benefits (HB), Mortgage Payment Protection Insurance (MPPI) and Council Tax Support, to the uncapped basic income variable, and by subtracting the annual approximate Council Tax bill for the household. The annual full household income is then capped at £100,000.

#### **Income from Housing Related Benefits that help pay towards rent**

Housing benefit, Local Housing Allowance (LHA) and the housing element of Universal Credit (UC) apply only to low income households that rent their home or are in a shared ownership scheme, designed to help people on a low income pay their rent. Housing related benefit is derived from the householder's response to the questions in the rent and housing benefit module in the EHS interview survey questionnaire.

Where households state that they receive a housing related benefit that helps pay towards rent but do not provide an amount, the amount is imputed in one of the following ways:

- i) If the household states that they are in receipt of full housing benefit/LHA then the weekly housing benefit is set to their theoretical guide rent amount (net of services included in the rent such as heating, meals, water rates etc.) based on their tenure, number of bedrooms and the English region in which they live.
- ii) If the household states that they are in receipt of partial housing benefit/LHA, receipt of the housing element of Universal Credit or if they do not know if their housing benefit/LHA covers all or some of their rent, then an amount of housing related benefit is imputed based on their total net rent payable and their theoretical entitlement to housing benefit. For a selected number of Universal Credit cases, the weekly housing related benefit amount received by the household is calculated earlier in the income model process, and then brought into the rent and housing benefit model to calculate the final amounts. From the 2013 modelling of EHS data onwards, the theoretical entitlement to partial housing related benefits includes the modelling of the under-occupation charge for working-age social tenants as introduced by Government in April 2013.

#### **Income from Mortgage Payment Protection Insurance**

Mortgage Payment Protection Insurance (MPPI) promises to make repayments on a householder's mortgage in the event of accident, sickness or unemployment. In the EHS interview survey, applicable households are asked if they are in receipt of contributions towards their mortgage payment under a MPPI policy and, if so, whether it covers full/partial payments. No information is collected on the amount of MPPI. For cases that select receipt of MPPI (typically fewer than 10 cases per survey year), an assessment is firstly made to the plausibility of the response to determine if the respondent is likely to receive a MPPI payment or whether it is more likely that the respondent has MPPI cover

(and not in receipt of a payment). For cases that remain selected for receipt of MPPI payment, an amount for MPPI is set equal to their mortgage payment amount.

### **Income from Council Tax Support**

Low income households may be eligible for Council Tax Support (CTS) (also known as Council Tax Reduction and previously known as Council Tax Benefit prior to April 2013). The EHS interview survey asks the HRP and any partner liable for paying Council Tax whether they are in receipt of CTS and, if so, whether it covers full/partial payments. For households in receipt of full CTS payments, their CTS is set to the full amount of Council Tax payable for their property. For households in receipt of partial CTS or households that do not know if they are in receipt of CTS, a CTS amount is assigned based on the Council Tax payable for the property and on their theoretical eligibility.

### **Council Tax Deduction**

The Council Tax band for each dwelling is collected via a data matching exercise undertaken by the Valuation Office Agency<sup>12</sup>. The approximate amount of Council Tax paid by the household is modelled using the Council Tax band of the dwelling, information about charges in the relevant local authority area (adjusted using a smoothing methodology to minimise the identification of lower geographical areas) and information from the EHS interview survey as to whether the household pays council tax. Single person discount is applied where appropriate based on household size and whether the respondent reported receipt of a discount on their Council Tax.

### **Output**

The fuel poverty full income variable (*fpfullinc*) is created by adding the income related to housing costs; i.e. housing related benefits that help pay towards rent, MPPI and Council Tax Support, to the uncapped basic income variable (*fpbasinc*) and subtracting the approximate Council Tax payable.

$$\begin{aligned} \text{Fuel poverty full income (fpfullinc)} \\ &= \text{fpbasinc} + \text{HB} / \text{LHA} / \text{UC housing element} + \text{MPPI} + \text{CTS} \\ &- \text{council tax payable} \end{aligned}$$

As mentioned in Section 3.4, there are a small proportion of cases with a fuel poverty basic income of zero. These incomes are retained, as recommended by the 2005 Sefton and Cheshire<sup>13</sup> Peer Review of the Fuel Poverty Methodology, in line with the treatment of zero incomes in the [Households Below Average Incomes statistics](#) (HBAI) which are based on data from the Family Resources Survey.

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<sup>12</sup> This is achieved by matching postcodes to Council Tax band information to feed into modelling undertaken by the survey contractors for the production of statistics only. Raw council tax data is deleted at the end of the process in line with data sharing agreements.

<sup>13</sup> Peer Review of the Methodology for Calculating the Number of Households in Fuel Poverty in England. Final Report to DTI and Defra, by Tom Sefton and John Cheshire. April 2005.

In these situations, and for cases with a low basic income, this can lead to a negative fuel poverty full income if the household does not report that they are in receipt of any housing related payments and where they are liable for Council Tax for which a deduction is made from their zero/low income.

### 3.6 Fuel poverty equivalised after housing costs methodology

The fuel poverty equivalised AHC income, as used in the calculation of the official fuel poverty statistics, is an extension of the fuel poverty full income variable. Housing costs including total mortgage repayments and net rent payments (as published in the EHS derived interview file) are deducted from the uncapped full income of the household, and the household income is equivalised to reflect the fact that different households have different spending requirements.

From 2022/23 onwards, whilst the same EHS total mortgage repayment derived variable is used in fuel poverty modelling, some assumptions used in the calculation of this variable were updated to reflect changes in the property/mortgage market and societal changes. These modelling changes only impacted cases that required their mortgage payments to be imputed and the imputation that was required. From 2022/23 imputations for 1) the age of retirement (as used in the imputation of unknown mortgage length) was updated to be in line with current retirement ages (previously the age of 60 was used for retirement age), 2) deposits (where unknown) are now based on 10 year averages for first-time buyers and previous owners (previously deposits of 10% were imputed for all mortgagors) and 3) mortgage payments for equity release mortgagors with a HRP aged 55 or older are now set to a nominal value (previously these were imputed). The impact of the mortgage assumption changes on EHS outputs was investigated and it did not highlight any differences that caused concern for fuel poverty modelling.

The final equivalised after housing costs income variable is then capped at £100,000 before the calculation of fuel poverty variables. Any negative AHC equivalised incomes are set to £0. The methodology is detailed in Chapter 6.

### 3.7 Validation of income data

The validation of the input data into the income calculations, through to validation of the final output fuel poverty income variables, is an important process to ensure data quality. This process is outlined below.

Checking of the income data collected begins at the interview stage. The EHS interview survey is collected using a technique called Computer Assisted Personal Interviewing (CAPI) where the interviewer enters the information collected from the respondent directly

into a laptop computer<sup>14</sup>. The EHS CAPI has in-built checks to ensure that the respondent's answers are as accurate as possible. For certain benefits, if an amount is entered outside a valid range then a check will appear on the computer screen. The CAPI system has cross checks between variables e.g. if housing benefit receipt is selected but not Council Tax Support. The checks in the CAPI system are periodically reviewed and updated as appropriate.

Once in receipt of the interview survey files, the input survey data is compared to the previous year to ensure consistency in the formatting of the variables and to highlight any discrepancies in the results that require further investigation. Before beginning the income calculations, further checks on the key interview survey input data to the income modelling are carried out to ensure they are as clean and complete as possible. This involves checking household characteristic data, which is later used for imputing missing values and validation and assessing implausible means tested benefit combinations. Implausible and missing values are identified, and editing/imputation takes place where necessary.

Checks are made at each stage of the income calculation process to ensure as far as possible that the data are reasonable, and that missing data have been imputed correctly. Implausible values are interrogated and only when it is determined that as certain as possible the information is incorrect is an imputation or change made. Any changes made are always noted alongside the data to indicate the nature and extent of any imputation. At the end of each stage additional checks are made to ensure that there are no missing values in the final variables.

Certain parameters are evaluated at the end of each stage of the calculation process and compared to previous EHS data. For example, once the benefit section of the calculation process is complete, the take-up proportion of imputed data and average values for each benefit are assessed.

Oddities in the results for the components of the fuel poverty income variables are investigated in detail, concentrating on the difference in the data between the two specific years to find explanations. This involves putting the data in context by comparing the components of the fuel poverty income to external administrative sources e.g. DWP/HMRC benefit statistics and data from other surveys e.g. the Annual Survey of Hours and Earnings (ASHE), and the Monthly Wages and Salaries Survey. From this process it may be deemed that the results are in line with other external sources, or the difference attributed to the underlying EHS data or changes to the EHS interview survey. The main external validation techniques applied to the fuel poverty income measures are trend analysis over time and comparison with specific year income data from other

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<sup>14</sup> For EHS 2020/21 and EHS 2021/22 data collection, due to the COVID-19 pandemic face-to-face EHS interviews were replaced with telephone interviews. The soft checks to clarify responses/values within the data collection tool remained in place for the telephone based interview survey.

surveys, notably the Office for National Statistics (ONS) Household Finances Survey and the Family Resources Survey (FRS).

The internal validation also occurs on the final fuel poverty income variables, comparing the total income measures to data from previous years, looking at the distribution of income across the population and the average income of certain household groups.

From 2021 onwards, the equivalised disposable household income based on estimates from the Office for National Statistics' (ONS) Household Finances Survey for overall households and income quintiles are compared to the results from the LILEE equivalised fuel poverty full income. Whilst the income measures are not an exact comparison between the two surveys, it still provides a useful comparison between survey income trends. Any unexpected divergence in the results between the income measures are investigated.

The FRS is considered to be the most comprehensive and accurate income survey conducted in this country, and one that is dedicated to measuring incomes. The FRS provides the best external income data source for comparison, and it is therefore important to compare a variant of the fuel poverty full income to the equivalent FRS income variable, focusing on the comparability of the distribution of incomes in both surveys and the characteristics of households with the lowest incomes. This analysis takes place periodically on an ad-hoc basis and last took place on 2019/20 data.

The FRS data are also the underlying source behind the AHC equivalised income figures presented in the Households Below Average Income (HBAI) series, published by DWP. The comparable year of the HBAI is not published until after the publication of the fuel poverty statistics but time series charts are produced annually on availability of the data to compare the HBAI equivalised AHC income to the fuel poverty AHC equivalised income (adjusted to include disability benefits), by overall households and income deciles.

## **Outliers**

Outlying cases are identified in the data and validated to ensure that the data modelling processes are being performed correctly. In rare cases where the data are deemed to require modification due to implausible outcomes, modifications to data imputation regimes may be made as appropriate. In the 2014 and 2015 dataset, an alternative income procedure was employed for one case, due to missing responses to their earnings from amounts. In response to this outlying case and to minimise occurrences of outliers that specifically affect fuel poverty, extra checks have now been incorporated into the income modelling procedure, at an earlier stage. In particular, checks are carried out on employment income values below minimum wage that correspond to the top quintile for property value/rent (i.e. those more likely to have low AHC incomes). Cases are also flagged and investigated further if their only private income source is investment income, the amount for this income source is missing and the dwelling is deemed to be 'Low

Energy Efficiency' (SAP band D or lower). Issues raised by the unusual circumstances of specific outlier cases are fed back into future validation routines, where checks and processes are added to help deal with similar issues in the future.

### 3.8 Changes in income methodology

Each year, minor modifications may be made to the fuel poverty income calculation methodology as a result of improvements in the treatment of missing data, changes in the benefit and tax system and minor alterations to the EHCS/EHS interview survey. Selected years have also undergone larger methodology changes to the income calculation assumptions which is the focus of this section.

Fuel poverty incomes were originally calculated for the 1996 statistics and a very similar methodology was followed for the 2001 statistics. Ahead of the production of the 2003 figures, the Department of Trade and Industry (responsible at the time for publishing fuel poverty statistics) commissioned a consultation to discuss proposed changes to the fuel poverty income methodology. This resulted in three initial changes to the calculation of household incomes, all of which came about due to additional information being collected in the EHCS interview survey. This updated method was first used to calculate the 2003 fuel poverty figures. Headline figures for 1996, 1998 and 2001 were also revised to adopt the new methodology. Further changes have taken place as a result of continual review of improvements towards data quality, definition changes and substantial changes to the interview survey as discussed in more detail below.

#### **Other Benefit Unit (OBU) income (2003 dataset)**

Prior to the work on the 2003 EHCS data, incomes from other benefit units (i.e. other adult household members who were not part of the same benefit unit as the HRP) were modelled using a correction factor based on the Expenditure and Food Survey (EFS – later replaced by the Living Costs and Food Survey). For the 2003 dataset a new method of computing the income of other benefit units was introduced that used data collected in the EHCS interview survey. Questions were asked of the respondent about any state benefits or income received by each of the additional adult household members and these were used to derive the income of the OBU.

#### **Council Tax Deduction and Council Tax Benefit (2003 dataset)**

Net Council Tax liability was not included in the fuel poverty full income definition prior to the 2003 EHCS data. From 2003, Council Tax payments (net of Council Tax benefit) were deducted from the fuel poverty full income. This was in order to be consistent with the Government's official Households Below Average Income (HBAI) measure and to ensure consistency within the income definitions (i.e. for full income, including both the payment of Council Tax, and the benefit received to help pay it; for basic income excluding both the payment and the benefit).



### **Low Income Imputation (2006 dataset)**

In 2004, alongside and in support of the fuel poverty consultation, an [independent review of the fuel poverty methodology](#) took place. In the peer review it was recommended that the treatment of very low household incomes on the EHCS should be investigated with the view to possibly amending the methodology to match more closely that of the Family Resources Survey (FRS), a dedicated income survey. The FRS does not impute very low incomes but leaves them on the dataset, including negative income amounts (e.g. a self-employed person who has made a loss in the year concerned), whereas the EHCS (at the time of the review) uplifted all households that were on a low income up to at least their basic Income Support entitlement.

Following an extensive income review by BRE and the Fuel Poverty Methodology Group (FPMG) a new low income method was decided upon and endorsed by the FPMG. The new method was first adopted for the 2006 fuel poverty calculations, whereby only the household composition categories of adults over pension age and lone parents are subject to the low income imputation (see details in Section 3.3).

### **Housing Benefit (2007 dataset)**

In the 2007 EHCS interview survey, the Rent and Housing benefit module of the interview survey was extensively revised leading to a more comprehensive set of questions on rent and housing benefit. The 2007 fuel poverty calculations were adjusted to incorporate these interview survey changes. As a result, the housing benefit amount assigned to applicable households changed from being based on theoretical entitlement to the amount provided by the occupant (where available).

### **Council Tax Benefit (2007 dataset)**

In the 2007 EHCS, the method used for calculating levels of Council Tax benefit was improved due to increased data quality in this area. Prior to 2007, the level of Council Tax benefit assigned to a household was based on theoretical entitlement to this benefit. In 2007, the methodology was improved to allow use of the reported receipt of Council Tax benefit receipt where provided.

### **Savings/Investment Income (2007 dataset)**

In the 2007 EHCS interview survey, the questions asked about savings/investment were adjusted to include more detail about savings/investment above £50,000. Questions on the savings of the HRP and partner were asked in banded savings amounts. Prior to 2007, the top savings band was £50,000 or over. For the purposes of fuel poverty income calculations, it was assumed that this represented a level of savings of £55,000. In the 2007 EHCS interview survey, the following additional bands were added: a) £50,000-£99,999; b) £100,000-£149,999; and c) £150,000 or over. For the purposes of fuel poverty, the income methodology assumes levels of savings of a) £75,000, b) £125,000 and c) £175,000 respectively.

### **Other Benefit Unit (OBU) income (2008 dataset)**

In April 2008, the English House Condition Survey (EHCS) merged with the Survey of English Housing (SEH) to create the English Housing Survey (EHS) leading to further changes in the 2008 interview survey. The main change relevant to the fuel poverty income due to the move to the EHS was the way income information is collected for additional adult household members.

Prior to the 2008 survey, there was an income module in the interview survey on the OBU that collected income and benefit information at the Benefit Unit level on other adult members living within the household (who were not part of the same benefit unit as the HRP). This information was used to compute the income of Other Benefit Units and missing values were imputed via two different methods based on working status. If an adult member of the OBU was working, then income data from ASHE was used to impute an income value based on full-time/part-time, age and sex. If no additional adults in the OBU were working, then the income of the OBU was imputed to their theoretical Income Support entitlement.

In 2008, the OBU income section was removed from the EHS interview survey. The required information was collected differently via questions asked of all household members aged 16 or over. Additional adult incomes can be extracted from these data and the 2008 fuel poverty income methodology was revised to incorporate the additional adult income survey changes. The method of imputing missing values also changed to hot-decking (for more detail see Section 3.4) to capture the variability found in actual income data on additional adults.

### **Savings Routine (2008 dataset)**

Prior to 2008, the addition of income from savings/investment was the last step in calculating the Primary Benefit Unit income (that of the HRP and Partner). This changed in 2008 and the routine is now performed before the low income imputation so that the amount of income from savings/investment can be added onto the net private and benefit income of the HRP and any partner before the low income assessment. This change was added as an improvement to the income methodology to ensure that the income of lone parents and pensioners are not imputed in the low income imputation routine if they have sufficient savings/investment to put them above the low income threshold.

### **Earnings from other work (2008 dataset)**

Prior to 2008, in the EHCS interview survey there were two income categories. In addition to the income category 'Earnings from main job' there was also an income category called 'Earnings from other work'. From the 2008 survey year onwards, the EHCS category 'Earnings from other work' was removed from the survey and the employment income category broadened from applying to the main job only (under the EHCS) to a general 'Earnings from employment' category under the EHS. From 2008 onwards earnings from

other work is likely to be recorded under the category 'Earnings from employment' or the category 'Other sources'.

### **After Housing Cost (AHC) income (2012 dataset)**

The 2012 fuel poverty calculations transitioned from using the 10% definition to the Low Income High Cost (LIHC) definition. This brought about a change to the income variable used in the fuel poverty statistics, switching from the fuel poverty full income variable to the AHC equivalised income variable.

### **Housing Benefit (2013 dataset)**

For the 2013 modelling of EHS data, the theoretical entitlement to partial housing related benefits includes the modelling of the under occupation charge for working-age social tenants (Removal of Spare Room Subsidy) as introduced by Government in April 2013.

### **Council Tax Support (2013 dataset)**

In April 2013 Council Tax Support (CTS) replaced Council Tax Benefit (CTB). Across all Local Authorities (LA), support for pensioners remained the same as under the old CTB scheme. Therefore, no changes were required to the calculation of theoretical CTS for pensioners in 2013. Different LA's adopted different approaches to the CTS scheme, but it is not feasible to model each scheme on the EHS data. Generally, across Local Authorities, the support for working age claimants was cut compared to the old CTB scheme. For 2013 and subsequent modelling, a blanket factor is applied to reduce the theoretical partial CTS entitlement for working age claimants (compared to applicable amounts under the old CTB scheme) for all Local Authorities. This factor previously derived each year between 2013 and 2018 by simulating theoretical CTS entitlement on EHS data and matching it to research undertaken on 2013-2018 Council Tax Support impacts by the New Policy Institute (commissioned by the Joseph Rowntree Foundation) varied slightly around the 0.85 mark. From 2019 modelling, a factor of 0.85 has been used.

### **Council tax payable (2015 dataset)**

From 2015, a smoothing methodology has been applied in the derivation of council tax to minimise identification of lower geographical details. Rather than using the exact council tax due for each Local Authority as previously used in modelling, an average council tax due is calculated based on several similar local authorities, resulting in very small differences to the amounts assigned.

### **Universal Credit (2016 dataset)**

Universal Credit is a benefit that was introduced in April 2013 and is gradually replacing the following means-tested benefits: income-based Job Seekers Allowance, income-based Employment and Support Allowance, Income Support, Child Tax Credit, Working Tax Credit and Housing Benefit. Due to an increasing number of households in receipt of this benefit, changes to the way Universal Credit is modelled were introduced in 2016, to better match how Universal Credit is paid to households in receipt of this benefit. This resulted in

a more accurate representation of how the benefit is split up into the main element (modelled as the Universal Credit benefit) and the housing element (modelled as housing benefit).

### **Personal Savings Allowance (2016 dataset)**

From April 2016, changes were made to the way income from savings is taxed. The personal savings allowance exempts basic rate taxpayers from tax on the first £1000 of savings income, while higher rate taxpayers are exempt from tax on the first £500 of savings income. Additional rate taxpayers have no personal savings allowance. The personal savings allowance has been incorporated into the calculation of income from savings.

### **Student households (2017 dataset)**

Student households in the EHS have previously been flagged as a group where it is believed that their total household income is typically underreported. Several measures were put in place to better represent student income from loans and family allowances. In the EHS 2017/18, a reminder was added to interview survey to prompt interviewers to include student loans and family allowances as income. Also, minor changes surrounding the income of student households were incorporated into the 2017 modelling: 1. If an additional adult is a full-time student, with no reported income, living in a house where the HRP is a full-time student in further education, then the additional adult income is set to missing (as it is likely that they have misreported presence of an income source) and an income amount is imputed. 2. If the HRP/partner is in full-time education (and not studying for A-Levels), with no reported income, modelled to be living in a university household, then the HRP/partner income is set to in receipt of 'other income', rather than 'no income' and an income amount is imputed.

### **Rental Income (2017 dataset)**

From April 2017, a property trading scheme was introduced whereby an individual can benefit up to £1,000 in tax-free allowance for property income. For the 2017 fuel poverty modelling, the property trading scheme allowance has been incorporated into the derivation of the personal tax allowance, as well as incorporating the pre-existing rent a room scheme that allows an individual to earn up to a threshold of £7,500 per year tax-free from letting out furnished accommodation in their home. If the HRP/partner selects receipt of income from rent, the fuel poverty income modelling assumes that the HRP/partner benefits in tax relief from either the £1,000 property trading allowance scheme or, if a lodger is present, the rent a room relief legislation. You cannot get both rental allowances; therefore, the greatest applicable tax allowance figure is derived based on the HRP/partner modelled rental income and their circumstances, and assigned to the individual.

### **Negative AHC equivalised incomes (2017 dataset)**

From 2017 modelling, any negative AHC equivalised incomes are set to zero. This is done to take account of the inappropriate action of equivalisation factors on negative incomes, which will act in the opposite direction to that which is intended. Setting to zero is based upon the recommendation of the [Canberra Group Handbook on Household Income Statistics](#). In addition to this, the fuel poverty income modelling and EHS rent/mortgage modelling (the latter from which the derived housing cost variables are sourced) are very separate models with little integration between the two. Due to this, there can be some cases every year that have extreme negative AHC incomes values which are highly implausible. Setting the AHC income values to £0 mitigates these extreme implausible situations. This has no effect on the fuel poverty status, or fuel poverty gap, for these households.

### **Support for Mortgage Interest (2018 dataset)**

Homeowners on certain benefits may be eligible to get help towards mortgage interest payments called Support for Mortgage Interest (SMI). However, from April 2018, SMI no longer exists as a benefit for new or existing claimant's, instead it is now paid as a loan which is repaid with interest upon the sale of the claimant's home, or on a claimant's return to work if the borrower can afford it. As SMI has switched from a benefit to a loan, from 2018 modelling, SMI is no longer included as a component of fuel poverty household income.

### **Universal Credit (2018 dataset)**

Since its introduction in April 2013, attention is paid to cases where the HRP or partner selects receipt of Universal Credit in the benefit module of the EHS interview survey. To better capture the data on Universal Credit amounts, questions regarding Universal Credit were altered in the EHS 2018 interview survey. The modelling of Universal Credit has been updated to reflect the EHS interview survey revisions. Universal Credit covers an 'income' component and (if applicable) a 'housing' component. To ensure that Universal Credit receipt is not double counted under both the income component (income based benefits) and the housing component (housing related benefits), cases where the HRP/partner selects Universal Credit in the detailed income benefits section of the interview survey, are assigned a Universal Credit Scenario between 1 and 20 in the benefit modelling. The scenario assigned depends upon how the suite of EHS Universal Credit/housing related benefit interview survey questions were answered in combination with theoretical modelled Universal Credit 'income only' amounts. Depending on the scenario assigned, the Universal Credit amount collected in the benefit section of the EHS interview survey is either treated as the total Universal Credit amount that includes help towards housing costs i.e. an 'income' element and a 'housing' element combined, or as an 'income' only amount i.e. an amount that excludes the housing element. In the former situation, the income only amount is derived by deducting the housing element (as collected in the housing benefit module of the EHS interview survey) from the total combined amount. The housing element of Universal Credit is not incorporated as income

in the Primary Benefit Unit (PBU) income variable, but the housing element of Universal Credit is included as income in the fuel poverty full income variable (an extension of the PBU income variable). The combination of the EHS interview survey revisions regarding Universal Credit and the revisions to the Universal Credit methodology, reduces the risk of double counting Universal Credit in the income modelling.

### **Disability benefits (2018 LILEE dataset and 2019 dataset)**

The 2019 fuel poverty calculations transitioned from using the LIHC definition to the LILEE definition. As confirmed in the [Sustainable Warmth strategy](#) published in February 2021, benefit payments made specifically to the HRP and any partner to cover the additional costs of living with a disability, including Disability Living Allowance, Personal Independence Payments and Attendance Allowance, are excluded from the income calculation for the LILEE fuel poverty indicator.

Prior to 2020 modelling, for the derivation of the LILEE income metric, removal of the disability benefits took place post low income imputation. Using this approach for the newly adopted LILEE income definition highlighted cases within the eligible groups for the fuel poverty low income imputation with extreme low income post disability benefit removal. As receipt of these specified disability benefits are received in addition to the minimum income from Universal Credit and Pension Credit, from a methodology standpoint, there was a strong case for removing disability benefits prior to making the low income assessment/low income adjustment (so that the disability benefits were not removed from an imputed minimum income threshold). However, before altering the location in the income modelling process where the income from disability benefits is removed, modelling took place on the 2019-20 single year data to ascertain the effect of the proposed change on the median household income and the LILEE low income group and fuel poor. Whilst altering the location in the income modelling process where the income from disability benefits is removed causes a notable difference in the income to a few selected individual cases, the results showed that the proposed methodology change did not translate to an observed income difference at the group level. Little difference was also observed in the proportion of the LILEE low income and fuel poor group. The revised methodology was adopted in 2020 modelling whereby benefit payments made specifically to the HRP and any partner to cover the additional costs of living with a disability, including Disability Living Allowance, Personal Independence Payments and Attendance Allowance are removed prior to undertaking the fuel poverty low income assessment.

### **Low Income Imputation (2020 dataset)**

The low income assessment for the working age lone parent group (and associated uplift of income) transitioned from being based on theoretical Income Support entitlement to theoretical Universal Credit entitlement. The latter benefit replaced the former as part of the 2013 Welfare Reform Act and Universal Credit is now the main working age benefit in our country. This revision was implemented to keep the income methodology up to date with the current welfare system.

### **Government income support packages (2022/23 only)**

In 2022/23, the modelled fuel poverty household income includes several government income support packages. These packages include:

- The means tested Cost of Living Payment paid to households on a low income benefit/tax credit (a payment of £650 in 2022/23).
- The pensioner Cost of Living Payment paid to households entitled to Winter Fuel Payment (a payment of £300 for winter 2022/23).

For more detail see Section 3.4.

### **Modelled income benefits from 2022/23 onwards**

Additional income benefits modelled in the 2022 and 2023 projections are described in section 7.3.

## 4. How are energy prices calculated?

This chapter details the fuel price element of the fuel poverty calculation. The fuel prices produced are combined with household energy requirement outputs to produce fuel costs (see Section 5.11). These resulting fuel costs are used in the calculation of the low income threshold for the LILEE indicator, and also the LILEE fuel poverty gap.

### 4.1 Overview

In the fuel poverty energy costs the price that each household pays for its fuel depends on four main factors:

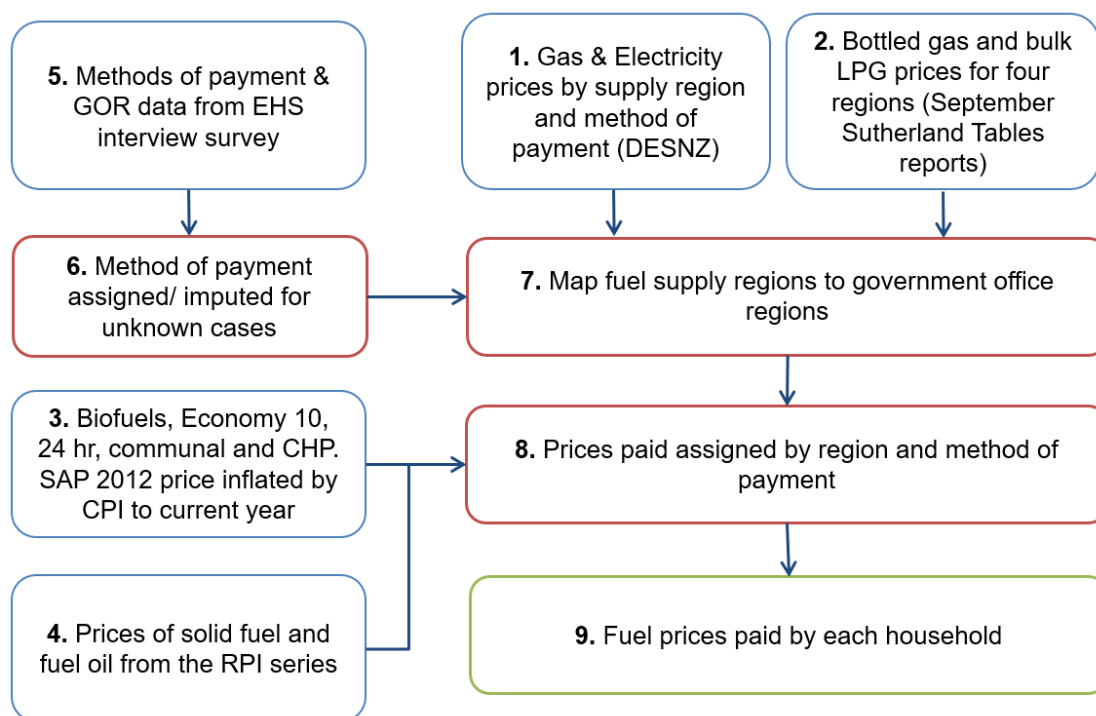
- The household's location within the country (as fuel prices vary regionally);
- The choice of supplier;
- The choice of tariff;
- The method of payment where relevant, i.e. payment by direct debit, standard credit or prepayment meter (PPM).

Information on the exact tariff or the supplier, is not collected in the EHS. The survey does however collect information on the geographical location of each case and on the method of payment for metered fuels (i.e. gas and electricity). Therefore, this allows the application of an average fuel price for each combination of region and method of payment, leading to the calculation of fuel prices specific to each household.

The process involved is shown as a flowchart in Figure 4.



**Figure 4: Process of calculating fuel prices**



## 4.2 Data sources

### Metered Fuels (electricity and gas)

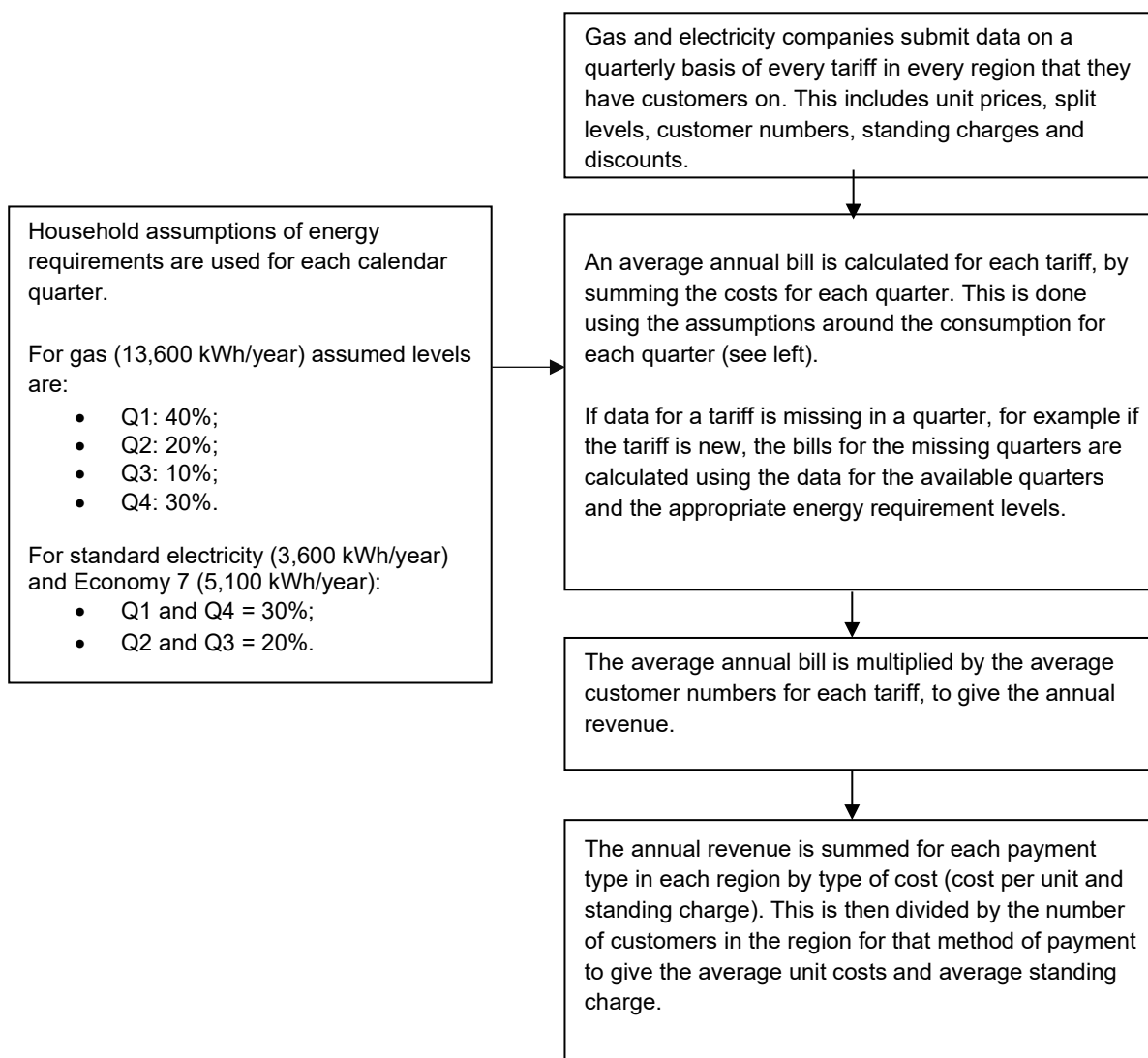
As outlined in Section 2.2, the average annual metered fuel prices are taken from tables 2.2.4 and 2.3.4 of the [Quarterly Energy Prices \(QEP\) publication](#) on a calendar year basis (prior to 2021/22) and on a financial year basis (from 2021/22 onwards). This data contains gas and electricity ‘average unit price’ and ‘average fixed costs’ (standing charges) for energy supply regions across England.

Prices are further split by three types of payment (direct debit, standard credit and prepayment). The method employed to produce the QEP table values is outlined in the flowchart in Figure 5.

In 2022, the QEP data included the Energy Price Guarantee, which was a support rate discount to all households with a domestic gas and/or electricity contract and worked to help reduce households domestic fuel bills during the winter of 2022/23<sup>15</sup>.

<sup>15</sup> [Energy Price Guarantee up until 30 June 2023 - GOV.UK \(www.gov.uk\)](https://www.gov.uk/government/news/energy-price-guarantee-up-until-30-june-2023)

**Figure 5: Energy price methodology used to produce the QEP prices used in the fuel poverty modelling (N.B. the estimates of consumption described in this flowchart are not used directly in any of the fuel poverty modelling).**



An example of this data can be found in Table 2 below<sup>16</sup>.

<sup>16</sup> [Annual domestic fuel costs](#)

**Table 2: Example of electricity average unit price and average fixed costs (standing charges) in 2022**

Standard electricity	Average Unit Price (£/kWh):			Average fixed costs (£/year):		
Region	Credit	Direct Debit	PPM	Credit	Direct Debit	PPM
East Midlands	0.309	0.292	0.319	138.21	167.04	138.50
East Anglia	0.329	0.311	0.335	160.57	144.22	126.98
London	0.355	0.324	0.337	139.06	122.56	127.10
Merseyside & North Wales	0.360	0.330	0.349	195.27	173.40	147.77
North East	0.302	0.286	0.319	196.92	180.50	122.40
North West	0.317	0.301	0.328	174.61	157.59	125.54
South East	0.352	0.323	0.339	172.12	152.03	127.37
South West	0.337	0.310	0.322	209.47	187.82	164.198
Southern	0.334	0.309	0.306	179.99	159.73	142.09
Midlands	0.317	0.300	0.323	196.15	177.35	151.68
Yorkshire	0.310	0.293	0.325	196.19	178.67	139.08

### Non-Metered Fuels

The prices paid for LPG and bottled gas (non-metered fuels) are taken from the [Sutherland Tables](#). These are independently produced reports which provide the average prices paid for fuels, split into four broad geographical regions.

The Sutherland reports are published quarterly. In 2021 and 2022 this was in April, June, September, and December<sup>17</sup>. For fuel poverty calculations the September Sutherland Tables prices of the survey year are used, as this reflects the time of year of high fuel demand and prices, taking the general methodological approach to avoid underestimating

<sup>17</sup> Historically, the Sutherland Tables were published quarterly in April, July, October, and January. Following the April 2021 publication, the publication dates have now moved to March, June, September, and December to coincide with the heating seasons.

fuel costs. The prices produced by Sutherland are taken from a sample of prices collected over the month of publication and the preceding two months. For example, the prices published in September represent the average price over the period July, August and September.

Prices for heating oil and smokeless fuel (including anthracite) are currently obtained from the [Consumer Price Index](#) (CPI), produced by the Office for National Statistics. For 2022, the price of coal is estimated from the price of smokeless fuel<sup>18</sup>. The prices of heating oil, coal and smokeless fuel have been split by English region and prior to 2021 they represented a 12-month average over the calendar year for each fuel. From 2021 data onwards, they represent an average over the financial year (e.g. April 2022 to March 2023 for 21/2022 survey data) for each fuel.

### Other minor fuels

The price of Economy 10 and 24-hour electricity is set as the SAP 2012 prices<sup>19</sup>, inflated to current prices using the CPI for electricity. Similarly, the prices of wood and other biofuels are also based on SAP 2012 prices, which are inflated using the change in the CPI for solid fuels. The price of communal heat is calculated using SAP 2012 communal prices, inflated using the change in CPI for gas.

### Plausibility checks

Metered and non-metered fuel prices are compared graphically against corresponding prices for previous years in order to identify any anomalies in prices or unexpected trends with time. This helps not only in the identification of suspect prices but also in understanding overall trends in relation to fuel costs and fuel poverty levels.

## 4.3 Method of payment data

The methods of payment are collected for mains gas and electricity only. Each household is asked in the interview survey how they pay for their electricity and gas. For each fuel there is the option of:

- (1) Direct debit (including online direct debit);
- (2) Payment on receipt of bill by post, telephone, online or at bank/post office;
- (3) Standing order;
- (4) Pre-payment (keycard, slot or token) meters;
- (5) Included in rent;
- (6) Frequent cash payment method (i.e. more frequent than once a month);
- (7) Fuel direct/direct from benefits;
- (8) Fixed Annual Bill (however much gas/electricity is used) e.g. StayWarm;

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<sup>18</sup> This is necessary because the index for the price of house coal is no longer published.

<sup>19</sup> BRE 2017. [Appendix S: Reduced Data SAP for existing dwellings](#), RdSAP 2012 v9.93.

- (9) Other (Please specify);
- (-9) Not applicable;
- (-8) Don't know (spontaneous only).

Since there are more methods of payment collected in the EHS survey than the three methods of payment within the QEP electricity and gas price data, assumptions are made in order to assign each household a method of payment, and the above categories are grouped as:

- Those stating, 'direct debit', 'included in rent', 'fuel direct/direct from benefits' or 'fixed annual bill (e.g. StayWarm)' are coded as Direct Debit.
- Those stating, 'payment on receipt of bill', 'standing order' and 'frequent cash payment method (more than once a month)' are coded as Standard Credit.
- Those stating 'pre-payment (keycard or token) meters' are coded as Pre-Payment.

For those coded as 'other', and where a written description is provided by the householder, the most suitable method of payment is imputed for each fuel, matching the written description to the above criteria, and the additional criteria below:

- Direct debit for any reference to: 'Included in rent' (to include all mentioning 'paying landlord', 'paying employer', 'payments to family'), 'stay warm scheme' includes direct from benefit, 'Pay council', 'Internet'.
- Standard credit for any reference to: 'Regular monthly payments', 'secure homes', 'Easypay', 'Moneyway', 'Cash', 'Cheque'.
- Pre-payment for any reference to: 'Payment cards', 'coin meters', 'gas stamps', 'Paypoint payment'.

After this process there may be a small number of cases without a method of payment (i.e. those who have said they don't know or "other" and where the description is missing or insufficient). For these cases, for electricity the standard credit method of payment is assigned, taking the general methodological approach of avoiding underestimation of fuel costs wherever data is unknown.

For energy modelling purposes, where the gas method of payment is N/A (i.e. not applicable, no gas), the gas method of payment is nominally assigned to be the same as the electricity method of payment, and a gas price applied accordingly. If no electricity method of payment is present, the gas price is set to the default 'standard credit'. This method ensures that any case which has a discrepancy between the householder response to the method of payment, and the surveyor response to the heating systems (e.g. where a householder says NA (no gas) to method of payment, but the surveyor says there is gas present and being used) allows reconciliation of the data to occur and prices still applied where applicable.

## 4.4 Mapping the fuel prices of each household

In addition to matching each household to a fuel based on the method of payment, the household must also be assigned a price based on its location within the country. The EHS collects information on which of the nine English regions each household is in, however the English region boundaries do not correspond directly with the electricity supply regions, gas distribution zones, or Sutherland Table region boundaries.

The fuel prices for each supply/distribution region or Sutherland Tables region are matched with the English region using a geographical matching technique. This is based upon estimates of the proportion of each English region within each supply region or distribution zone, as shown in Table 3 and Table 4.

**Table 3: Mapping technique for mains gas and electricity**

<b>EHS boundary (English region)</b>	<b>Prices calculated using proportions of electricity/gas distribution area prices as:</b>
North East	(1.0) North Eastern
Yorkshire & Humberside	(0.48) North Eastern + (0.52) Yorkshire
North West & Merseyside	(0.7) North Western + (0.3) N. Wales and Merseyside
East Midlands	(1.0) East Midlands
West Midlands	(0.875) West Midlands + (0.125) East Midlands
South West	(0.7) South Western + (0.3) Southern
Eastern	(1.0) Eastern
South East	(0.55) South Eastern + (0.4) Southern + (0.05) Eastern
London	(1.0) London

**Table 4: Mapping methodology for Sutherland tables non-metered fuels**

<b>EHS boundary (English region)</b>	<b>Prices calculated using proportions of Non-metered fuel region prices as:</b>
North East	(0.95) Northern England + (0.025) Midlands + (0.025) Wales and South West
Yorkshire & Humberside	
North West & Merseyside	
East Midlands	(0.92) Midlands + (0.08) Northern England
West Midlands	
South West	(0.97) Wales and South West + (0.03) Midlands
Eastern	(0.95) South East + (0.05) Midlands
South East	
London	

For example, if a household’s English region lies 40% within one supply region and 60% within another supply region the price applied will be a 40/60 weighted average of the two prices. This approach assumes a uniform population density across England.

The prices of biofuels, Economy 10 electricity, 24hr electricity, communal from boilers and communal from Combined Heat and Power (CHP) are calculated on a national scale, so no regional mapping is necessary. Prices for heating oil and smokeless fuel are provided by English region and therefore do not require mapping.

## 4.5 Changes in prices methodology

Each year, minor modifications may be made to the fuel poverty fuel price calculation methodology as a result of improvements in the treatment of missing data, alterations or additions to fuels used, and updates and changes to the EHS survey questions or other data sources. In some years more major methodology changes have been implemented, details of which are given below.

### **Time period represented by fuel prices (2021 data onwards)**

The calculation of mains gas, electricity, heating oil and smokeless fuel prices up to and including the EHS 2020-21 survey year data used prices based on the calendar year (i.e. January 2020-December 2020). From the 2021-22 EHS survey year onwards data

methodology was altered to use prices based on the financial year (i.e. April 2021 – March 2022) to align the prices more closely with the survey period.

#### **House coal (2022 data onwards)**

The RPI series for prices of house coal have been discontinued from January 2022, owing to the reduced domestic use of coal. For 2022 data, therefore, it was necessary to derive coal prices based on the RPI series for prices of smokeless fuel

#### **LPG and bottled gas (2022 data onwards)**

Prices per litre of LPG and prices per kg of bottled gas are obtained from the Sutherland Tables. From 2022, their prices per kg or per litre are converted to prices per kWh using the calorific values supplied by the Digest of UK Energy Statistics (previously they had been converted using the calorific values supplied in Sutherland Tables).

#### **Sutherland Tables change in publication date (2021 data onwards)**

Historically, the Sutherland Tables were published quarterly in April, July, October, and January. Non-metered fuel prices for the EHS survey year were obtained from the October publication for use in the fuel price modelling. Following the April 2021 Sutherland Table publication, the Sutherland Tables publication dates moved to March, June, September, and December to coincide with the heating seasons. Therefore, non-metered fuel prices for each survey year were obtained from the September tables, implemented from the 2021-22 EHS survey year onwards.

#### **Energy prices and rebates from 2022/23 onwards**

The modelling of energy prices used for 2022/23 onwards are described in section 4.2. Furthermore, section 7.4 describes the methodology for projecting energy prices for the 2023/24 and 2024/25 periods.

Changes to the energy rebates and government support schemes used for 2022/23 are described in section 5.11.



## 5. How is the household energy efficiency rating and energy requirement calculated?

This chapter outlines the calculations used to produce metrics related to the energy efficiency of the dwelling and the notional energy costs for the household living in the dwelling to heat it to a satisfactory standard, both of which are used in the calculation of the LILEE fuel poverty indicator (chapter 6).

The energy efficiency of the dwelling is measured through the calculation of the Fuel Poverty Energy Efficiency Rating (FPEER), outlined in 5.1, which determines the energy efficiency threshold calculation for the LILEE indicator.

Energy costs to heat the dwelling to a satisfactory standard combine modelled energy use based on household characteristics (as determined by the methodology outlined in sections 5.2 to 5.10 below) and current fuel prices (Chapter 4) to create fuel costs (section 5.11). These fuel costs are used in the calculation of the LILEE income threshold and also the LILEE fuel poverty gap (details given in chapter 6).

### 5.1 Calculation of the Fuel Poverty Energy Efficiency Rating

#### Overview

The Fuel Poverty Energy Efficiency Rating (FPEER) forms one of the thresholds for determining whether a household is fuel poor under the LILEE indicator. A household living in a dwelling with an FPEER of band D to G is categorised as 'low energy efficiency' and is at risk of being in fuel poverty depending on the household income. In addition, the FPEER rating of a household is used to track progress towards the Government statutory fuel poverty target, which is in place to ensure that as many fuel poor households as reasonably practicable have an FPEER rating of band C by 2030<sup>20</sup>. Progress towards the target is measured based on the share of all low-income households.

The Fuel Poverty Energy Efficiency Rating methodology is predominantly based on the Government's Standard Assessment Procedure (SAP) that measures the energy performance of domestic properties. This is an assessment of the energy performance of

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<sup>20</sup> With interim milestones set for 2020 (FPEER rating of band E or above) and 2025 (FPEER rating of band D or above).

the building fabric, heating system and lighting of homes using standardised assumptions for occupancy and use<sup>21</sup>.

The 2013 [Fuel Poverty Strategic Framework](#) set out that in addition to physical improvements to the energy performance of the home, the Government believes there are further cost-effective ways to help to improve the standard of fuel poor homes or assist in managing energy costs in the long term. As a result, the FPEER methodology builds on SAP by accounting for policies that directly affect the cost of energy – for example at present this relates to the Warm Home Discount (WHD) scheme. The 2022 government energy support packages are not included in the FPEER calculation.

### **SAP methodology**

SAP is the Government's official methodology for assessing the energy performance of dwellings. It is used to perform a range of important functions, including mapping performance against an A to G banding scale, as shown on Energy Performance Certificates. A detailed description of the version of SAP adopted for the Fuel Poverty Energy Efficiency Rating methodology can be found in version 9.94 of the SAP 2012 documentation<sup>22</sup>.

The SAP methodology details an approach to calculating how much energy is required to meet a standardised heating regime (e.g. heating the home for 2 hours in the morning and 7 hours in the evening on weekdays) to achieve prescribed indoor temperatures (e.g. 21°C in the main living area and 18°C elsewhere) in the dwelling being assessed. In addition, standardised assumptions are used about the amount of lighting required. A range of factors are included in the calculation, including the consideration of:

- The building materials used to construct the dwelling;
- The extent to which the building fabric has been insulated (e.g. whether the dwelling has loft and/or wall insulation);
- How well ventilated the building is;
- The degree to which solar gains affect energy requirements;
- The efficiency of and degree of control over the dwelling's heating system;
- The extent to which energy may be required to cool the home;
- The type of fuel(s) used to heat, cool, light, and (where applicable) ventilate the home; and
- The presence of any renewable energy technologies.

This information about the dwelling is derived from EHS data, which is processed to form the data required for a SAP calculation.

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<sup>21</sup> A detailed [FPEER methodology](#) is available.

<sup>22</sup> BRE 2019. [Appendix S: Reduced Data SAP for existing dwellings](#), RdSAP 2012 v9.943.

The SAP methodology produces modelled estimates of the amount of energy required for space heating (and cooling<sup>23</sup>), water heating and lighting respectively, less the energy generated from the presence of renewable energy technologies such as solar panels. Fixed individual fuel prices are then applied to generate estimates of total annual standardised heating, cooling (where relevant) and lighting costs for the dwelling.

### **Accounting for energy cost policies**

Additionally, for the calculation of FPEER, any policies that directly affect the cost of energy are taken into account by discounting these from the total standardised fuel costs for the dwelling where applicable.

The energy cost policy applied to the 2022 fuel poverty data is the Warm Home Discount (WHD). This is a government scheme designed to help fuel poor and vulnerable households by giving those eligible a rebate off their electricity bill. In 2022 this was £150 per eligible household, with the price adjusted to 2012 levels to be comparable with the SAP 2012 modelled costs, using the Consumer Prices Index (CPI) for domestic fuels<sup>24</sup>. Information about the Warm Home Discount is not collected in the EHS. As information about the Warm Home Discount is not collected in the EHS, receipt is modelled based on eligibility criteria and overall scheme receipt numbers (see section 5.11 for detailed Warm Home Discount methodology).

### **FPEER rating**

The standardised annual fuel costs for the dwelling after the application of the WHD rebate are adjusted for floor area, enabling comparison of efficiency across different sizes of dwelling. This is then converted to a scale from 1 to 100, with 1 representing very inefficient dwellings (homes with high energy costs) and 100 representing very efficient dwellings (zero energy costs), which is also translated into an energy efficiency band from G (lowest) to A (highest) (Table 5).

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<sup>23</sup> At present the EHS data does not collect details of fixed cooling systems in a dwelling, therefore cooling does not form part of the FPEER calculation in these statistics.

<sup>24</sup> Following the process outlined in the [FPEER methodology](#) document and using the average CPI for domestic fuels for the time period corresponding to SAP 2012 and the EHS survey year (QEP 2.1.3).

**Table 5: Fuel Poverty Energy Efficiency Bands**

Fuel poverty Energy Efficiency Rating	Band
1 to 20	G
21 to 38	F
39 to 54	E
55 to 68	D
69 to 80	C
81 to 91	B
92 or more	A

## 5.2 Overview of the energy requirement calculation

Modelled household fuel costs, which are a function of the energy efficiency of a home, property size, energy prices and household characteristics are used in two areas of a fuel poverty calculation under the LILEE indicator. These are:

- Whether a household’s income, after removing housing costs and modelled fuel costs, falls below a poverty threshold; and is therefore classified as ‘low income’.
- Where a household is fuel poor, fuel costs are used in the calculation of the fuel poverty gap (the change in £ to a household’s modelled fuel bill that would be required to remove them from fuel poverty, see 6.2 for more details).

Under the fuel poverty definition, the modelled energy required to heat and power a home can be grouped into four categories:

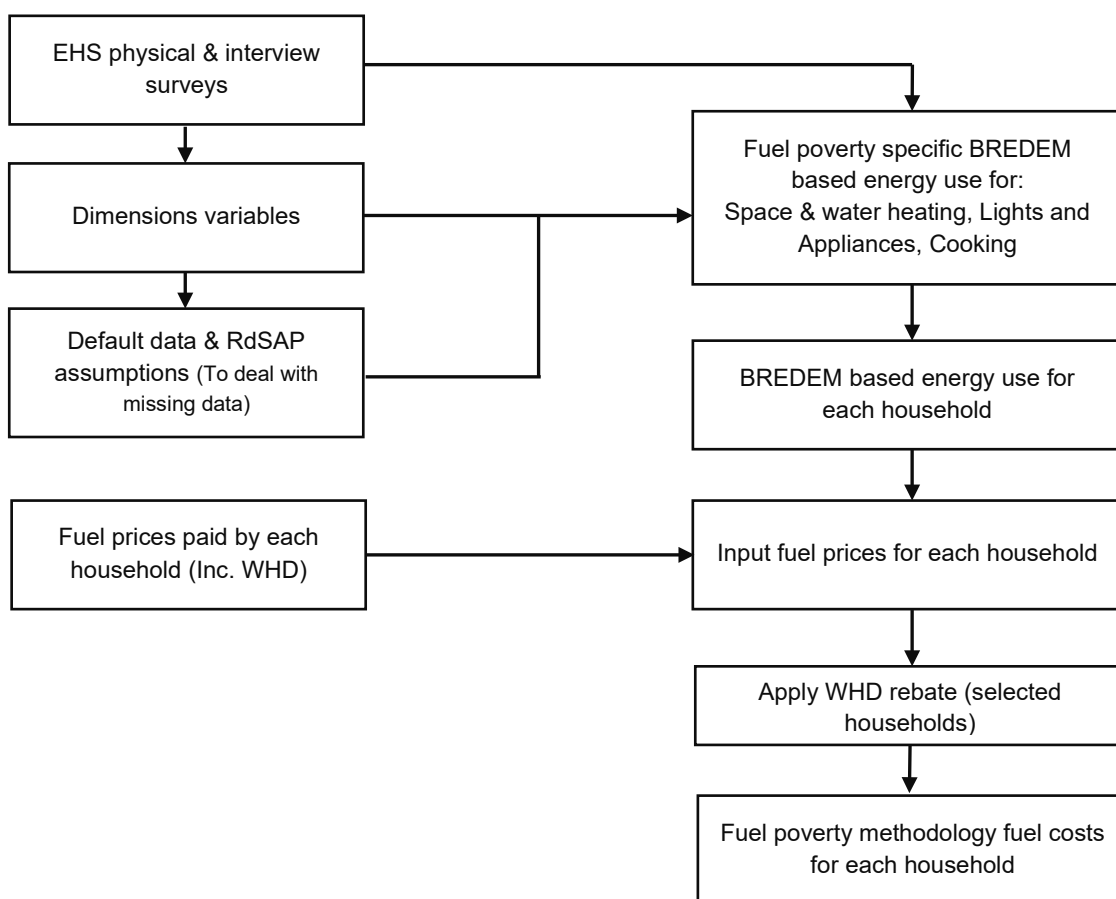
- i) Space heating –  $E_s$  (kWh/year);
- ii) Water heating –  $E_w$  (kWh/year);
- iii) Lights and appliances –  $E_{LA}$  (kWh/year);
- iv) Cooking –  $E_c$  (kWh/year).

A fuel poverty specific version of the [Building Research Establishment Domestic Energy Model \(BREDEM\)](#) methodology is used to predict the energy requirements of a household where:

$$Total\ household\ energy\ requirements = E_S + E_W + E_{LA} + E_C$$

Total household energy requirements include space and water heating (to meet defined standards), energy for lights and appliances (including requirements for pumps, fans and electric showers, and energy generated by renewables), and energy for cooking. The amount of energy required to heat a dwelling will depend on the building’s specifications such as insulation levels, heating systems, the geographical location of the dwelling, and construction type. A household’s demand for energy will depend on the number of people within the household and the lifestyle and habits of these individuals. Information from the EHS is used to provide details about both dwellings and households. The calculation process is summarised in Figure 6 below. Reduced Data SAP (RdSAP) assumptions are used to deal with missing data and can be found in the [SAP procedure document \(Appendix S\)](#).

**Figure 6: Calculating household energy requirements and associated fuel costs**



### 5.3 Dimensions calculation for energy requirements

Data from the EHS physical survey are used to calculate the dimensions of the dwelling and the heated volume and heat loss areas. This involves utilising data from many different modules that relate to different parts of the EHS physical survey form.

The following information is calculated:

- Internal and external wall areas;
- Roof area;
- Room specific floor areas;
- Habitable floor area and footprint area<sup>25</sup>;
- Perimeter of building;
- Ceiling heights;
- Window and door areas;
- Number of floors and rooms in a dwelling.

Key variables are the width and depth of the main and additional parts of the dwelling, which are directly collected in the EHS physical survey. These are used to determine the area (m<sup>2</sup>) of each floor. All physical data relating to the dwelling must have a value for the width and depth of the building to be considered part of the main data set. The EHS survey form collects the widths and depths of up to three levels, so the dimensions of any further levels are imputed. In general, wherever possible, imputations are based on the case in question, not on archetypes or on the rest of the data set.

### **Initial consistency and plausibility checks**

Ahead of the production of derived dimensions variables, a period of raw data input validation takes place. The internal integrity and the consistency of the data is checked. The purpose of these checks is to firstly detect and eliminate certain logical inconsistencies that would cause problems for modelling, and secondly to identify highly implausible answers which, if deemed necessary, are corrected. Where a conflict exists, these investigations take the form of inspection of all relevant data items by an analyst and a judgement being drawn on the most appropriate course of action for each case. In some cases, the raw EHS physical survey data is altered following these consistency and plausibility checks.

Checks include:

Levels checks – data may be inconsistent with regard to the number of storeys in the building, and the floor occupied by the dwelling. The following possible errors are:

- A room on a level that does not exist (e.g. 3rd floor of a three-storey module);
- A room on a level that is not part of the flat (e.g. room on the 3rd floor but flat on the 2nd floor);
- A measured level that is not part of the module (e.g. dimensions for 3rd floor when the dwelling only has three storeys);
- A flat on a level that does not exist (e.g. flat on the 3rd floor when the module only has three storeys);

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<sup>25</sup> Footprint area is the area of the dwelling in contact with the ground.

- Cross checks for presence of a habitable attic/basement and number of floors.

Plausible dimensions – statistical range checks are carried out on the dimensions, to identify any floor area that seems too large or too small for the number of rooms.

Non permissible values – if a dimension is equal to a value that is reserved for special purposes in the EHS coding scheme. The numbers 77, 88 and 99 are reserved to indicate the section not applicable, question not applicable, or unknown. When investigation suggests these figures occur as real measurements, they are reduced by one.

Incorrect number of flats – the dimensions of the surveyed flat are checked against the total floor area of the survey module to identify if the number of flats per module seems realistic.

Incorrect roof type – in the EHS, certain roof types (chalet and mansard) can only be defined where the dwelling has an attic. On occasions, surveyors may mistake steep pitched roofs for chalet roofs. In this situation, the data for pitched and chalet roofs is swapped over.

Implausible wall and window areas – where a dwelling seems to have a wall or window area that is too high or too low the data is checked.

Wall thickness – cases are identified and checked where the wall thickness as measured by the EHS surveyor is not typical of the wall selected.

Heating system consistency checks – where cases contain inconsistent heating system data on the EHS physical survey the data is checked.

### **Dimensions variables for use in fuel poverty energy modelling**

Due to the complexity in producing dwelling dimensions, a specific derived file is produced within the EHS called: Dimensions.sav and provides additional data on dwelling dimensions<sup>26</sup>. The dimensions derived data file is available to researchers on request under the EHS Special Licence (SL) through the [UK Data Service](#) following publication of the EHS Annual Reports. Users are strongly advised to use these dimensions for any secondary analysis.

Details of the derived dimensions variables are provided below. All variables in this file are described in detail in the EHS data dictionary which can be obtained from the UK data service. Users are recommended to refer to this when using the Dimensions.sav file. All EHS raw data files mentioned in this section are also available under the EHS Special Licence (SL) through the [UK Data Service](#).

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<sup>26</sup> Note that the *Dimensions.sav* file now includes variables previously found on the *EnergyDims.sav* file.

## Floor area

For fuel poverty energy modelling, the floor area of the dwelling heated space (the variable BREDEMFloorArea) is needed to calculate the extent of heating required. The calculation of floor area uses the methodology as set out in the SAP 2012 methodology documentation and dimensions data for individual dwellings collected in the EHS survey.

The EHS records the external width and depth dimensions of a dwelling (taken from page 13 of the EHS form), and these dimensions are converted to internal measurements using the external wall thickness<sup>27</sup>. Where a dwelling shares a wall with another heated space, party walls are considered to have a thickness of 0.125m, which is derived by dividing the average wall thickness for the EHS stock by two. The calculated internal widths and depths are multiplied to calculate an internal floor area at each level of the dwelling. The floor area includes all building elements which are part of the heated space envelope such as staircases, internal walls, and cupboards.

The EHS survey form collects the widths and depths of up to three levels, so the dimensions of any further levels are imputed. They are assumed to be the same size as the floor below, with the exception of any attics, which are imputed based on the floor area dimensions, and basements, which are assumed to be the same size as the floor above. The floor area of conservatories with no separating door are included in the floor area (taken from page 16 of the EHS form). Areas of the dwelling which are unheated and separated from the main heated space are not included in the floor area, for example integral garages which are not heated by the central heating system, or porches which are thermally separated from the dwelling.

## Storey heights

Data on storey heights (floor to ceiling distance) is collected on page 3 of the [EHS form](#) and can be found in the interior.sav raw data file. Following the data consistency, plausibility and integrity checks, derived storey heights for each level are produced by taking the mean of the ceiling heights on each level. These are included in the Dimensions.sav derived file and are defined in the data dictionary.

## Wall areas

Following the data consistency, plausibility and integrity checks, derived wall areas are produced. Wall areas for houses are calculated using measurements from page 13 of the EHS form. Measurement variables used to create these are found in the shape.sav raw data file.

Gross areas (inclusive of openings) are obtained by multiplying the internal dimensions of each floor by the storey height. Assumptions based on the RdSAP methodology for inter-floor thickness are applied so that 0.25m is added to each storey height except the lowest. Basements are included in the wall area, however, a storey containing a room in the roof is

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<sup>27</sup> Thickness of walls was measured for the first time in the 2013 EHS.



not (RdSAP has a separate methodology for modelling rooms in the roof, which is used instead).

The party wall area of each face is calculated by taking the fraction of the gross area that is recorded as attached. This information is collected on page 14 of the EHS form and can be found in the `elevate.sav` raw data file. The exposed wall area of each face is calculated by removing the party wall area, window, and door area from the gross wall area. The same procedure is followed for flats with dimensions that are not the same as the module, except information from page 9 of the EHS form (`flatdets.sav`) is used instead. The variables relating to the fraction of wall “to outside air” and fraction of wall “to internal accessways” are used to determine the exposed and semi-exposed wall areas respectively. For flats with dimensions the same as the module, the wall area for the whole module is calculated as described above for houses, using data from page 13 of the EHS form. This is then divided by the number of flats, factoring in if there is any non-residential use in the module. This information is collected on page 11 of the EHS form and can be found in the `numflats.sav` raw data file. Flats wholly within a room in the roof are treated as timber framed dwellings according to RdSAP procedures.

Derived wall areas for the module are included on the `Dimensions.sav` derived file but need to be adjusted to remove the area of wall at ceiling height on the top floor and converted to internal dimensions for the purpose of BREDEM fuel poverty modelling.

### **Door areas**

The area of external doors is not directly collected as part of the EHS, but the number of external doors is collected on page 17 of the EHS form and can be found in the `doors.sav` raw data file. For the purposes of BREDEM fuel poverty energy modelling, it is assumed that all external doors are of area 1.85 m<sup>2</sup> which is the standard RdSAP assumption.

### **Window areas**

Window areas for houses are calculated by taking the fraction of gross wall area that the surveyor records as fenestration (windows + doors) and then subtracting the door area. This information is collected on page 14 of the EHS form and can be found in the `elevate.sav` raw data file. In the case of flats, the window area (m<sup>2</sup>) can be taken directly from page 9 of the EHS form and can be found in the `flatdets.sav` raw data file. The fenestration area is produced in the `Dimensions.sav` derived file. The age of the windows is collected on page 17 of the EHS form and can be found in the `windows.sav` raw data file. It is used to determine whether the double-glazed windows are assigned a pre-2003 or post-2003 U-value.

### **Roof area**

The roof area is taken as the floor area of the largest storey, unless there is a room in the roof in which case RdSAP assumptions are applied.

## 5.4 Dwelling energy requirements

The calculation of energy requirements for fuel poverty uses information from the raw physical and interview survey files, along with the derived EHS datasets Physical.sav, Interview.sav and Dimensions.sav. These files are available to researchers on request under the EHS Special Licence (SL) through the [UK Data Service](#) following publication of the EHS Annual Reports. The data is used to derive the following:

- Heat loss due to conduction from all the external house structure to the external environment, for example heat lost through the walls or roof (fabric heat losses);
- Heat gain from solar fluxes and other gains such as from lights, appliances and occupants;
- Heat loss due to ventilation;
- Energy required for space and water heating systems;
- Heating regime of the inhabitants (when and to what extent they heat their home). This is used to estimate the required energy use based on the occupancy of the household. If a property is under-occupied the heating demand will be reduced but if a property is occupied all the time a longer heating period will be assumed.;
- Energy required for lights, appliances and cooking;
- Energy generated from renewable technologies (photovoltaics, solar hot water and micro generation wind turbines).

This information is calculated using data collected from the interview and physical surveys, as outlined in sections 5.5 to 5.10.

## 5.5 Information used in the calculation of fabric heat losses

Fabric heat loss is calculated for the dwelling using information on each of the external building elements (e.g. wall, floor, roof, windows, doors) and details of thermal bridging.

### U-values

The rate of heat loss through each element is calculated by multiplying the element area by the U-value of the material that the element is constructed from. The U-value is a measure of the effectiveness of a material as a heat conductor. U-values of external elements are assigned according to the actual construction date of the property, as recorded in the firstimp.sav file. These are matched to the RdSAP default U-values.

Where the age of individual elements is different from the age of the dwelling, U-values are assigned in line with RdSAP defaults by subtracting the age of the element (as reported on the EHS) from the whole-year date of the EHS single survey year. For example, a window identified as 10 years old in the EHS survey year which ran between April 2015 and March 2016 (the '2015 EHS single year') is considered for the purposes of the fuel poverty

modelling to date from 2005 (i.e.  $2015 - 10 = 2005$ ). This remains the case if the actual survey took place in the first three months of 2016.

If the main wall type is predominantly cavity ( $\geq 50\%$ ) then a party wall U-value of  $0.25 \text{ W/m}^2\text{K}$  is assumed for houses and flats with dimensions that are the same as the module, otherwise, no heat loss is assumed for the party wall. Access corridors are assumed to be unheated and an adjustment factor, for the thermal resistance of  $0.4 \text{ m}^2\text{K/W}$ , is applied to the U-values of walls adjacent to these areas.

### **Non-repeating thermal bridging**

For the purposes of fuel poverty BREDEM modelling, the effect of non-repeating thermal bridges is taken into account. The heat loss rate for non-repeating thermal bridges is calculated in line with table S13 of RdSAP for dwellings of different ages.

## **5.6 Identification of space and water heating systems**

All data of relevance to the identification and use of space heating systems in fuel poverty modelling can be located in the derived EHS Physical.sav file and EHS raw data services.sav file. For the purposes of secondary analysis, users are strongly recommended to use the derived Physical.sav variables where possible. They should also refer to the detailed documentation of these variables as provided in the Physical.sav data dictionary available from the [UK Data Service](#).

The type and characteristics of the space and water heating systems present in the dwelling are collected on pages 5, 6 and 7 of the EHS form. These pages collect data on:

- Mains gas and electricity connections;
- Primary space heating system type and fuels;
- Boiler names and models;
- Heat distribution systems;
- Heating controls;
- Secondary heating system type and fuels;
- Water heating systems types and systems
- Hot water tank presence; and
- Presence, type and levels of loft insulation.

Two types of space heating system are defined and used in the fuel poverty BREDEM modelling: main heating and secondary heating. In addition, one water heating system is defined. The method of determining these systems from the EHS data are described below.

## Main heating

Information relating to the heating systems assigned for each dwelling is taken directly from the EHS physical survey. The primary heating group, fuel and type are essential for the allocation of the primary heating system and the calculation of energy use for each household.

When an EHS surveyor first inspects the heating systems in a dwelling, they are required to identify whether there is any system which can be considered a “Primary System” and then to identify what this system is. A primary heating system is a system which provides heat to more than one room. Where multiple systems exist, the primary system is the one in the main living room. The vast majority of dwellings contain a primary heating system and this is recorded on page 6 of the EHS form. Where a primary heating system is identified by a surveyor, details about the primary heating system are used as the main heating system within the fuel poverty BREDEM modelling. In cases where primary data are missing for the heating systems, information from ‘other heating’ (secondary heating) is used in its place according to the SAP methodology. The surveyor records:

- Primary heating group (e.g. central heating, storage radiators);
- Primary heating type (e.g. boiler type);
- Primary heating code (a three digit coding system that allows more details such as type of flue to be recorded);
- Primary heating fuel;
- Primary system age;
- Boiler name and model information (if applicable);
- Distribution type (radiators or underfloor); and
- Details about primary heating controls.

The initial source of information used to determine the type of heating system present is the boiler name and model. The boiler model is searched for in the [Product Characteristics Database](#) (PCDB) of efficiencies, and where a match is found, details of the boiler efficiency and flue type are used within the fuel poverty BREDEM modelling. For combination boilers, additional information is extracted from the PCDB for use in the modelling where available, such as combi loss factors, keep-hot information, and storage details (if the system is a storage combi).

Where no match can be found or these data are missing, the primary heating code is used to define the type of heating system. If the primary heating code is insufficient to define the system the primary heating type, fuel, and age are determined from these items on the EHS form. The type of heating system is then used to determine the default efficiencies via a lookup table of heating system efficiencies in SAP.

## Secondary heating

Surveyors are also asked whether there is an “other” heating system within the home. This is recorded as the system in the main living room, where present, otherwise it is the system in any other room. The data on these systems is recorded on page 6 of the EHS form. The type of system recorded as “other” heating is taken as the secondary heating system in the home. SAP defaults for each type of system provide the data on the relative efficiencies of each system. Where no “other” system is indicated the fuel poverty BREDEM calculation uses the primary heating system only. According to SAP rules, storage heaters require a secondary heating system so if a secondary heating system is not already recorded, electric room heaters are added.

## Water heating

Information relating to the presence and specification of the water heating system is also obtained from the EHS physical survey. Water heating systems are identified on page 7 of the EHS form.

The EHS surveyors are able to specify and list the various water heating systems present in the dwelling. Only one of these systems is taken forward into the BREDEM modelling. In the case of multiple systems, the order of system preference is:

- Boiler with central heating;
- Boiler for water heating only;
- Back boiler;
- Communal;
- Single immersion;
- Dual immersion;
- Single point instantaneous;
- Multi point instantaneous; and
- Other.

Data on the cylinder dimensions, insulation (where present) and water heating controls are also collected on page 7 of the EHS form and affect the water heating efficiency and water heating energy requirement. Where the system is with the central heating system, the data on the main heating system is used for the calculation of water heating system efficiency.

In the BREDEM 2012 methodology the water heating demand is a function of the number of showers and baths taken per day, as well as the type of shower. The specific rules applied for calculating water heating from EHS data are as follows:

- If an instantaneous electric shower has been marked as present on the EHS form, the shower type is set to electric.
- If the dwelling has a combi boiler then set the shower type to Mixer (combi).
- Otherwise assume shower type is Mixer (not combi).

## 5.7 Space heating assumptions and definition of heating regime

The amount of energy required for space heating is estimated using the fuel poverty BREDEM algorithm using information on the space heating systems (Section 5.6), applied insulation, dwelling construction and materials, in addition to the external climate conditions and acceptable level of heating.

The external conditions are determined for the geographic location of the dwelling and time of year. The acceptable level of heating is defined in terms of the demand temperature of a dwelling, the extent to which the dwelling space is heated, and the number of hours that the occupants heat the house for (the heating regime). These are described below.

### Geographical Location

The BREDEM methodology defines twelve geographical regions for England. These BREDEM regions define monthly average climatic conditions such as temperature, solar flux (i.e. heat gains from the sun) and wind-speed. Each dwelling in the EHS has a geographical identifier that can be used to determine in which BREDEM region the property is located.

### Heating Season

The heating season is defined as the months of October to May, in line with the SAP methodology.

### Demand Temperature

The BREDEM methodology suggests that (generally) a house can be split into three distinct zones: a primary heated zone, secondary heated zone, and unheated zone. For the modelling of fuel poverty, the demand temperature of all dwellings within the primary zone is assumed to be 21°C, the secondary zone is assumed to be heated to 18°C and the temperature of the unheated zone relates to the external temperature and therefore varies depending on the local climatic conditions.

### Extent of Heating/under-occupancy

Some dwellings are considered excessive in size for the number of occupants that live there. In these cases, the house is assumed to be “under-occupied”, and that only a proportion of the dwelling will need heating. For a dwelling to be considered under-occupied it must fulfil criteria that depend on both the number of bedrooms in a dwelling and the total floor area of the dwelling. These criteria are described in more detail below.

A dwelling is considered to have surplus bedrooms if there are one or more extra bedrooms than required for homes without dependent children (children under 18 years), or there are two or more extra bedrooms than required for homes with dependent children.

A separate bedroom is allowed for each married or cohabiting couple, any other person aged 16 or over, each pair of adolescents aged 10-15 of the same sex, and each pair of children under 10. Any unpaired person aged 10-15 is notionally paired, if possible, with a child under 10 of the same sex, or, if that is not possible, he or she is counted as requiring a separate bedroom, as is any unpaired child under 10.

There is considered to be surplus floor area in a property if the floor area of the property is over double that considered to be the “standard” living area required for the number of occupants, as defined by the Parker-Morris Standard<sup>28</sup>. This standard is defined in Table 6 below.

**Table 6: Parker Morris Standard**

Occupants	Standard living area required (m <sup>2</sup> )
1	33.0
2	48.5
3	61.0
4	79.0
5	89.5
6	97.0
7	114.5
8	128.0
9	140.0

For the purposes of fuel poverty, a dwelling is considered to be under-occupied if there are both surplus bedrooms and surplus floor area.

If a dwelling is under-occupied then it is assumed that exactly half of the dwelling is heated, that is:

$$A_{heated} = 0.5 * A$$

Where A is the total floor area of the dwelling.

The remaining space is declared as a BREDEM unheated space. Because under-occupying households will always live in large dwellings (to be classed as under-occupying the floor area must be large), Zone 1 (living area) is assumed to be fully heated under this methodology. This will result in the area of Zone 2 that is heated being reduced for all

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<sup>28</sup> “Homes for today and tomorrow”, Department of the Environment, HMSO 1961.

under-occupying households. The proportion of Zone 2 that is heated can be calculated as follows:

$$\text{Area of Zone 1} = Z1$$

$$\text{Area of Zone 2} = Z2$$

$$\text{Unheated Zone 2 area for under – occupancy} = (Z1 + Z2) / 2$$

$$\text{Heated Zone 2 area for under – occupancy} = Z2 - (Z1 + Z2) / 2$$

$$\text{Proportion of Zone 2 heated} = (Z2 - (Z1 + Z2) / 2) / Z2$$

### Heating Hours

A standard heating regime assumes that the occupants are not occupying the dwelling during normal working hours. In this case it is assumed that the occupant heats the dwelling for two hours first thing in the morning and then for seven hours from late afternoon. During the weekend it is assumed that the property is heated throughout the day for 16 hours. The SAP methodology also makes this assumption to calculate the energy requirements in a dwelling.

This heating pattern does not apply for large sectors of the population, in particular the vulnerable such as the elderly and those caring for young children. The EHS interview survey includes a direct question asking whether anybody within the household occupies the dwelling during the morning or afternoon in the winter. This question is directly utilised to approximate the heating pattern. If anybody is in the house in either the morning or afternoon during weekdays, the house is assumed to require all day heating. In these cases, all day heating is assumed throughout the week as well as the weekend.

### Heating Regimes

A heating regime which defines heating pattern (heating hours), heating extent (floor area heated) and demand temperature is assigned to each household. The values assigned are determined using the criteria as given in the previous three sections.

The below tables set out the details for each of the four possible heating regimes used to calculate the energy requirements of a household:



**Table 7: The standard heating regime for the fuel poverty heating calculations**

	Details of STANDARD heating regime
Heating Pattern	Weekday 9 hours of heating Weekend 16 hours of heating (not at home during weekdays)
Heating Extent	Whole house (not underoccupying)
Demand Temperature	Primary living zone 21°C Secondary living zone 18°C

**Table 8: The full heating regime for the fuel poverty heating calculations**

	Details of FULL heating regime
Heating Pattern	Weekday 16 hours of heating Weekend 16 hours of heating (at home during weekdays)
Heating Extent	Whole house (not underoccupying)
Demand Temperature	Primary living zone 21°C Secondary living zone 18°C

**Table 9: The partial standard heating regime for the fuel poverty heating calculations**

	Details of PARTIAL STANDARD heating regime
Heating Pattern	Weekday 9 hours of heating Weekend 16 hours of heating (not at home during weekdays)
Heating Extent	Half house (underoccupying)
Demand Temperature	Primary living zone 21°C Secondary living zone 18°C

**Table 10: The partial full heating regime for the fuel poverty heating calculations**

	Details of PARTIAL FULL heating regime
Heating Pattern	Weekday 16 hours of heating Weekend 16 hours of heating (at home during weekdays)
Heating Extent	Half house (underoccupying)
Demand Temperature	Primary living zone 21°C Secondary living zone 18°C

## 5.8 Water heating

Energy demand for water heating ( $Q_w$ ) is the energy required to heat the volume of water needed for baths, showers and other uses. The detailed equations are presented in the BREDEM 2012 '[A technical description of the BRE Domestic Energy Model](#)' documentation, and use information on the water heating systems as discussed in Section 5.6.

Most methods of water heating involve energy losses that relate to storing the water in hot water tanks and distribution losses. Therefore, the total water energy demand must satisfy the hot water requirements and account for the energy losses inherently involved in satisfying the supply required. Hot water storage losses are mostly influenced by tank insulation and tank volume.

The energy required for water heating  $E_w$  (kWh/yr) is given as:

$$E_w = (kQ_w + Q_{Loss} - Q_s) / \epsilon_w$$

Where  $Q_{Loss}$  are losses through water storage/distribution,  $Q_s$  is solar hot water heating,  $\epsilon_w$  is the efficiency of the water heater and  $k$  is a constant.

## 5.9 Lights and appliance requirements

Energy demand for electricity  $E_{LA}$  (kWh/yr) includes lights, appliances, pumps, fans and electric showers, less the household electricity generated by renewable electricity sources such as photovoltaics and wind turbines (where applicable). The algorithm for lighting energy requirements includes provision for low energy lighting. The full equations can be found on page 6 of the BREDEM 2012 documentation.

## 5.10 Cooking energy requirements

Energy demand for cooking is given as  $E_C$  (kW/yr) and is a function of household size:

$$E_{c1} = 275 + 55N \text{ (for all electric cooker)}$$

$$E_{c2} = (138 + 28N) + (241 + 48N) \text{ (for electric and gas cooker)}$$

Where  $N$  is the number of people in the household. The full equations can be found on page 6 of the BREDEM 2012 documentation.

Several types of cookers can be modelled in BREDEM 2012, but data on cooker type is not collected in the EHS. For fuel poverty modelling, if the dwelling is fully electric it is assumed that a normal sized electric cooker is in use. Otherwise, it is assumed that a normal sized gas/electric cooker is in use. Therefore:

- Where a gas connection is present (i.e. a gas meter is identified by the surveyor), but no gas space or water heating appliances are present, it is assumed that the gas connection is not in use. In these cases, 100% of energy demand for cooking is assumed to be met by electricity. No gas standing charge will be applied in the final calculation of fuel cost.

## 5.11 Total fuel costs

The total fuel cost is the sum of the fuel cost for each component:

$$\text{Total energy cost (£)} = \text{£}_S + \text{£}_W + \text{£}_{LA} + \text{£}_C$$

Where:

£<sub>S</sub>: Fuel cost for space heating (including standing charges where appropriate);

£<sub>W</sub>: Fuel cost for water heating;

£<sub>LA</sub>: Fuel cost for lights and appliances (including standing charges, Warm Homes Discount and government energy support packages (2022));

£<sub>C</sub>: Fuel cost for cooking.

The fuel cost for each energy component is calculated by multiplying the total number of units required under each of the components by the unit cost (see Figure 4 in Section 4.1) for the fuel used and adding the appropriate standing charge. Each survey case is unique, with the appropriate fuel prices being applied based on the type of fuel given for each component of energy use. Where a household uses Economy 7 or Economy 10 with both a 'high rate' and 'low rate' tariff, the proportion of energy assigned to each tariff is based

on the heating system or use type as defined in SAP 2012 tables 12a and 13. Where a household uses a communal system for water heating only, half the communal system standing charge is applied, following SAP 2012 methodology for communal systems.

### **Warm Home Discount**

The Warm Home Discount (WHD) scheme targets households who are on a low income to help with their energy costs. It is a one-off payment that is taken directly off their energy bill in the winter and from October 2022, the rebate amount increased to £150. Eligibility for the WHD was updated in 2022 and is split into 'core group 1' and 'core group 2'.

Households who receive the 'guarantee' element of pension credit, make up core group 1 of the WHD. For the core group 2, qualification is based on a combination of low income criteria and the householders property having a high energy cost score; which is determined using the property age, floor area and dwelling type. The WHD is given automatically to those calculated to be eligible for both core group 1 or core group 2, with an additional helpline for those who were eligible for the WHD but did not automatically receive it.

The fuel costs are initially calculated without the receipt of Warm Home Discount (WHD) applied, as this data is not available to match with the cases in the EHS survey data. It is important, however, that the WHD policy (and legacy tariffs included prior to 2015) are accounted for in the fuel poverty statistics. Receipt of WHD will change a household's FPEER rating, and also their fuel poverty BREDEM fuel costs. To achieve this, some final adjustments are made to the dataset which act to reduce the total fuel costs for those households considered likely to be in receipt of the WHD. The total number of households modelled to receive the WHD is set to be equal to the total number of households in receipt of support through these elements of the WHD scheme, as reported by Ofgem.

Information on eligibility for each element of the WHD is also provided by [Ofgem](#) which allows the modelling of receipt of this discount. There are, however, more households theoretically eligible for this scheme than actually in receipt of these rebates. Therefore, a process of selecting a sample from the pool of eligible households, is undertaken.

The process of assigning the WHD for the 2022 data is as follows:

- a) Details of the number of households in receipt of each component of the WHD. In 2021/22, Core group and Broader group with figures provided by Ofgem. In 2022/23 Core Group 1 and Core Group 2 figures from the [Warm Home Discount statistics](#).
- b) Flags are created in the EHS dataset based on the eligibility of households determined based on eligible benefits and in the case of Core Group 2 recipients also meeting the [high energy costs threshold](#).
- c) A stratification algorithm is used to assign those in receipt of a WHD.
- d) The number of households in receipt of each element of the WHD is used to constrain this modelling.

The WHD has been applied for all years from 2011 to current.

### **Government energy support packages in 2022**

In 2022 there were several government energy support packages that were accounted for in the modelled fuel costs. These packages were:

- Energy Bill Support Scheme (EBSS) - £400 given to all households, this was provided through a household's electricity bill.
- Alternative fuel payment (AFP) - £200 given to those not on mains gas. In the fuel poverty datasets, this was households using heating oil or LPG as their main heating fuel.
- Council tax rebate - £150 rebate for households in council tax bands A to D, in the fuel poverty dataset, this rebate was taken off households' energy costs.

These three rebates were taken off the total fuel costs and for the cost splits they were taken off the costs associated with lighting. These rebates were not included in the FPEER calculation and like the Warm Home Discount they do not impact the LILEE gap.

These government energy support packages were applied to all applicable cases for the 2022/23 dataset (surveyed between April 2022 and March 2023).

### **Standing charges**

In the fuel poverty datasets, standing charges are assigned to the most appropriate component of fuel cost as follows:

Fuel cost for space heating (£<sub>S</sub>) includes cost of space heating (units consumed multiplied by unit cost) and:

- The gas standing charge if gas is present;
- Standing charges associated with communal systems or other fuels;
- Standing charges from off-peak electricity tariffs, above the standard rate charge.

Fuel cost for lights and appliances (£<sub>LA</sub>) includes the cost of lights and appliances (units consumed multiplied by unit cost) and:

- The standard electricity charge, not related specifically to heating;
- The Warm Home Discount rebate if applicable (assigned as a reduction in cost).
- The government energy support packages (2022) if applicable (assigned as a reduction in cost).

Due to the simplified way of assigning standing charges to the fuel costs, this may result in a small number of cases where a standing charge is assigned to space heating despite the fuel not being used in this way. For example, households with a gas space heating cost but no gas space heating usage can be due to the standing charge allocated to the space heating costs arising from a gas-based water heating system. These cases are however rare and this method of assigning standing charges is used to simplify the dataset.

## 5.12 Handling missing values

### Alteration to the dwelling data

When performing detailed checks on the output's, cases are flagged where values recorded on the physical survey form are deemed implausible and require alteration to the raw data within the energy modelling process. Each case is assessed on a case-by-case basis using other information from the survey form in order to apply the appropriate action for the data to be processed correctly.

### Missing dwelling data

Most of the data required to calculate the energy requirements of the household are available from the EHS survey. Where there are missing data items, these are dealt with in accordance with RdSAP assumptions for existing buildings as specified in [Appendix S](#) of the SAP 2012 methodology. The exception is where data for loft insulation is missing, and the occupant has access to the loft space. Loft insulation is assigned using the mean value for dwellings of that age and tenure using what is referred to as 'default data'. This data is constructed using national averages from the EHS.

### Missing household data

The number of occupants living in a dwelling and the composition of the household is provided in the interview survey. Data are required for each individual household therefore vacant dwellings are not included in fuel poverty calculations.

### Validation

Validation of the energy requirements and cost outputs is an important process in the delivery of reliable results. The level of validation applied will depend on the level of accuracy quoted, the significance of the indicator, the type of result quoted, and the resource provided for the task. Several layers of data validation are applied to the fuel poverty energy use and cost variables. These include cross checking from an independent member of staff, time series analysis, interrogation of important metrics, and comparing results against external data sources such as the [Digest of UK Energy Statistics \(DUKES\)](#).

### Outliers

Outlying cases are identified in the data and validated to ensure that the data modelling processes are being performed correctly. In rare cases where the data are deemed to require modification, the fuel costs are imputed based on the median value from a group with similar characteristics (grouped according to dwelling type and main heating fuel category).

## 5.13 BREDEM versions

BREDEM is the calculation procedure used for modelling energy requirements in dwellings for fuel poverty. It was first developed in the early 1980s and has been continuously

updated as a result of changes to our understanding of dwelling energy requirements and the use of energy in the national housing stocks.

The latest version of [BREDEM 2012, version 1.1](#), is used for the current fuel poverty datasets and trends data. All years in the timeseries use U-values from the latest version of RdSAP (version 9.94). In 2018, a further methodological update was implemented concerning the modelling of flues, fans and chimneys. The effect of this is outlined in Section 5.14 and should be taken into account when comparing the latest data with previous years.

## 5.14 Changes in energy modelling methodology

Each year, minor modifications may be made to the fuel poverty energy modelling calculations as a result of improvements in the treatment of the data, changes to the modelling methodology, and alterations to the EHS physical survey data collection. In some years more major methodology changes have been implemented.

### **Incorporation of RdSAP 9.93 U-value (2016 dataset onwards)**

U-values for solid brick, stone, system build, and cavity walls have been updated in timeseries data to reflect the updated U-values in version 9.93 of the RdSAP procedure document. Overall, this had a minor effect on energy requirements at a stock level, as energy reductions in dwellings with wall types that received an improved (lower) U-value were offset by the increased energy demand in dwellings which received a higher wall U-value under new RdSAP assumptions.

### **Pumps and fans methodology update (2018 dataset onwards)**

The methodology for calculating energy use from pumps, flues and fans was updated for the 2018/19 (single year) which is half of the 2018 dataset with a full update for the 2019 dataset (2018/19 and 2019/20) to align with the RdSAP methodology. The principal change was a switch from external observations (e.g. chimneys) to internal (e.g. open fireplaces). Analysis indicates that this change will have increased the mean SAP ratings of the stock as a whole by approximately 0.7 SAP points between 2017 and 2019 (measured using the combined year datasets).

### **Energy related data collection methodology update (2020 and 2021 datasets only)**

Due to COVID-19 restrictions in place during the 2020/21 and 2021/22 survey years, an alternative methodology was implemented to carry out the EHS physical survey. Surveyors collected the physical inspection data using an assessment of the exterior of the dwelling together with a short interview carried out (socially distanced) to ask the occupants for details of items usually captured internally by the [survey](#). This included items such as the type of heating system present, and extent of low energy lighting. Whenever possible, surveyors also used information from energy performance certificates (EPCs) and web-based tools such as Google Street View and Rightmove to inform decisions.

Where data was missing (e.g. loft insulation present but no insulation thickness given) due to the data collection method changes, imputed default values were used consistent with the approach used in a full survey year.

### **Solid floor methodology update (2020 and 2021 datasets only)**

Energy calculations require the internal dimensions of the surveyed rooms (living room, kitchen, bedroom, and bathroom) to calculate the extent of solid floors on the basement/ground level to inform the calculation of ground floor heat losses.

As surveyors were unable to collect internal room dimensions in the 2020/21 and 2021/22 survey years, internal dimensions from the EHS 2015/16 and 2017/18 combined year datasets were used to calculate proxy room areas to calculate the extent of solid floors. Analysis of 2019 data indicated that this change decreased the annual mean SAP rating by around 0.05 SAP points.

### **Drylining and internal wall insulation methodology update (2020 and 2021 datasets only)**

Data on the presence of drylining and internal wall insulation was not collected in the 2020/21 and 2021/22 physical survey years. It was assumed there was not drylining present for all cases. The household questionnaire was used to determine whether there was any internal wall insulation present.

### **Boiler model update (2022 dataset onwards)**

The boiler model was improved for the 2022/23 survey year data. The new model has better data-matching to the published 'PCDB' database and a better user-interface that allows for an improved audit trail and therefore better consistency in decision making. When comparing the old and new boiler model, only a small difference in the resulting mean efficiencies and mean SAP rating were seen, indicating satisfactory agreement between the two models.



## 6. Calculating fuel poverty under Low Income Low Energy Efficiency (LILEE)

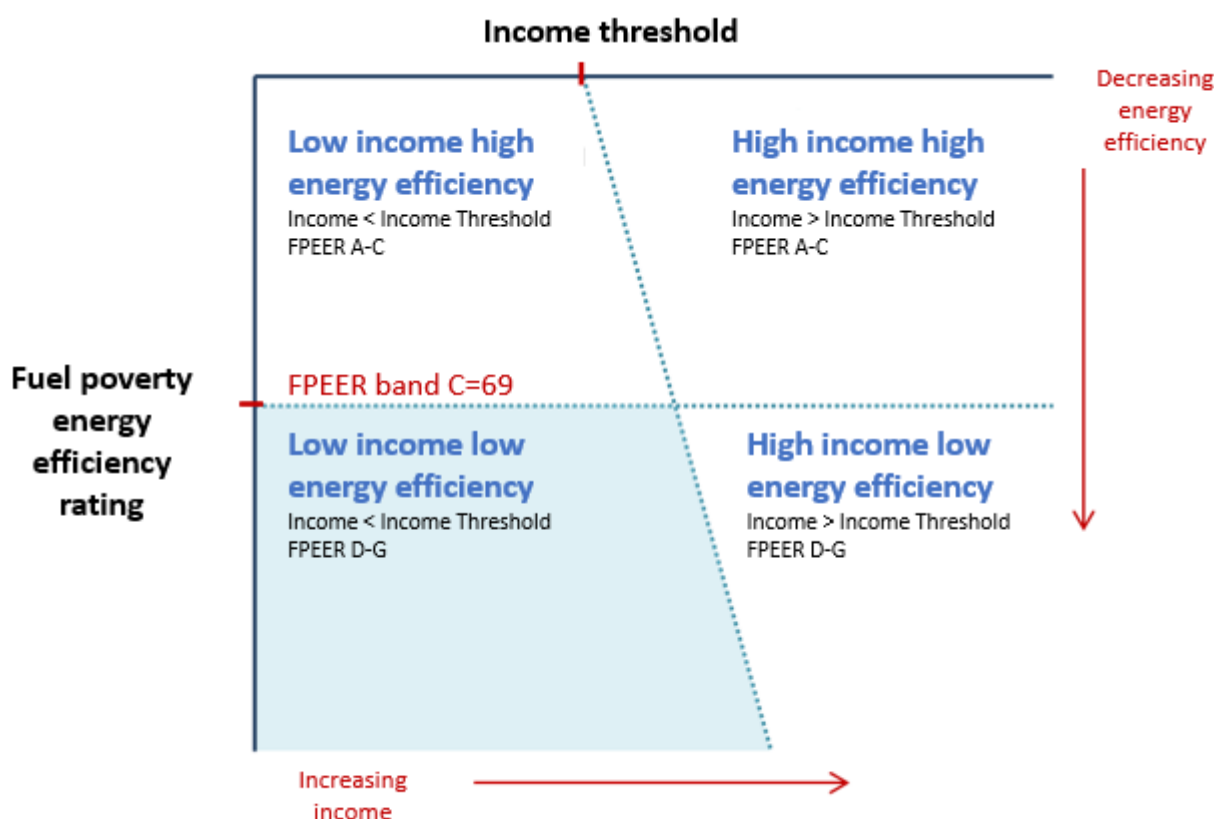
This chapter describes the method used to identify households living in fuel poverty under the Low Income Low Energy efficiency (LILEE) indicator. Under this indicator, households are considered to be fuel poor if:

- they have a fuel poverty energy efficiency rating (FPEER) of Band D (68) or below, and
- its disposable income (after housing costs and energy needs) would be below the official poverty line.

Under the Low Income Low Energy Efficiency indicator of fuel poverty, the depth of fuel poverty is represented by the 'fuel poverty gap'. This is defined under LILEE as the change in modelled fuel costs which is associated with increasing the energy efficiency of a fuel poor household to an FPEER rating of 69 (Band C threshold); or which increases the disposable income after fuel costs to a level where the household is no longer in income poverty. Installing efficiency measures can result in an 'overshoot' of the FPEER and/or income thresholds. To account for this, the improvement measures are capped at the point at which they cross either threshold, and the associated cost savings are adjusted accordingly when calculating the fuel poverty gap.

Figure 7 shows the four possible groups a household can fall into under this indicator.

Figure 7: Classifications under the Low Income Low Energy Efficiency matrix



## 6.1 Calculating the number of households in fuel poverty

The following section describes how to calculate whether a household has a ‘low income’ coupled with ‘low energy efficiency’.

### Household income threshold

Households are below the income threshold if their required fuel expenditure leaves the household with a residual income below the official poverty line<sup>29</sup>. This is calculated by:

1. Taking the full income for the household from the fuel poverty dataset (the “fpfullinc\_LILEE” variable).
2. Subtracting housing costs from the income to arrive at After Housing Costs (AHC) income. Housing costs consist of:
  - a. Weekly total mortgage repayments (“mortwkx” variable from the EHS interview file)

<sup>29</sup> Relative low income (or poverty) is defined as 60% of the median equivalised disposable income, and is used in official UK statistics. For example, in section 2 of the [Poverty in the UK and EU publication](#) produced by the ONS.

- b. Weekly net rent payments (“rentExS” variable from the EHS interview file). This variable also includes housing benefit. Note, the “rentExS” variable is used rather than the “rentwKx”, as “rentwKx” includes the cost of any services that the household pay alongside their rent. To ensure consistency in reporting only the true housing costs, variable “rentExs” is used.
- 3. Dividing the after housing costs income by the relevant After Housing Costs (AHC) income equivalisation factor. Equivalising effectively increases the incomes of single people, and reduces the incomes of larger households, similarly to fuel costs, with the intention of making them comparable. The equivalisation factors for each person in the household are shown in Table 11 below.

**Table 11: After housing costs income equivalisation factors for the LILEE indicator**

Number of people in the household	After Housing Costs (AHC) income equivalisation factor
First adult in the household	0.58
Subsequent adults (includes partners and children aged 14 or over)	0.42
Children under 14	0.20

The AHC income equivalisation factors used are consistent with that used by the DWP in their production of Households Below Average Income (HBAI) statistics. These factors were first devised by the OECD, and are used widely across Europe, including by Eurostat.

Two key elements are needed to derive an individual household’s equivalisation factor: the number of occupants in the household, and their age (as the OECD scale distinguishes between those under and over 14 years old).

The number of household occupants is taken from the “hhsz” variable (from the EHS “interview file”) and combined with information on the occupants age from the “DVHsz” variable (from the EHS “people” file)<sup>30</sup>. The AHC income equivalisation factor excludes any household members who are living away in halls of residence,

<sup>30</sup> The “hhsz” variable only excludes people living in halls of residence from 2008 onwards, following a change from the EHCS to the EHS. Prior to that, “hhsz” was consistent with “DVHsz”, and so people living in halls of residence were included in our income equivalisation method. There is therefore a small break in the consistency of the time series between 2007 and 2008.

making the calculation of AHC income equivalisation factors consistent with fuel costs equivalisation factors, by counting only household members living in the residence.

A worked example of how to arrive at a households AHC income equivalisation factor is given below. Suppose a household consists of the following members:

**Table 12: Worked example household details**

Household member	Age (years)	Status	AHC equivalisation factors
HRP	54	Lives at home	0.58
HRP partner	52	Lives at home	0.42
Additional adult	21	Lives in halls of residence	- NA Lives in halls of residence
Additional adult	18	Lives in halls of residence	- NA Lives in halls of residence
Additional adult	16	Lives at home	0.42
Child	12	Lives at home	0.2
		Total	1.62

Here the:

Household size = 4 (excludes the two people living in halls of residence)

The overall equivalisation factor, after accounting for the 2 people living in halls of residence, is given by:

$$\text{AHC income equivalisation factor} = (0.58 + 0.42 + 0.42 + 0.2) = 1.62$$

4. Calculating the income threshold for each individual household is done by taking the following steps:
  - a. Take the weighted median of all the AHC equivalised incomes in the dataset
  - b. Calculate 60% of this value, to produce the relative low income threshold<sup>31</sup>.
  - c. Add on the equivalised required fuel costs of the particular household.

<sup>31</sup> Relative low income (or poverty) is defined as 60% of the median equivalised disposable income, and is used in official UK statistics. For example, in section 2 of the [Poverty in the UK and EU publication](#) produced by the ONS.

The income threshold is therefore higher for households with large energy costs compared to those with smaller energy costs. In other words, households with larger costs require a greater level of income to meet this greater cost. As a result, the income threshold will appear as a diagonal line on diagrams of the indicator, as seen in Figure 7.

The threshold for income varies by household, depending on the required fuel costs of the household. The equivalised required fuel costs for the household is calculated using the ‘fuelexpn’ variable in the fuel poverty dataset.

5. Applying the corresponding equivalisation factor for each household. These are shown in Table 13 below.

**Table 13: Equivalisation factors for fuel costs under the Low Income Low Energy Efficiency indicator**

Number of people in the household	Equivalisation factor
One	0.82
Two	1.00
Three	1.07
Four	1.21
Five or more	1.32

The fuel costs equivalisation factors are not intended to be reviewed on an annual basis. They may however be revisited periodically in the future to ensure they do not become dated.

The fuel costs equivalisation factors are based on three years of required fuel cost data from the English Housing Survey (using the 2008, 2009 and 2010 Fuel Poverty datasets). The combined 3 year weights (from the EHS “3yr\_weight890” file) were used to arrive at the above set of equivalisation factors. Median fuel costs for each of the above five household size group from this dataset<sup>32</sup> are calculated. These medians are then indexed to the two-person households. Adults and children are treated equally in the equivalisation of fuel costs, a household with two adults and two children are treated the same as a household with four adults.

6. Then, divide the required fuel costs by the equivalisation factor to get the equivalised required fuel costs for that particular household. Equivalising effectively increases the costs of single person households, and decreases the costs of multiple person households, with the aim of making them comparable.

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<sup>32</sup> Based on the “hhsizex” variable from the EHS interview file.

### Energy efficiency threshold

The energy efficiency threshold is used to classify households between Low Energy Efficiency (LEE) and High Energy Efficiency (HEE). Households with a FPEER rating of band D or below are classified as fuel poor if they are also classified as Low Income. The required fuel costs at this threshold will vary based on the size of property, required heating pattern and appliance demand.

### Worked example (2023): fuel poverty status

Fuel costs: £2,484

FPEER rating: 66.15

Total income: £22,907

Housing costs: £100 per week

Households: Family composition: lone parent (one adult, one dependent aged > 14 years, one dependent aged < 14 years)

$$\begin{aligned} \text{AHC equivalised income: } & (\text{income} - \text{annual housing costs}) / \text{equivalisation factor} \\ & = (£22,907 - (52 * £100)) / (0.58 + 0.42 + 0.2) \\ & = £17,707 / 1.2 \\ & = £14,755 \end{aligned}$$

(Income equivalisation factors as set out in table 11)

$$\begin{aligned} \text{Equivalised fuel costs: } & \text{fuel costs} / \text{equivalisation factor} \\ & = £2,484 / 1.07 \\ & = £2,321 \end{aligned}$$

(Where 1.07 is due to a household size of 3 as set out in table 13)

60% of equivalised AHC median income for 2022 data = £17,291

Household income threshold = £17,291 + £2,321 = £19,612

Here:

FPEER rating of 66.15 is less than 69 (Band C)

AHC equivalised income (£14,755) < Household income threshold (£19,612)

Since both the low income and low energy efficiency criteria are met the household is fuel poor.

## 6.2 Calculating the fuel poverty gap

The depth of fuel poverty is measured by the fuel poverty gap. This is the reduction in fuel costs (£/year) required to remove a household from fuel poverty. Households can be removed from fuel poverty by either: increasing the energy efficiency of the home sufficiently by improving to an FPEER rating of band C or above, or by reducing fuel costs so that their household income is no longer below the income threshold. The method which provides the smallest cost difference provides the fuel poverty gap for the household (which for the majority, is the reduction in fuel costs to reach the FPEER threshold).

To calculate the fuel poverty gap under the LILEE fuel poverty definition, the following steps are undertaken:

### 1. Simulate energy efficiency improvements to remove households from fuel poverty

Households are removed from fuel poverty by improving their energy efficiency. Energy efficiency improvements are applied incrementally and cumulatively until the household is removed from fuel poverty, allowing for the calculation of the reduction in fuel costs associated with these improvements. These improvements follow the order and specification of measures laid out in Appendix T of SAP specification v9.93. Each measure is simulated in turn, and both BREDEM fuel costs and the FPEER rating are calculated after each improvement modelling stage.

A handful of the measures given in SAP Appendix T are not included in the FPEER (and EHS) improvement modelling. This is because the EHS data available means it is not possible to assess how effective a measure would be, or the EHS does not have enough information to assess whether the dwelling has satisfied the installation condition. More detail is given about this process in the [EHS Technical Report](#).

An initial check is applied to ensure that the installation of the measure results in an FPEER improvement of at least 0.95 points (as consistent with the Appendix T criteria). This caveat prevents the simulated installation of measures which have very poor cost effectiveness. If this criterion is not met the improvement is 'rolled back' (i.e. not installed). In addition, measures are only applied to households eligible for the improvements.

After each energy efficiency improvement is added, assuming a measure meets the 0.95 improvement criterion, a check is made to determine whether:

- a) The FPEER rating has been increased to at least band C; or,
- b) The BREDEM fuel costs have been reduced sufficiently to remove the household from income poverty.

If either of these conditions are satisfied, the overall reduction in BREDEM fuel costs for the cumulated improvements applied to each household is recorded as the fuel poverty gap of that household.

## **2. Fuel poverty gap adjustment**

Where the final improvement measure applied has increased the FPEER rating and/or reduced the BREDEM fuel costs beyond that which is needed to remove the household from fuel poverty, an adjustment is needed to factor in this 'overshoot' and cap the fuel poverty gap to the appropriate fuel poverty threshold.

To adjust the fuel poverty gap, the model calculates the proportion of the savings associated with the final measure which would be needed to reach the FPEER or income threshold exactly (whichever is closest). The final FPEER rating and BREDEM costs are then adjusted accordingly, and the overall reduction in BREDEM running costs (including this adjustment) is recorded as the fuel poverty gap.

## **3. Remaining households not removed from fuel poverty**

There remain several cases who are not moved out of fuel poverty through standard applied improvements. These cases therefore do not have an associated fuel poverty gap calculated. However, it is important for a gap to be calculated so the scale of fuel poverty can be assessed for these households.

For each household that remains fuel poor once all possible standard measures have been applied, the remaining reduction in fuel costs required to remove the household from fuel poverty is calculated using the installation of solar photovoltaics (PV) as a proxy for reducing energy use. From this a fuel poverty gap can be calculated for these remaining cases.

## **4. Fuel poverty gap**

Finally, the fuel poverty gap can be calculated as the difference between the base BREDEM running costs and the adjusted post-improvement BREDEM running costs. The fuel poverty gap is unequivalised (multiplied by the fuel cost equivalisation factor for each case, see Table 13) in order to provide a cash value for the gap on the same terms as the BREDEM fuel costs.

### **Worked example (2022): fuel poverty gap**

Figure 8 below illustrates the fuel poverty gap calculation for two typical fuel poor households, A and B. In 2022, the Income threshold for a particular household is defined as the sum of:

- 60% of equivalised AHC median income for all households (£17,291), and,
- the equivalised fuel costs specific to the household in question.



In the examples below, household A has an AHC income below the income threshold while household B has an AHC income above the overall income threshold and is brought below this due to its equivalised fuel costs.

For fuel poor households, the fuel poverty gap can be generalised as:

$$\text{Fuel poverty gap} = (y - y_m) - \max\{[x - (x_m + y_m)], 0\}$$

Where:

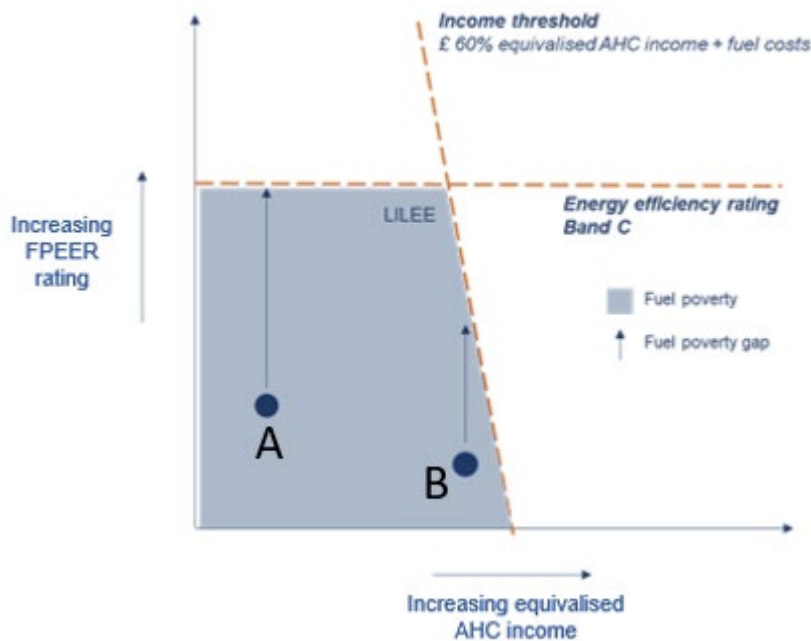
- x = equivalised household income
- x<sub>m</sub> = 60% of equivalised AHC median income
- y = equivalised required household fuel costs at current FPEER
- y<sub>m</sub> = equivalised required household fuel costs at band C (FPEER 69)

60% of equivalised AHC median income = £17,291

Median fuel costs = £2,200

Overall income threshold (at median fuel costs) = £17,291 + £2,200 = £19,491

**Figure 8: Fuel poverty gap under the Low Income Low Energy Efficiency indicator**



**Household A** income- fuel costs is below the Overall income threshold (equivalised household income = £17,291) and therefore their fuel poverty gap is calculated as the

difference between their current required fuel costs and their estimated required fuel costs at FPEER 69 ( $y - y_m$ ).

(Equivalentised household income) A = £17,291

(Equivalentised fuel costs) A = £2,420

(Equivalentised fuel costs at FPEER 69) A = £2,050

Fuel cost equalisation factor = 1.21

(Fuel poverty gap) A = Equivalentised fuel costs – equivalentised fuel costs recalculated at FPEER 69:

$$= £2,420 - £2,050$$

$$= £370$$

(Final unequivalised fuel poverty gap) A = (Fuel poverty gap) A × equalisation factor:

$$= £370 \times 1.21$$

$$= £448$$

**Household B** income is above the Overall income threshold (equivalised household income – equivalentised fuel costs = £19,500) and by a slight reduction in fuel costs can reach the income threshold faster than reducing costs to band C and therefore their fuel poverty gap is calculated as the reduction in fuel costs needed to be above the income threshold.

(Equivalentised household income) B = £19,500

(Equivalentised fuel costs) B = £2,150

(Fuel poverty gap) B =

(Overall income threshold – (Equivalentised household income – Equivalentised fuel costs):

$$= £17,291 - (£19,500 - £2,150)$$

$$= £59$$

Fuel cost equalisation factor = 0.82

(Final unequivalised fuel poverty gap) B = (Fuel poverty gap) B × equalisation factor:

$$= £59 \times 0.82$$

$$= £48$$

## 6.3 Cost of Improvements

Alongside the fuel poverty gap, an estimate of the cost of installing the measures which have removed the household from fuel poverty is calculated. These installation costs are notional costs obtained from the Product Characteristics Database (PCDB), which

contains a range of installation costs for these measures. The midpoint of the PCDB range has been used in these calculations, full indicative costs are provided in Table 181 of the PCDB (available at [Product Characteristics Database file](#)).

**Table 14: Costs applied for each measure**

Item	Measure	Average PCDB indicative cost (£)
A	Loft insulation	225
A2	Flat roof insulation	1,175
A3	Roof room insulation	2100
B	Cavity wall insulation	1,000
Q	Solid wall insulation	9,000
W	Floor insulation (suspended and solid)	1,000 and 5,000 respectively
C	Hot water cylinder insulation	22.50
D	Draught proofing	100
E	Low energy lighting	5 (per unit)
F	Cylinder thermostat	300
G	Heating controls for wet central heating system	400
H	Heating controls for warm air system	400
J	Biomass boiler	10,000
K	Biomass room heater with boiler	10,000
I	Upgrade boiler, same fuel	2,600
R	Install condensing oil boiler	5,000
S	Condensing gas boiler no fuel switch	5,000
T	Condensing gas boiler fuel switch	5,000
L2	Replacement/New storage heaters	500 (per unit)
M	Replacement warm air unit	1,875
N	Solar water heating	5,000
O	Double glazing	4,900
O3	Glazing replacement	1,200
X	Insulated doors	500 (per unit)
U	Photovoltaics	4,500
V2	Wind turbine	20,000

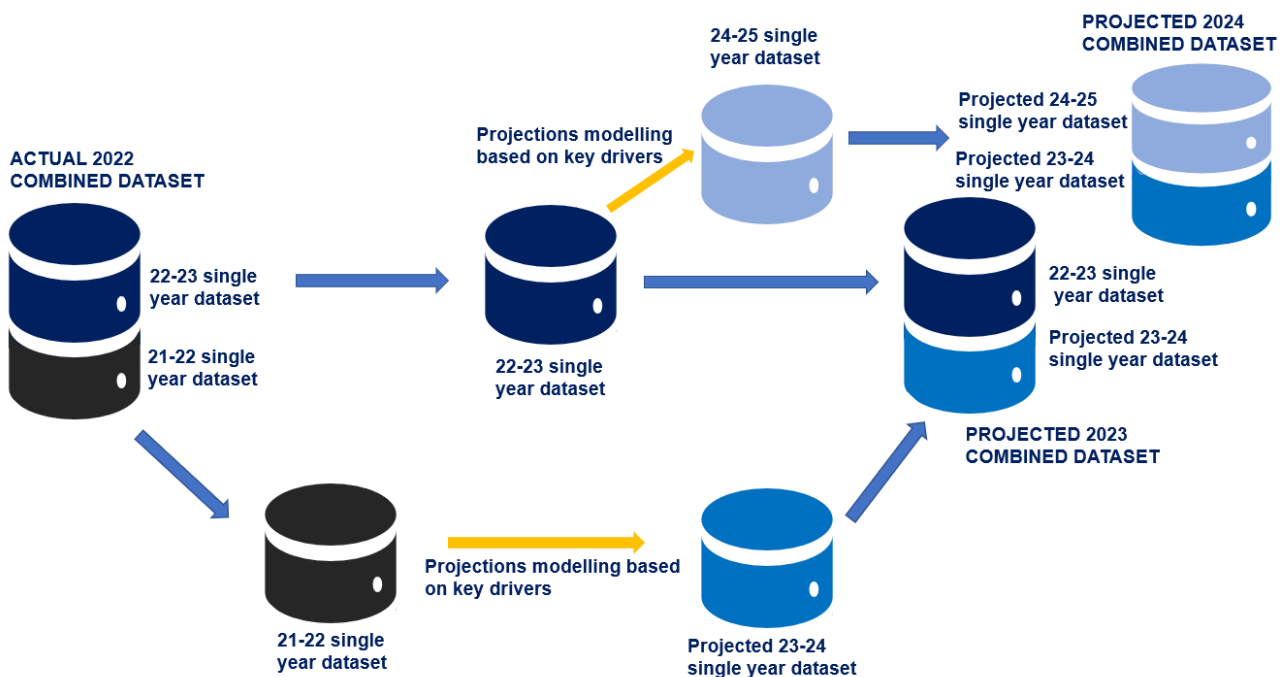
# 7. Projections methodology

## 7.1 Introduction

This fuel poverty projections methodology is split into sections for each of the three drivers that are projected: household energy efficiency, household income and fuel prices. The calculation of the projected fuel poverty figures is then detailed in the fourth section and the final section covers projections against the Government’s fuel poverty energy efficiency rating (FPEER) targets.

Projections run in 2024 were based on the 2021/22 and 2022/23 single year EHS datasets. As discussed in Section 2.1 the EHS data for the 2022 year is made up of two single year datasets collected April 2021 to March 2022 (21-22 single year dataset) is combined with the data collected April 2022 to March 2023 (22-23 single year dataset). As shown in figure 9 below, the projections are made by making a projection forward of each single year dataset to get to combined year datasets. The 2023 projection is based on projecting the 2021/22 data forward two years and combining this with the 2022/23 data. The 2024 projection is based on the 2022/23 data projected forward two years and combining this with the 2021/22 dataset projected forward two years to create a projected combined 2024 dataset.

**Figure 9: Process flow of how projections are made based on combine year datasets**



## 7.2 Projecting energy efficiency

One of the key drivers of fuel poverty is how energy efficient a dwelling is. This can be determined by a dwelling's Fuel Poverty Energy Efficiency Rating (FPEER) and whether the dwelling has reached a minimum of Band C, but also by calculating the required fuel costs needed to determine if a household's income after fuel costs is below the poverty threshold. For example, if a dwelling is poorly insulated, it will have low energy efficiency and high energy requirements. To establish to what extent the levels of fuel poverty are likely to decrease, the number and type of improvements to the housing stock needs to be modelled.

### **The number of measures to allocate**

There are several different types of measures that can be installed to improve the energy efficiency of a dwelling. For this model, the key measures that have been used are:

- Cavity wall insulation
- Solid wall insulation
- Loft insulation
- Floor insulation
- Solar photovoltaic panels
- Condensing boilers
- Central heating
- Heating controls
- Double Glazing
- Draught Proofing

The first step is to establish how many of each of these measures have been installed under different policies in the period that is being projected. The number of measures installed under each policy for the year being projected is required, so that measures can be allocated to appropriate properties to model the change in energy requirements over time.

This process uses the administrative datasets of policy delivery to match where measures have been installed in homes within the EHS dataset after the date of that survey, with other measures allocated randomly. DESNZ has already published national statistics on the number of installations by policy area for most of 2023, covering the [Energy Company Obligation \(ECO\)](#), [Social Housing Decarbonisation Fund \(SHDF\)](#), [Local Authority Delivery \(LAD\)](#), [Home Upgrade Grant \(HUG\)](#), [Great British Insulation Scheme \(GBIS\)](#) and [Microgeneration Certificate Scheme \(MCS\)](#) household energy efficiency policies and schemes.

From October 2018, the ECO scheme has been wholly targeted to low income vulnerable households, delivering energy efficiency and heating measures to homes in Great Britain. In previous phases of the ECO scheme, any household was entitled to subsidies towards energy efficiency improvements, regardless of their income.

The Social Housing Decarbonisation Fund (SHDF) scheme aims to upgrade a significant amount of the social housing stock to Energy Performance Certificate (EPC) rating of C.

The Government launched Wave 1 of the SHDF in August 2021 and delivery began in March 2022.

LAD and HUG award funding to Local Authorities to help them upgrade energy inefficient homes of low-income households in England. LAD Phase 1 allocated £200m in grants to 136 Local Authorities. LAD Phase 2 allocated a further £300m in grants to five Local Net Zero Hubs. Sustainable Warmth (consisting of LAD 3 and HUG 1) has allocated a combined £439m funding to Local Authorities. LAD 1 installations ran from October 2020 to December 2022, LAD 2 from August 2021 to December 2022, and Sustainable Warmth from January 2022 to September 2023.

HUG Phase 2 will allocate up to £630m of funding from September 2023 until March 2025.

The Microgeneration Certification Scheme (MCS) certifies, quality assures and provides consumer protection for microgeneration installations and installers. These consist of admin data on small scale renewable electricity technologies such as solar PV, biomass, wind, heat pumps and heat products, which are allocated in projections.

The Great British Insulation Scheme is a new government energy efficiency scheme (formerly known as ECO+) that is administered by Ofgem. It is designed to deliver improvements to the least energy-efficient homes in Great Britain.

As well as supporting low-income and vulnerable households (through the scheme's low-income group), this scheme will also help those living in homes within a wider, general group. The general group is for those households with properties that have an Energy Performance Certificate (EPC) rating of D to G, and which are within Council Tax bands A to D in England and A to E in Scotland and Wales.

Another area that is important to consider is improvements to the energy efficiency made by householders or property owners not under a Government policy, a key example is boiler improvements. According to the English Housing Survey (EHS), the proportion of households with condensing boilers is increasing each year. To estimate how much this will increase for the projected years, the change between each year over the previous 5 years in the EHS is used as a proxy. The number of estimated replacement condensing boilers installed under ECO is then deducted from this figure.

Furthermore, the projections model continues to account for the incremental improvements in the housing stock that occurs as newer, more energy efficient, properties are built, and older buildings are demolished. These changes are captured in the projections model by altering the household weights of the original EHS sample. Household weights of newer A/B/C and D properties are increased in line with ONS and DLUHC statistics on population figures and the number of households in 2023 and 2024.

### **Allocating installations**

We are able to match households that have received a measure under energy efficiency policies up until September 2023 with the EHS data (this match has been undertaken only for households that have consented for their data to be matched). This has improved the accuracy of allocations within the model in particular for the year 1 projection.

Measures under other energy efficiency policies are then randomly allocated to households that meet the relevant eligibility criteria for each policy and measure. These are then combined to make up the total number of allocations within the half year sample.

Different types of installations are only available to certain types of households. For example, to receive cavity wall insulation, the house must have uninsulated cavity walls. Eligibility criteria for each household are then matched from the energy performance dataset. A SQL model allocates measures based on meeting the relevant criteria. The random allocation of measures is repeated in turn for each of the individual measure (e.g. insulation) and policy (e.g. ECO) combinations. If a household is eligible for more than one type of measure, they can receive multiple measures, for example loft insulation and cavity wall insulation.

### Energy Requirements Calculation

Once individual energy efficiency measures have been allocated, they are combined to create an overall allocation per household, this could be one measure, multiple measures, or none. The next step is to model the impacts of these measures on a household's energy requirements and, ultimately, fuel costs.

Savings factors for every possible combination have been created to indicate the level of savings for different dwelling types for every possible combination of measures. The relevant savings factor for the measures allocated is then applied to a household's energy requirement. This is done for each fuel type (e.g. gas) and each type of use (e.g. space heating). This provides an estimate of the new projected SAP rating of the property and hence the reduction in energy requirements that each given combination of measures allocated would have on that household. The total energy use by fuel type is then used to calculate the total new fuel cost per household using the prices (see Section 7.4 below). This whole process is completed for each single year of the projections, as a different number of measures are allocated for each single year dataset, along with different fuel prices.

### SAP Costs calculation

The [standard assessment procedure](#) (SAP) is a measure of energy efficiency. The SAP costs are part of the SAP calculation, which is used to create the fuel poverty energy efficiency rating (FPEER). FPEER is based on the SAP methodology however, it additionally considers any energy rebates given to the household. In a similar way to the recalculation of the energy requirements, savings factors are applied to the original SAP costs, based on the combination of measures allocated to the household.

After recalculating the SAP values, the SAP energy costs are adjusted based on Warm Home Discount if this is allocated to the households and FPEER is calculated (See section 7.5).

## 7.3 Income

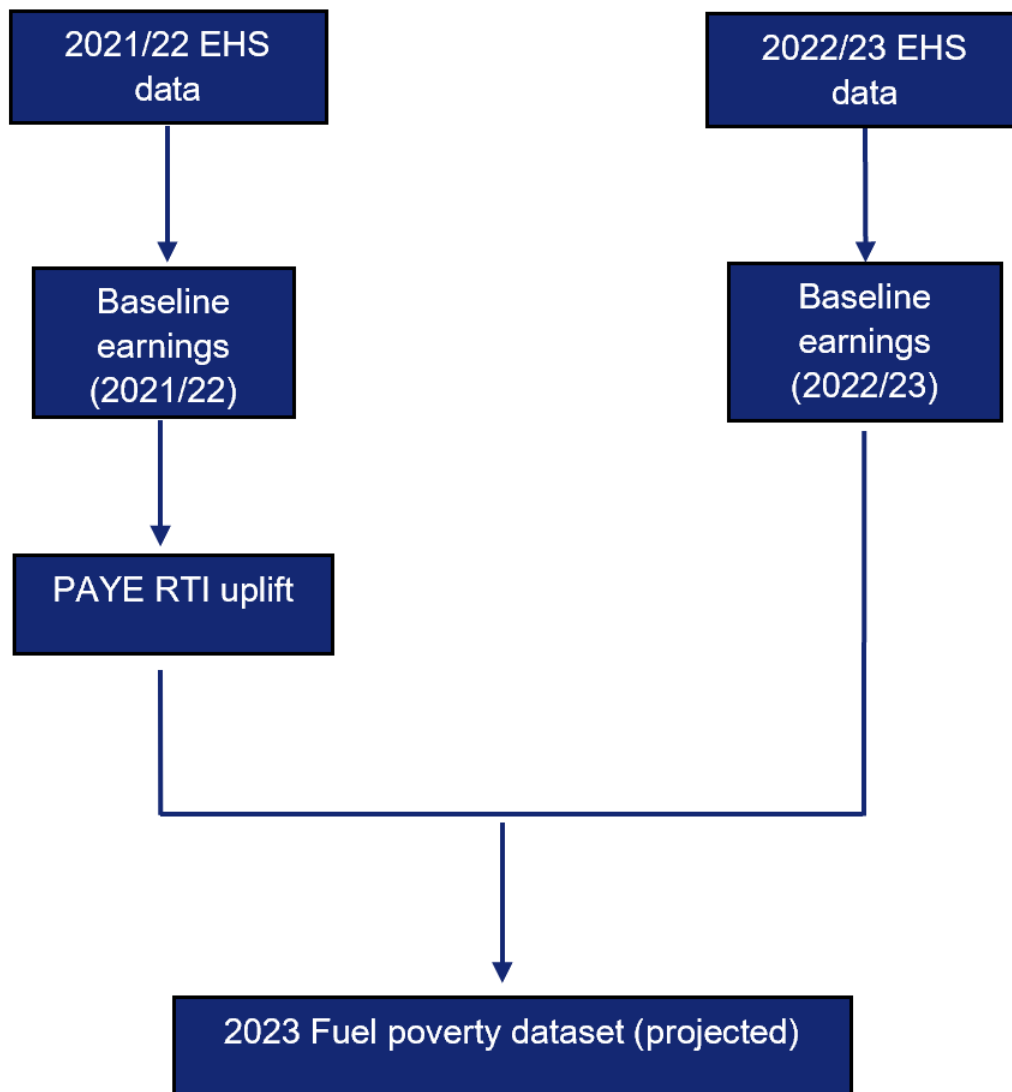
Within the fuel poverty dataset, different sources of household income are recorded. This is categorised into income from: earnings, savings, benefits, winter fuel payment and

‘other’ which includes private pensions. Council tax is then deducted from these combined income streams. Income is uprated dependent on its source, for the subsequent two years. Figures from the [Economic and Fiscal Outlook](#), which is produced by the Office for Budget Responsibility (OBR), are applied to uprate incomes from: earnings, savings, benefits and ‘other’ income sources in addition to statistical data of post survey changes already observed.

### Earnings

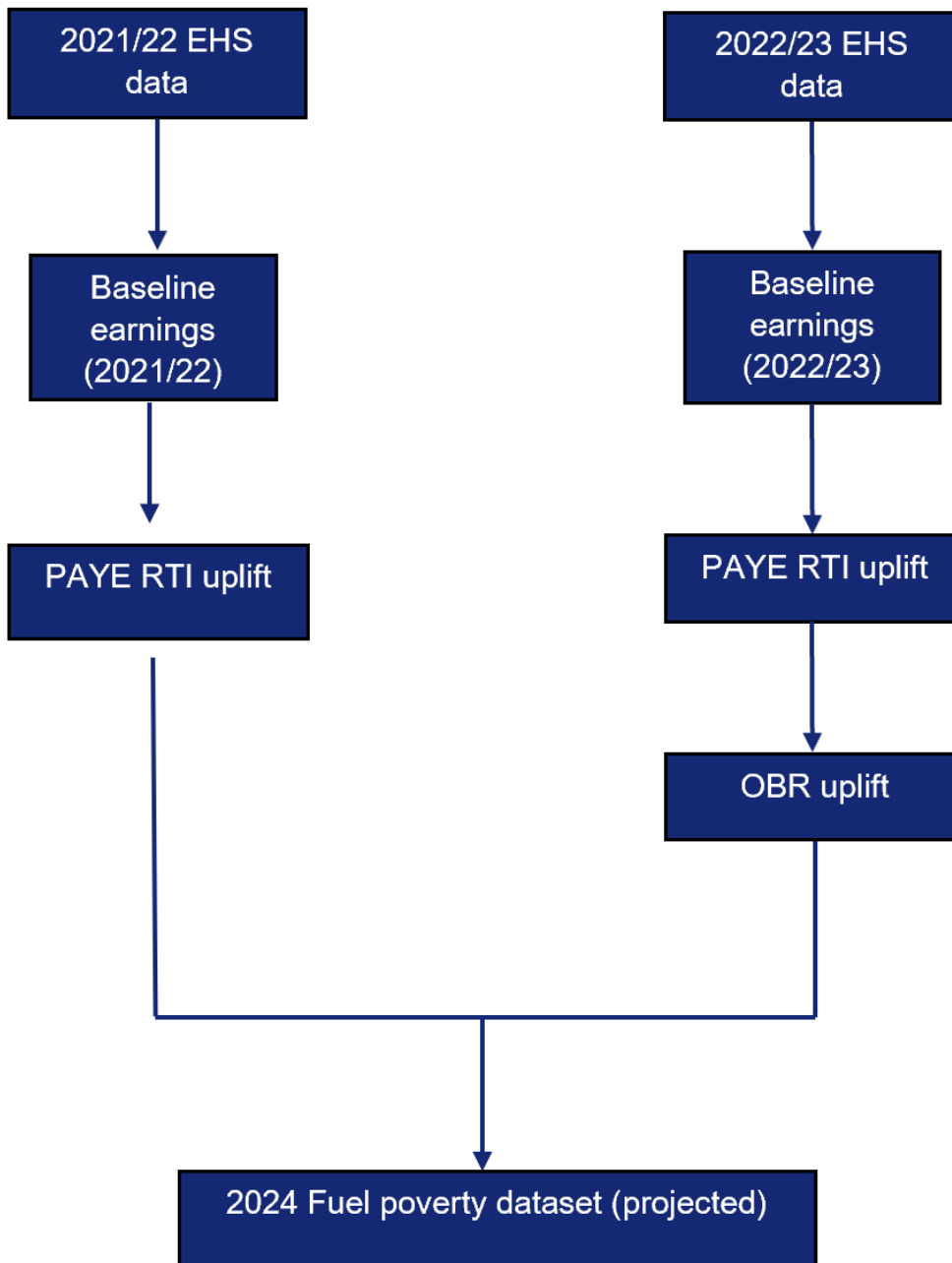
Earnings have been uplifted in a two-step manner. The English Housing Survey (EHS) earnings figures were uplifted by [PAYE Real Time Indicator \(RTI\) data](#), taken from a joint ONS and HMRC monthly publication, for Year 1. For Year 2, data from PAYE RTI has been used to uplift single-year 2022-23 data to 2023-24, which is then uplifted further by the weighted average of the 2024 and 2025 Average Earnings growth projection from the latest OBR forecast.

**Figure 10a: Flow diagram of earnings projection for 2023**





**Figure 10b: Flow diagram of earnings projection for 2024**



The 2024 projections are based on combining projected 2021/22 data with projected 2022/23 data.

**Savings**

Although interest rates have changed during this period, suggesting that income from savings would rise, there have also been significant cost of living pressures which offset these gains, therefore no changes have been made to savings values.

## Other

Any income from sources categorised as 'other' is updated by the Consumer Price Index (CPI) figures, sourced from OBR fiscal outlook tables. This will include private pensions.

## Benefits

Benefits are a broad term for any type of Government financial support, of which the amount received increases or decreases at different rates, dependent on the type of benefit received. However, for simplicity, they are treated as one type of benefit and are inflated based on [Universal Credit rates](#) published in June 2023. Year 1 projections are uplifted based on the change in universal credit amounts between 2021/22 and 2023/24. Year 2 projections are uplifted based on the change in amounts between 2022/23 to 2023/24 whilst also accounting for the benefits increase for 2024/25 as announced in the [Autumn Statement in November 2023](#).

These included an uplift of £650 (2022/23) and £900 (2023/24) for households on benefits.

## Winter fuel payment

In this modelling an uplift of £300 has been applied to Winter Fuel Payment in the base data to represent the Pensioner Cost of Living payment during the income projection calculations for 2023.

As part of the fuel poverty calculation the low income threshold is updated based on the estimated household incomes (after housing costs). The updated median income used for this is calculated from the projected datasets.

## 7.4 Prices

The main fuel prices considered in projections are the price of gas and electricity.

### 2023/24

Price assumptions for electricity and gas are based on the Ofgem default tariff [price cap](#). Figures for April – June 2023 apply the Energy Price Guarantee which capped prices at lower levels than the default price cap. Other fuels are modelled based on trends consistent with price cap changes for gas where applicable.

### 2024/25

Price assumptions for 2024/25 have been estimated by DESNZ economists based on forward market prices from January 2024. These are combined with the confirmed 2023/24 prices to make the combined 2024 estimate of prices. Based on these estimates, gas bills are projected to decrease by 21 per cent for all payment types between 2023 and 2024. Over the same period, electricity bills are also projected to decrease across all methods of payment, with an 11 per cent decrease estimated for 2024.

The methodology uplifts the fuel prices of households based on their calculated consumption which may have been reduced if the household has been allocated an energy efficiency measure in the projection. The overall financial year prices are taken as a weighted consumption average with 70 per cent of gas and 60 per cent of electricity assumed to be consumed between October and March.

Prices are applied in two ways:

1. For those households that have not received an energy efficiency measure and
2. For those households that have received an energy efficiency measure.

For point one, the standing charge for the base data is deducted from the total fuel costs depending on the main fuel type and if applicable. The difference is then uplifted (by multiplying it with a calculated uplift factor for the unit price) and the total fuel cost is achieved by adding the new standing charge for the projected year to get a new total fuel cost estimates.

For point two, the unit costs of each of these fuel types are then multiplied by the new number of units of energy required. This is done at a household level and is done separately for the half sample. Any standing charges associated with each fuel type are added to give a total fuel cost per fuel. The total fuel costs by fuel are added together to give a total fuel cost per household per year.

For heating oil, coal, and smokeless fuel, prices are known because they are used in the calculation of the CPI for 2022 and are used in the 2023 projection.

## 7.5 Projecting fuel poverty

To calculate the proportion of households projected to be in fuel poverty and their average fuel poverty gap, projected national level incomes for each year are used to calculate new fuel poverty thresholds for income. Based on the 2021/22 and 2022/23 data, each household record is projected on how income, energy efficiency rating and fuel costs would be expected to look in the future, based on the assumptions above.

The fuel poverty status in the future is determined based on the projections of FPEER and an assessment of whether (household income – fuel costs) is below the new poverty threshold, following the methodology defined in Chapter 6. For each projected year, the relative position of households to the new income threshold, and ultimately their fuel poverty status is recalculated.

Under LILEE, the fuel poverty gap for projections is calculated using a simplified method of the main fuel poverty model as it is the difference between current fuel costs (net of [Warm Home Discount](#) (WHD)) and the fuel costs for that household at FPEER 69 (the band C threshold) or the difference between (equivalised AHC income – equivalised fuel costs) and the low income threshold whichever is smaller. While the value of WHD is applied as a cash rebate to the total modelled energy bill the impact in reducing FPEER varies depending in prices, as SAP costs are based on current energy prices deflated to 2012. In the 2023 projection, the modelling included policy changes announced for the 2022/23 financial year which include the £400 Energy Bills Support Scheme rebate on energy bills, £150 rebate for council tax for homes identified as being in council tax bands A-D and the £200 [Alternative Fuel payment](#) for non gas or electricity heated homes. The council tax rebate has been treated as an energy bill saving because it was given as part of the [Energy bills rebate scheme](#).

## 7.6 Projecting against the target

The result of the projection of fuel poverty is to classify all households into their new fuel poverty quadrant based on their income, fuel costs and FPEER rating.

Using this projected fuel poverty status of the households, the projected progress against the target (see Chapter 2 of the main fuel poverty publication) can then be calculated.

These targets require the projection of the proportion of low income households that have an energy efficiency rating of Band D or above (2025 milestone) and Band C or above (2030 target).

## 8. Affordability metrics

Prior to 2013, England used an affordability measure whereby a household was considered to be fuel poor if it was required to spend at least 10 per cent of its income on energy costs. England stopped using this measure following a [review by Professor John Hills](#).

Two headline affordability measures have been included as supplementary indicators from 2023 but these are not directly comparable with previous metrics using in England due to differences in how incomes are calculated.

- **Metric 1 (BHC income)** – Household income after deductions for income tax and national insurance. This uses the `fpfullinc_LILEE` described in section 3.5. The main difference with the historic metric for England is the exclusion of disability benefits.
- **Metric 2 (AHC income)** – Before Housing Costs (BHC) income minus housing costs. This uses the `AHC_Income` described in section 3.6.

Income and fuel costs have not been equivalised in either of these simple metrics.

The metric is then the aggregation of all households where:

$$\text{fuel costs} \div \text{income} > 0.1$$

## 9. What fuel poverty statistics are available to users?

### 9.1 Fuel poverty data

DESNZ publish a large set of detailed tables, which accompany the main report, showing fuel poverty by income decile, tenure, dwelling type, household composition and many other factors concerning both the householders and the dwelling itself (e.g. insulation measures). DESNZ also publish an Excel workbook looking at trends in fuel poverty since 2010 for a range of sub-groups. To allow comparison, these tables show the results over time with financial figures deflated using the GDP deflator to real term prices.

All tables can be found on the Fuel Poverty statistics page of the [DESNZ website](#).

The detailed fuel poverty datasets are available via the UK Data Service. The 2022 datasets will be made available later this year. These datasets contain the underlying data used to calculate fuel poverty and the corresponding crosstab variables used within the fuel poverty report and are intended for advanced users of fuel poverty data. Documentation covering variable names and descriptions are also provided alongside the datasets.

Anonymisation techniques are applied to the End User Licence and Special Licence fuel poverty datasets deposited on the UK Data Service to maintain the confidentiality of respondents. Prior to releasing the data on the UK Data Service, and in-line with EHS disclosure control, all disclosive variables are removed to maintain the confidentiality of respondents. Some response categories are also condensed; several variables are top coded and, in a few rare situations, data swapping between cases takes place for disclosure control reasons.

Most fuel poverty variables are included in the dataset deposited at the UK Data Service under the standard End User Licence. To comply with the data disclosure control guidance issued by the Government Statistical Service, supplementary fuel poverty variables are released under the more restricted Special Licence on the UK Data Service.

In addition to this, DESNZ also publish fuel poverty data at a sub-regional level. Data for Local Authorities, Counties, Parliamentary Constituencies and Lower Super Output Areas (LSOAs) can be found on the [DESNZ website](#).

## 9.2 Fuel poverty publications

The 2023 Annual Report on Fuel Poverty Statistics reports the headline fuel poverty statistics for 2022 under the LILEE metric. The report provides an explanation of these figures, and the reasons for change from previous years, by looking at household income, household energy efficiency and energy prices. In addition, the report explores the trends in fuel poverty since 2010 amongst various subgroups.

These publications are available, alongside the reports from previous years, at the [Fuel Poverty statistics publication](#) page.

## 9.3 Methodology information

This methodology handbook is specific to the current LILEE measure of fuel poverty. For a description of the LIHC measure refer to the LIHC Handbook published in April 2020.

## 9.4 Consultation

Through the Energy Act 2013, the Government implemented a new legal framework to monitor fuel poverty in England using the Low Income High Costs Indicator (LIHC). This indicator of fuel poverty was first proposed in [Professor Hills' review of Fuel Poverty](#) and following consultation, the Government confirmed its intention to adopt the [indicator](#) in July 2013. In the accompanying strategic framework document, ['Fuel Poverty: a framework for future action'](#), the Government set out how the new indicator will inform the strategic approach to tackling fuel poverty, including setting a new fuel poverty target which will be underpinned by a new fuel poverty strategy.

A draft strategy and consultation document, 'Cutting the cost of keeping warm' was then published in July 2014. This proposed the creation of an additional indicator known as the Fuel Poverty Energy Efficiency Rating (FPEER) for use in targeting, and a number of targets tied to specific dates. Secondary legislation was put forward in December 2014 for this rating, alongside the LIHC fuel poverty definition, to form the basis of the statutory target for fuel poverty. This requires, as far as reasonably practicable, for all persons living in fuel poverty to have an FPEER of Band C or above by 31st December 2030.

In March 2015 the final [Fuel Poverty Strategy](#) was published, confirming the main and interim targets, alongside the responses to the July 2014 consultation.

In July 2019 the Government published the 'Fuel Poverty Strategy for England: Consultation document, in order to assess the implementation of the 2015 fuel poverty strategy so far and to seek views on proposals to update the fuel poverty strategy. [The Government response to this consultation](#) and the [Sustainable Warmth: protecting](#)

[vulnerable households in England strategy](#) were published in February 2021. This included the adoption of the current Low Income Low Energy Efficiency definition of fuel poverty.



## 10. How accurate are the fuel poverty statistics?

Fuel poverty in England is published as a point estimate of the number of households affected. A series of models are used to calculate the figure using inputs from a variety of sources, many of which are approximations. Therefore, the modelling process requires numerous assumptions. For example, there is no information on the energy supplier and the tariff that a household uses. Instead, households are assigned an average price depending on the region that they live in and the way in which they pay for their energy (e.g. standard credit, direct debit, etc.).

In 2014, DECC (now DESNZ) published analysis that estimated the uncertainty around the point estimates of fuel poverty for 2012. This analysis looked specifically at the uncertainty around household incomes, fuel prices and energy requirements, using these to then estimate the levels of uncertainty around the overall national estimates of fuel poverty. This analysis suggests that the addition of uncertainty is likely to increase the levels of fuel poverty observed.

We can interpret this in the context of the distribution of households across the LILEE metric – particularly in terms of how many households can be placed into the LILEE quadrant by the addition of uncertainty, compared to how many can be removed from this quadrant. Since currently 13.0% of households are in fuel poverty, there are far more households outside the LILEE quadrant than inside and in particular more households outside the LILEE quadrant close to the income and fuel costs thresholds (in the HILEE and LIHEE quadrants). Therefore, the application of uncertainty moves more households into fuel poverty than out of it (i.e. of eight households, one would be in fuel poverty and seven not fuel poor – so it is more likely to place a number of the seven households into fuel poverty than remove the one household out of fuel poverty). This has the net effect of increasing the average number of fuel poor households, resulting in a slightly higher distribution of possible values for the number that are fuel poor, and so consequently the aggregate gap, after the addition of uncertainty.

Annex A of the report shows the confidence intervals for key estimates up to the last year of actual data in 2022. The decision taken for the 2023 annual report to make the year 1 projection the headline figure reflects the need for timely estimates but does increase the uncertainty of the estimate as sampling error is combined with modelling error. Annex E of the report is a summary of the revisions made to the previous year 1 projection headline figures. Annex E details a comparison between the 2023 annual report year 1 projection (2022) and the subsequent final 2022 fuel poverty estimates, based on measured 2022 data. The central estimates have been revised in the final 2022 estimates, however, there

have been no statistically significant revisions to these metrics as all provisional estimates were within the confidence intervals shown in Annex A of the 2024 report.

These results need to be interpreted with caution. Any analysis of this kind is ultimately dependent on the input distributions used within the modelling, and the majority of the input distributions used are in themselves best estimates of uncertainty in each factor. Further to this, the analysis has been designed with a cautious approach, with conservative assumptions made throughout. As a result, these figures should be treated as indicative of the effect of uncertainty upon the national estimates of fuel poverty, rather than strictly quantitative.

# 11. Statistical Assessment

The UK Statistics Authority (UKSA) is an independent body operating at arms-length from the Government as a non-ministerial department, directly accountable to parliament. The UKSA's objective is to promote and safeguard the quality and comprehensiveness of official statistics and to ensure good practice in relation to official statistics.

Between February and July 2010, the UKSA carried out an assessment of DESNZ's (then DECC) fuel poverty statistics against the Code of Practice for Official Statistics. The Code is structured in terms of 8 principles and 3 protocols, which encompass meeting user needs, impartiality and objectivity, and sound methods, amongst others. If, after an assessment by the UKSA, official statistics are found to comply with the Code, they are designated as National Statistics. This indicates to users that the statistics have been produced in line with the Code. More details of the Code can be found on the [UKSA website](#).

In this assessment, the UKSA judged that the fuel poverty statistics are readily accessible, produced according to sound methods and are managed impartially and objectively in the public interest. As a result, the UKSA confirmed that the statistics published in the Annual Report on Fuel Poverty Statistics can be designated as National Statistics.

The continued designation of these as National Statistics was confirmed in July 2022 following a [compliance check by the Office for Statistics Regulation](#). The statistics last underwent a [full assessment](#) against the [Code of Practice for Statistics](#) in 2014.

## 12. Acronyms

<b>Acronym</b>	<b>Definition</b>
AA	Attendance Allowance
AHC	After Housing Cost
BHC	Before Housing Cost
BRE	Building Research Establishment
BREDEM	BRE Domestic Energy Model
CAPI	Computer Assisted Personal Interviewing
CHAID	Chi-squared Automatic Interaction Detector
CHP	Combined Heat and Power
CPI	Consumer Price Index
CTB/CTS	Council Tax Benefit/Support
DLA	Disability Living Allowance
DESNZ	Department for Energy Security and Net Zero
DUKES	Digest of UK Energy Statistics
DWP	Department of Work and Pensions
EHS	English Housing Survey
FPEER	Fuel Poverty Energy Efficiency Rating
FPMG	Fuel Poverty Methodology Group
FRS	Family Resources Survey
HB	Housing Related Benefits
HBAI	Households Below Average Income
HRP	Household Reference Person
LA	Local Authority
LCFS	Living Cost and Food Survey
LHA	Local Housing Allowance
LIHC	Low Income High Cost
LILEE	Low Income Low Energy Efficiency
LPG	Liquefied Petroleum Gas
DLUHC	Department for Levelling Up, Housing and Communities
MPPI	Mortgage Payment Protection Insurance
OBU	Other Benefit Unit
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
PBU	Primary Benefit Unit
PIP	Personal Independence Payment
PPM	Prepayment Meter
RdSAP	Reduced Data Standard Assessment Procedure
SAP	Standard Assessment Procedure
SMI	Support for Mortgage Interest
UKSA	UK Statistics Authority
WFP	Winter Fuel Payment
WHD	Warm Home Discount



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