PEER REVIEW OF THE METHODOLOGY FOR CALCULATING THE NUMBER OF HOUSEHOLDS IN FUEL POVERTY IN ENGLAND

FINAL REPORT TO DTI AND DEFRA

By

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Chapter 1: Introduction

1.1 Background

In 2001, the Government set out the definition of fuel poverty in England that it would use to estimate the extent of the problem and to monitor progress towards its objective of eliminating fuel poverty among vulnerable households as far as reasonably practicable by 2010.[1] In the context of the UK Fuel Poverty Strategy, a household is vulnerable if it contains an older person aged 60 or over, a child under the age of 16 or someone who is disabled or has a long term illness. According to the principal definition used by the Government for target setting, a household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income, including Housing Benefit or ISMI[2], on all household fuel use.

A considerable amount of analysis of fuel poverty has been carried out in recent years. In the process, a number of possible changes to the methodology used to produce the figures for fuel poverty in England have been identified by the Building Research Establishment (BRE), which maintains and runs the fuel poverty model on behalf of DTI/Defra.

The latest estimates of fuel poverty using the 2001 English House Condition Survey (EHCS) were published in July 2003[3]. A short paper accompanying these estimates explained the proposed changes to the methodology, concluding that the combined effect of these changes would make very little difference to the numbers in fuel poverty. Further analysis by the BRE over the summer of 2003 showed that these changes would in fact lead to a substantial reduction in the number of fuel poor households of around half a million households. At this stage, it was decided that the proposals could not be implemented without consulting more widely. DTI/Defra issued a consultation paper on 26 April 2004 asking for responses by July. Ministers also commissioned this independent Peer Review of the methodology to ensure that the figures for fuel poverty are as robust as possible. The remit of the Peer Review is broader than the consultation. As well as examining the six proposals put forward by the BRE, it also provides an overall assessment of the methodology used to produce the fuel poverty estimates.

1.2 Aims and scope

The Peer Review is divided into three stages. The terms of reference, as recorded in the consultation paper, are to undertake:

a. an investigation of the specific proposals raised by BRE and, taking account of the responses to these proposals received through a consultation exercise to be

[1] See Annex D of the UK Fuel Poverty Strategy, which is available on the DTI website: (www.dti.gov.uk/energy/consumers/fuel_poverty/strategy.shtml)
[2] Income Support for Mortgage Interest.
[3] Modelled estimates for 2002 have been produced since, but estimates based on the 2002/03 (and 2003/04) EHCS will not be published until the Spring of 2005.

carried out by Government, provide advice on whether and in what form they should be implemented (see Chapter 2 of this report);

b. an assessment of the overall methodology, within the current definition of fuel poverty, for calculating the number of households in fuel poverty in England and recommendations on how it could be improved (Chapter 3 of this report); and
c. consideration of whether further analytical work is required to give a better understanding of the degree of, and trends in, fuel poverty and its associated problems (Chapter 4 of this report).

In commissioning this Peer Review, Ministers made clear that they were not prepared to consider changes in the current definition of fuel poverty at this time, on the basis that these issues were explored in the period leading up to the publication of the Fuel Poverty Strategy, both within government and as part of the external consultation on that document. This review focuses, therefore, on the methodology used to measure fuel poverty *within the existing definition*, although some broader issues that were raised in the consultation responses are explored in the third stage of the review (see Chapter 4).

Some of the recommendations in this Peer Review are expected to feed into Ministerial decisions on changes in the methodology to be used in findings reported in the UK Fuel Poverty Strategy Third Annual Report, which is due to be published in the Spring of 2005. Other recommendations require additional work to be carried out and will need to be considered over a longer time-scale.

1.3 Approach

This Peer Review took on board views and evidence from a wide range of sources, starting with a consideration of the responses to the Government's consultation on the BRE's proposals. At an open workshop held at the DTI on 27 May 2004 to inform the consultation exercise, participants were encouraged to use their responses to this consultation to comment more broadly on the approach to measuring fuel poverty, as well as on the six specific proposals put forward by the BRE. This process has helped to identify issues that should be examined in the second and third stages of the Peer Review, as well as informing our recommendations on the first stage.

An initial Scoping Note, setting out our proposed conduct of the Peer Review, was completed on 29 July 2004 and published on the DTI website.[4] Following on from the consultation, we have conducted a series of bi-lateral meetings with government officials, the BRE, other key players in the area of fuel poverty and academics working in this area. These took place between August and November 2004. A full list of consultees is provided in Appendix A. These meetings helped deepen our own understanding of the methodology used to produce the fuel poverty numbers and the roles of different players involved in managing this process, as well as providing an opportunity to discuss in more depth specific issues raised in the responses to the consultation.

[4] Available at: www.dti.gov.uk/energy/consumers/fuel_poverty/peer_review.shtml.

In addition, we have carried out a certain amount of empirical analysis using data from several large-scale household surveys to test the validity of the data and assumptions underlying the current fuel poverty model; and to examine in more detail the implications of the BRE proposals and other proposals that have arisen during the course of the Peer Review. Wherever possible, we have also drawn on existing analyses by the BRE and others.

Our assessment of the overall methodology for calculating the numbers in fuel poverty has been guided by a number of general principles. In particular, we think it is important that the measurement of fuel poverty should:

- be based on a sound conceptual framework;
- make use of the best available evidence, for example on patterns of domestic energy consumption;
- be consistent with established standards elsewhere, where relevant, for example in the way incomes are defined and measured;
- provide consistent estimates over time, so that trends in fuel poverty can be accurately monitored;
- be able to capture the beneficial impact of policies aimed at tackling fuel poverty;
- take into account the varying circumstances of different types of household;
- command the broad support of the key players in the fuel poverty field;
- be as transparent as possible;
- be subject to external validation on an ongoing basis; and
- be 'future-proofed' with established procedures for updating the model as new information becomes available.

A Steering Group of Departmental officials has overseen the conduct of the Peer Review and provided both helpful guidance and further information requested by us. The members of the Steering Group were: Graham White (Chairman), Marilyn Booth and Peter Matejic (from the DTI); Pam Wynne and John Mason (Defra); John Sparrow (H M Treasury); Stephen Balchin (DWP); and Terry McIntyre (ODPM).

1.4 Fuel poverty model

The fuel poverty model generates estimates of fuel poverty based on a large and representative sample of households in England, using data from the English House Condition Survey (EHCS). The latest estimates are based on a sample of 16,750 households from the 2001 EHCS.

The current model consists of two main components:

- a fuel cost model: this generates estimates of total required fuel costs for each household for space and water heating, cooking, lighting and other appliances. This in turn depends on a set of assumptions about heating regimes (i.e. expected patterns of heating and temperature standards) and fuel prices, as

well as detailed information on the heating systems and standards of insulation in each dwelling.

- an income model: this uses information collected in the EHCS to estimate the total net income of each household, including earnings, state benefits, private pensions, investment income, and other sources of income for all adult members of the household.

Together, these estimates of required fuel costs and household income are used to identify whether a household is in, or out of, fuel poverty. The Fuel Poverty Index is calculated by dividing required fuel costs by household income. If the index is greater than 0.1 then the household would need to spend more than 10% of its income on domestic fuel in order to heat its home to an adequate standard of warmth and meet other energy requirements and is thus considered to be in fuel poverty. A more detailed description of the fuel poverty model, prepared by the DTI, is provided in Appendix B.

1.5 Outline of report

The core chapters of this report cover the three different stages of the Peer Review. Chapter 2 examines each of BRE's six proposals in turn, recommends certain changes to the methodology, and estimates the impact of these recommendations on the fuel poverty estimates.

Chapter 3 looks beyond this set of specific proposals to assess the overall methodology for calculating the number of households in fuel poverty. The key income- and energy-related components of the fuel poverty model are assessed, focusing in particular on whether the assumptions underlying the model create any potential bias in the fuel poverty estimates. This chapter also considers various process issues, such as the way the model is updated and the results validated.

Chapter 4 considers some broader analytical issues relating to the measurement of fuel poverty, including: the notion of a 'standard' for non-heating fuel use; servicing costs for heating systems; supplementary indicators of fuel poverty; the concept of affordability that underlies the definition of fuel poverty; and the treatment of households with varying needs related to household size or disability status. We emphasise that this chapter is not intended to challenge the current definition of fuel poverty. It is rather to identify other possible sources of evidence on the scale and incidence of households who may have difficulty paying their fuel costs. This could be used to help interpret and complement the official fuel poverty statistics, whilst understanding that the Governments primary objective is to eradicate fuel poverty as defined in the UK Fuel Poverty Strategy 2001.

Chapter 5 summarises the key recommendations of the Peer Review. As well as listing our recommendations, we set out our views on whether any proposed changes should be made in the short-, medium-, or long-term and their likely impact on the fuel poverty estimates.

Chapter 2: Discussion of the BRE Proposals

2.1 Introduction

The Building Research Establishment (BRE) is proposing a number of changes to the methodology used to produce the figures for fuel poverty in order to improve the model's accuracy:

(1) To use EHCS (English House Condition Survey) data relating to additional benefit units to determine whole household income rather than the FES correction factors used in the current fuel poverty model;
(2) To include income derived from Council Tax Benefit in the income measure;
(3) To update the algorithm for calculating lights and appliance energy use;
(4) To use actual household numbers (rather than modelled numbers) to estimate the energy consumed by lights and appliances and for hot water;
(5) To apply a 20% increase in hot water use across all households; and
(6) To undertake a study of domestic hot water use to inform a possible revision of the hot water algorithm.

The last two proposals are treated together in this Peer Review as they deal with the same issue: proposal 5 is a short-term solution, which would be superseded by proposal 6 if a decision were made to go ahead with the proposed study.

These proposals and the reasons for them are described in more detail in two papers prepared by the BRE, which were presented at an open workshop held at the DTI on 27 May 2004.[5] These papers also examined the likely impact on the fuel poverty estimates of each of these proposals. The combined effect of the first five proposals would be to reduce the number of fuel poor households in England from 1.7 million to 1.1 million[6] (see Table 1 in Appendix D). Updating the lights and appliances and hot water algorithms increases the fuel poverty estimates, but this is more than offset by the impact of the other proposals.

Table 2, based on our own analysis, shows how the changes in the methodology proposed by BRE would affect the *composition* of fuel poor households. The combined effect of their proposals is to increase the share of single person households and reduce the share of larger (other multi-person) households; they also increase the share of the least energy efficient homes. There is very little impact on the distribution of fuel poor households by tenure, region, income group, or level of occupancy.

The rest of this chapter discusses each of these proposals in turn, including their rationale as given by the BRE, the arguments for and against the proposed changes, the views of those we consulted as part of this Peer Review, other evidence (e.g. from analysis of survey data), and our recommendations. The final section considers the

[5] The two BRE papers are: "Modelling incomes for fuel poverty" and "Fuel poverty: updating estimates for the cost of energy" and are available on request from Peter Matejic at the DTI on Peter.Matejic@dti.gsi.gov.uk.
[6] The impact of the sixth proposal cannot be estimated in advance, because it depends on the results of the proposed study of hot water usage.

combined impact of these recommendations on the number and composition of fuel poor households (also shown in Tables 1 and 2).

2.2. Proposal 1

BRE's first proposal is to use newly available data on the income of additional benefit units in place of FES-based correction factors.

2.2.1. Background

The income measure used in the current definition of fuel poverty is total household income, including the income of secondary benefit units – for example a grown-up child living with their parents, or two or more people sharing a house.

In previous years, the EHCS only collected information on the income of the primary benefit unit i.e. the householder, their spouse or partner (if they have one), and any dependent children. So, the income of other benefit units had to be estimated. Using data from a separate survey, the Family Expenditure Survey (FES), the incomes of households with more than one benefit unit were adjusted upwards in line with the incomes of similar households in the FES for that year.

An additional question was added in the 2001 EHCS asking about the income of each additional benefit unit. The proposal is to use this data on 'actual' incomes to produce more accurate estimates of the total incomes of households with two or more benefit units, which account for around one in five households in England.

2.2.2. Use of correction factors

The method of calculating correction factors in the 2001 fuel poverty model was based on documentation provided to BRE, who took over responsibility for producing the fuel poverty numbers in 2000. This documentation was incomplete and assumptions had to be made to complete the methodology. It appears from our discussions with Richard Moore, who produced the 1996 figures, that the methodology used to calculate the correction factors in the 2001 fuel poverty model was not in fact the same as in the 1996 model and that they were applied to a different subset of households.

In 1996, the correction factors were based on examining the average incomes of 15 different household types in the FES and adjusting upwards the incomes of similar households in the EHCS where the average for all households of that type was significantly lower – by 10% or more – than those found in the FES. This covered 5 out of the 15 categories: two men or two women, three adults, three adults with children, four or more adults, and four or more adults with children. The correction factors were calculated as the ratio between the average income of households of that type in the FES and EHCS (e.g. if the average income of three adult households were £500 per week in the EHCS and £750 per week in the FES, then the correction factor for this group would be 1.5). In 2001, the correction factors were calculated differently (and, in our view using an incorrect methodology), by comparing the average income of different types of household with the average income of all households in the FES (rather than the average income of similar households in the EHCS). Furthermore, the 2001 correction factors were applied to a much smaller,

sub-set of "other multi-person" households, which excludes many of the households in the five categories above.

Other things being equal, the published figures will have over-estimated the number of fuel poor households in 2001 on a like-for-like basis. Our own analysis using Family Resources Survey (FRS)-based correction factors[7] produces an estimate of fuel poverty of just over 1.5 million households - around 0.2 million households lower than the published estimates (see Table 3).

Even if the correction factors were calculated in what we consider to be the most appropriate manner, the use of correction factors is not recommended. Using correction factors implicitly assumes that the incomes of additional benefit units are closely and positively correlated with the incomes of the primary benefit unit they are co-sharing with (i.e. that where the primary benefit unit has a relatively low income, additional benefit units in the same household will also have a low income and vice-versa). However, analysis of income data from the Family Resources Survey shows that the incomes of secondary benefit units are uncorrelated with the incomes of the primary benefit unit – the correlation coefficient is only around +0.01 (on a scale of -1 to +1). Table 4 compares the gross incomes of the primary and additional benefit units in households with two or more benefit units. Households where the primary benefit unit has a low income (of less than £150 per week) are only marginally more likely than average to be sharing their home with another low income benefit unit (40% vs. 36%) and only marginally less likely than average to be sharing with a high income benefit unit (18% vs. 20%).

2.2.3. New EHCS data

There are a number of significant issues relating to the new EHCS income data on additional benefit units that we think need to be examined more thoroughly if this information is to be used in the fuel poverty model in place of correction factors. These include:

- The amount of missing data and the methodology used to impute incomes where data is missing; and

- The quality of the data (where it is not missing) and how this information is converted into the point estimates of net incomes that are used in the fuel poverty model.

Missing income data

In the 2001 EHCS, data on the incomes of additional benefits units is missing in a relatively high proportion of cases – in around 50% of cases according to BRE (see Table 5).[8] The proportion of missing cases is especially high where the additional

[7] It is preferable to use the Family Resources Survey (FRS) to derive these correction factors, because the sample is substantially larger than the Family Expenditure Survey and the quality of the income data is generally recognised to be better.

[8] The proportion of missing cases is even higher in the published data set (58%). There are 394 cases where BRE have since re-sequenced the benefit units in order to match the benefit unit numbers assigned in the household grid to those assigned in the income of other benefit units (so that the household reference person is always in the first benefit unit). According to BRE, this reduces the proportion of missing cases from 58% to 50%.

benefit unit is unemployed or inactive, middle-aged, and/or not a single person (see Table 6).

BRE have identified several problems with the data collected in the 2001 survey. Firstly, the interview was carried out with the household reference person or their partner who may have had little or no knowledge of income of other benefit units in the household. For example, people in shared houses often do not know what other people earn or what benefits they receive. This is a continuing problem, because of constraints on the household interview schedule.

Secondly, some households with additional benefit units were not identified as such during the interview because of anomalies between the details of people living in the household and what had originally been coded as the number of benefit units. The income data for these cases is missing as the relevant questions were never asked. According to the ODPM, this particular problem has been resolved in more recent EHCSs. As a result, the proportion of missing cases[9] has fallen from around a half in the 2001 EHCS to less than a quarter in the 2002/03 and 2003/04 EHCS, based on figures provided by the ODPM. We would support the efforts of ODPM to reduce further the proportion of cases with missing income data within the constraints on the design and conduct of the EHCS (which is not primarily designed to collect income data).

Where income data is missing, BRE imputes their income using information from the New Earnings Survey on the average wages of people of the same age and gender (where the person in question is in work) and average imputed state benefits (where they are not in work). Whilst correct on average, this method of imputation does not allow for the spread of incomes around the average and will therefore under-estimate the number of such households with very low and very high incomes. This is particularly important in this context, because it is those on the very lowest incomes who are most likely to be at risk of fuel poverty.

We recommend that the imputation of incomes within the fuel poverty model is reviewed by DTI, Defra and ODPM in close consultation with the DWP. More specifically, we believe that BRE should consider employing alternative methods of imputation, such as hot-decking[10], that would make use of the income data collected in the survey to 'fill in' missing observations. Hot-decking is the most common method of imputation and is used in the Family Resources Survey to impute most missing income data. The advantage of using hot-decking in place of the current methodology is that it would be better at capturing the variability in incomes found in actual income data.

[9] Where information is not available on at least one benefit unit in the household.

[10] Hot-decking essentially looks at the characteristics of the household containing the missing income data to be imputed and matches it up to another household with similar characteristics for which income data is not missing. It then takes the known income data and copies it to the missing cases. This method ensures that imputed solutions are realistic and maintains variability in the data. The characteristics used to match households should be those that are most closely correlated with incomes, for example the size of benefit unit and the work status of adults in the benefit unit.

Quality of EHCS data
Even where data is not missing, there are some doubts about its veracity. Whereas income data on the primary benefit unit is based on a series of questions to householders about a range of possible sources of income, the data on additional benefit units is essentially based on a single question elicited from a third party. It seems very likely that the householder or their partner may not always be very well informed about the incomes of other benefit units in their household.

Whilst this is clearly impossible to verify on a case-by-case basis, it is possible to compare the overall distribution of the incomes of additional benefit units with data from the Family Resources Survey, which collects more detailed and accurate income data. The distribution of incomes in the 2001 EHCS is in fact very similar to that found in the 2001/02 FRS. Whilst not conclusive, this analysis suggests that the raw income data that was collected in the 2001 EHCS is consistent with the best available data on the incomes of additional benefit units, at least in aggregate (see Table 7).

An additional complication is that the data collected is on *gross* incomes and is *banded*.[11] In order to derive the measure of total household income used in the fuel poverty model, assumptions have to be made about where incomes lie within these bands and how much tax they are paying (to convert gross into net incomes). BRE assume all households within a particular income band receive the mid-point of that range, except for the bottom income band (less than £100 per week) who are assigned the calculated income support amount for that type of benefit unit. Using the mid-point of each range will not fully capture the variability in actual incomes.[12] Furthermore, as discussed more fully in Section 3.3, we do not believe that a basic minimum income should be imputed to those households reporting very low incomes and recommend that the appropriateness of doing so is examined in close consultation with the DWP. This will have a knock-on effect on proposal 1, by reducing the incomes of 'low income' additional benefit units.

It was not possible in the time available to review the methodology used to convert gross into net incomes.[13] The assumptions appear reasonable at face value, but we recommend that these, too, are reviewed with the DWP alongside other aspects of income measurement.

2.2.4. Conclusions
We support the BRE proposal *not* to use correction factors to estimate the incomes of additional benefit units. The use of correction factors assumes that the incomes of additional benefits are closely and positively correlated with the incomes of the primary benefit unit, whereas our analysis of data from the Family Resources Survey shows this is not the case.

[11] Respondents are asked whether the incomes of other benefit units lie within certain pre-specified ranges: under £100 per week, £100-149 per week, £150-199 per week, and so on.
[12] Our own analysis of FRS data suggests that incomes are distributed fairly evenly within each income band, except within the bottom band (less than £100 per week), where they are bunched towards the bottom of the range.
[13] For couples, BRE assume that income is split evenly between the two partners. National Insurance contributions are deducted at the standard rate for contracted out employees, as there is no information on whether they are self-employed.

It seems sensible to make use of new data on the incomes of additional benefit units, as proposed, to generate a more accurate measure of household incomes within the current definition. Most respondents to the consultation supported this proposal, with one or two exceptions who felt that in practice the incomes of other benefit units would not always be available to help pay the household's fuel bills.

However, there are a number of technical issues that we think need to be examined more thoroughly to help validate the use of this data within the fuel poverty model - and which we do not feel were given sufficient attention in developing and presenting the BRE's proposals. We have identified three issues in particular: the extent of missing data (although this is less of a problem in more recent surveys); the imputation of incomes where data is missing; and the assumptions made in converting banded gross incomes into point estimates of net income. In addition, the treatment of benefit units with very low reported incomes should be covered as part of the review into the methodology of looking at fuel poor households on low incomes. The latter is discussed further in Chapter 3, as it does not only apply to households with additional benefit units.

We do not wish to be prescriptive about how this review is conducted, although we have already suggested to officials that the BRE team works closely with the HBAI and FRS teams within the Department for Work and Pensions to ensure that the methodology is consistent with best practice in the field of income measurement. We understand that it will not be possible to complete this work in time for the next set of fuel poverty estimates in 2005. However, we think this further review is a high priority for the fuel poverty model and that the results should be available and published alongside the fuel poverty estimates contained in the Fourth Annual Progress Report in 2006.

2.3. Proposal 2

The BRE's second proposal is to include Council Tax Benefit in the "full" income measure.

2.3.1 Background

Previously there was no information on the level of Council Tax Benefit (CTB) being claimed. On the initiative of the ODPM (formerly DETR), new questions were added to the 2001 EHCS (and subsequent surveys). As this information is now available, it is proposed by BRE that CTB should be included in the "full income" definition of income (though not in the "basic income" definition) in order to be consistent with the treatment of Housing Benefit and Income Support for Mortgage Interest.

2.3.2 Discussion

Respondents to the consultation were divided on the merits of this proposal, with a slight majority against. Some of those who supported the inclusion of CTB said this was on condition that council tax payments were also deducted. **Our view, also, is that it is inappropriate to count a benefit, but not to deduct the tax it is designed to cover. Deducting council tax payments (net of CTB) would be consistent with the government's official (HBAI) income measure and with international best practice in the measurement of household incomes.** The Canberra Group on

Household Income Statistics was formed with the aim of improving national statistics on income distribution and inequality, with a desire to improve the quality of international comparisons in this area. It recommended deducting local taxes such as council tax to obtain net income.[14]

The only argument given for not deducting council tax payments is that this is consistent with the treatment of housing benefit (i.e. housing benefit is included in incomes without deducting rental payments). But, council tax is a tax and, like income tax, is unavoidable (within the law). As such, income spent on paying council tax is not available to cover fuel bills and should not be included in households' disposable incomes. (The treatment of other housing costs is discussed in Chapter 4).

The combined effect of deducting council taxes net of CTB would be to increase the number of households in fuel poverty by around 0.3m, whereas adding in CTB without deducting council tax payments would reduce the overall number of households in fuel poverty by 0.1m[15], according to our own calculations, detailed in Table 1.

2.4. Proposal 3

BRE's third proposal is to update the algorithm for calculating lights and appliances' energy use.

2.4.1. Background

The lights and appliances algorithm is used to estimate energy consumption for all lights and appliances, except for hobs and ovens (which are covered by a separate "cooking" algorithm), as a function of a dwelling's floor area and the number of occupants. The original form of this algorithm dates back to an analysis using data from the early 1980s.[16] In 1993 further work was done on this and other topics for BRE by Energy Advisory Services Ltd (now National Energy Services Ltd) using data (probably from the late 1980s) that had been obtained from the Electricity Council.[17] This unpublished review of BREDEM assumptions produced a revised equation, having the same basic form as the original. This is the current version used to produce the published estimates for 2001 and in the 1996 fuel poverty model (see Box 1).

[14] More information is available at www.lisproject.org/links/canbaccess.htm

[15] The actual estimates are 1.722m fuel poor households (before including CTB) and 1.533m (with CTB included) – a reduction of 0.169m (i.e. nearer to 0.2m than 0.1m). However, when the overall numbers in fuel poverty are rounded to the nearest one hundred thousand, as in Table 1, the difference is 0.1m (i.e. a reduction from 1.7m to 1.6m).

[16] Henderson, G. and Shorrock, L. (1986), 'The BRE domestic energy model: testing the predictions of a two-zone version', *Building Services Engineering Research and Technology*, Vol. 7, No. 2.

[17] Chapman, P. (1993), *BREDEM-12: the supporting evidence and theoretical basis*, unpublished BRECSU Research Project.

Box 1: Lights and appliances algorithms

Current algorithm

$\mathbf{E_{LA}} = 2.23 + (0.0232 \times \mathbf{TFA} \times \mathbf{N})$ *for TFA x N < 710*

$\mathbf{E_{LA}} = 9.74 + (0.0146 \times \mathbf{TFA} \times \mathbf{N}) - 2.78 \times 10^{-6} \times (\mathbf{TFA} \times \mathbf{N})$ *for 710 < TFA x N < 2400*

$\mathbf{E_{LA}} = 28.77$ *for TFA x N > 2400*

Where $\mathbf{E_{LA}}$ is imputed electricity consumption for lights and appliances in GJ/year.
TFA is the total floor area of the dwelling in m^2.
N is the number of occupants in the dwelling.

Proposed algorithm

$\mathbf{E_{LA}} = 4.47 + (0.0232 \times \mathbf{TFA} \times \mathbf{N})$ *for TFA x N < 710*

$\mathbf{E_{LA}} = 11.98 + (0.0146 \times \mathbf{TFA} \times \mathbf{N}) - 2.78 \times 10^{-6} \times (\mathbf{TFA} \times \mathbf{N})$ *for 710 < TFA x N < 2400*

$\mathbf{E_{LA}} = 31.01$ *for TFA x N > 2400*

The decision to revise the lights and appliances algorithm was driven by a combination of fuel supply data from DUKES[18] and DECADE[19] data on the lights and appliances split, plus anecdotal evidence that energy consumption on these items has been rising steadily over time and that the current algorithm was becoming increasingly out-of-date.

The DECADE model is designed to estimate overall energy demand across the stock as a whole and does not examine how usage varies between different types of households or dwellings. Consequently, a simple modification was introduced into BREDEM to ensure that for an average dwelling it predicted the same average use of lights and appliances as implied by DECADE[20], but the general form of the relationship already in use was retained. The constant in the equation was increased and the slope coefficients were left unaltered, as this was felt by BRE to be the best that could be done in the circumstances (see Box 1).

2.4.2. Discussion

There is widespread agreement that the current algorithm needs updating. It significantly under-estimates average levels of energy consumption and, in addition, misrepresents the pattern of consumption between different sizes of household. The algorithm was already out-of-date in 1996, so the model would also need to be re-run

[18] Digest of United Kingdom Energy Statistics.

[19] DECADE is a detailed end-use bottom-up model of domestic electricity and gas use in lights, appliances, and water heating, which was developed by the Environmental Change Institute at the University of Oxford.

[20] We have asked BRE on several occasions to provide further information on how the new algorithm was derived and the data underlying this revision, but we had not received any additional material at the time of completing this Peer Review.

on the 1996 data set using the modified algorithm in order to obtain more consistent estimates over time.

The proposed algorithm is assessed against two criteria. Firstly, it should accurately predict the average level of electricity consumption on lights and appliances – or rather the best available estimates of this. Secondly, the algorithm should capture as much of the variation in consumption between different types of household as is reasonably possible (at least in so far as this reflects genuine differences in need).

Average domestic use of electricity for lights and appliances
Estimates of domestic energy consumption per household are presented in Table 8 and compared with the average consumption levels implied by the BRE algorithm. The first set of figures is produced by Defra's Market Transformation Programme (MTP), building on a long-running series originating with the Environmental Change Institute (ECI) at Oxford University. These estimates are based on a detailed end-use (or bottom-up) model of domestic energy use for different types of appliances.[21] Average domestic electricity consumption on all lights and appliances (including cooking) in 2001 is estimated at 13.0 GJ/yr per household. This is forecast to rise to 13.9GJ/yr per household by 2010 (under the MTP's reference case scenario).

Table 8 also presents a separate series produced by the DTI, based on data supplied by BRE, which shows lower levels of electricity consumption on lights and appliances – an average of 11.4 GJ/year per household in 2001. These figures are top-down estimates based on estimates of total electricity consumption by the domestic sector, which is then broken down into electricity used for space heating, water heating, cooking, and other lights and appliances. (The figures presented here are the sum of the last two categories.)

The current algorithm clearly under-estimates domestic electricity consumption on lights and appliances; it produces an average estimate of 8.8 GJ/year per household in 2001, which is substantially lower than implied by both the ECI/MTP and DTI series. The proposed algorithm generates estimates that are much closer, on average, to aggregate estimates of domestic electricity consumption. Whether it is still significantly under-predicting consumption depends on which series you compare it with. The implied consumption of 11.0GJ/yr per household in 2001 is close to the DTI figures for the same year, though still nearly 20% lower than the latest ECI/MTP estimates (and 25% lower than the forecast for 2010). Officials at DTI (who publish both series in their Energy Consumption Tables) say they would give more weight to the figures they derive from BRE data, because they are based on actual amounts of electricity delivered to the domestic sector (less estimates of consumption for space and water heating). However, it is perhaps surprising that this series shows no rise in average consumption per household over the whole of the 1990s – indeed a slight fall – when all the evidence suggests that the ownership and usage of domestic appliances have been rising (partly offset by a fall in average household size and the improved energy efficiency of appliances).

[21] The model contains information on the ownership, sales, usage and electricity consumption of different types of household appliances. The model has been validated wherever possible by using monitored energy consumption data and average household bills, and reconciled with top-down estimates of total domestic sector energy consumption.

The proposed algorithm is clearly a step in the right direction and is close to a series based on BRE's own estimates of average consumption on lights and appliances, though still significantly lower than an independent series produced by Defra's Market Transformation Programme. **We recommend that further work is undertaken to understand the differences between the DTI and ECI/MTP series and make a more informed judgment on which of these series is likely to be a more accurate representation of actual consumption levels. In either case, this algorithm may need to be updated between now and 2010 to keep up with the anticipated trend rise in consumption over this period.**

Patterns of domestic electricity consumption

As already noted, the lights and appliances algorithm should reflect needs-related variation in consumption between different types of households – for example, between smaller and larger households. One way to assess this is to compare actual or reported levels of electricity consumption by different types of households against the amounts implied by the current and proposed algorithms. We use data from two large scale household surveys: metered data from the fuel sub-sample of the 1996 English House Condition Survey (EHCS) and expenditure data from the 2000/01 Family Expenditure Survey (FES). The focus here is on relative levels of consumption (between different types of households) as opposed to absolute levels, which were examined in the previous sub-section. This analysis is carried out on the sub-sample of households with gas central heating, where it can reasonably be assumed that all (or nearly all) the electricity consumed by these households is on lights and appliances (and not space or water heating).[22] Cooking, though treated separately in the BREDEM model, is included in this analysis, because it is not possible to differentiate between this and other uses of electricity.

The pattern of energy use implied by the proposed algorithm is found to mirror quite closely that found in household-level data on actual electricity consumption and reported expenditure on electricity (see Table 9). The main differences are that the proposed BRE algorithm still appears to over-estimate energy consumption in the largest dwellings and the largest households and does not capture the variation in consumption between income groups. But, the 'fit' is considerably better than the current algorithm, which substantially over-estimates the energy consumption of larger households.

Additional analysis of this data suggests that the simple structure of the algorithm - using just two variables, household size and floor area - captures most of the variation in the use of energy for lights and appliances that can be accounted for by standard socio-economic variables. Although income does have a significant effect on energy consumption over and above the impact of dwelling size, it does not seem appropriate to take this into account in this context, since these differences are not related to need (see Table 10).

However, there is a case on both conceptual and empirical grounds for separating out household size and floor area, rather than inter-acting the two as in the current and

[22] The 1996 EHCS includes additional information that allows us to identify more clearly those households that are not using electricity for their main or secondary space heating and do not have an electric water heating system.

proposed algorithm.[23] As argued in a short briefing note by the Environmental Change Institute (ECI),[24] the energy consumed by lights and appliances usually depends on either the total floor area or occupancy, *but not both*. For example, energy use for lighting is likely to be closely correlated with floor area, whereas energy use for wet appliances (e.g. washing machines) is likely to be closely related to the number of occupants. It follows that these parameters should ideally be included separately in the algorithm. Modifying the algorithm in this way should also improve the explanatory power of the model.[25]

Whilst there is a large amount of unexplained variation in households' actual or reported electricity consumption, it would not be feasible to capture all of this variation within the algorithm - and nor would it be appropriate, at least in so far as this is unlikely to reflect differences in need.

2.4.3. Summary

All those who responded to the consultation (and who expressed an opinion on this specific proposal) agreed there was a need to update this algorithm. The evidence presented here broadly supports the form of the proposed algorithm. However, there are some important provisos:

- **We recommend that further work is undertaken to understand the differences between the two series of overall levels of domestic electricity consumption published by the DTI. The average consumption (per household) predicted by the proposed algorithm is consistent with the DTI series based on BRE data, but still significantly lower than that implied by the ECI/MTP series. This would enable a more informed judgment to be made about which of these series is likely to be a more accurate representation of actual consumption levels and should, therefore, be used to calibrate the BREDEM algorithm. If the ECI/MTP series is found to be the more reliable source, this could be taken into account relatively easily by using the option available within the BREDEM-12 model to apply a 20% across-the-board increase in energy consumption on lights and appliances (as is already being proposed in the case of the hot water algorithm).**

- **The derivation of the proposed algorithm was not made available, but it appears that the adjustment was rather crude and not informed by household-level data on domestic electricity consumption. That the revised structure of the proposed algorithm is broadly consistent with the evidence presented in this report would appear to be more by chance than design.[26]**

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[23] The proposed revision to the algorithm would take the form: A + (B x TFA) + (C x N), where A is the constant term, B would capture the relationship between the floor area and energy usage for lights and appliances and C would capture the relationship between the number of occupants and energy usage for lights and appliances.

[24] *The accuracy of the BREDEM-12 algorithm for lights and appliances*, an unpublished briefing note prepared for Defra by Christian Jardine at the ECI, University of Oxford.

[25] Comparing the current and modified algorithms (columns (1) and (2) in Table 10) shows an increase in the R-squared (i.e. the proportion of variation in energy consumption explained) from 0.32 to 0.36.

[26] BRE have not provided a plausible rationale for only changing the constant terms in the algorithm (and not the slope coefficients), even though this clearly alters the nature of the implied relationship

- **The BRE argue that the most recent data suitable for testing and developing the model is from the late 1980s and seem reluctant to use data from the kind of large-scale household surveys used in the analysis in Table 9 of this report. However, we believe that greater use could and should be made of household-level survey data to update this and other BREDEM algorithms, including expenditure data from the annual Family Expenditure Survey (now the Expenditure and Food Survey) and metered data from the 1996 English House Condition Survey and the 1998 Energy Follow Up Survey.**

- **The lights and appliances algorithm is already in the process of being modified again (as part of the development of BREDEM-12), which may involve some fundamental changes to the structure of the algorithm. It was not clear to us what plans, if any, there were for incorporating these changes into the fuel poverty model in the near future and how this would affect the consistency of the series over time.**

There is, in addition, a much more fundamental question about whether it is appropriate to use an algorithm of this kind in the context of the fuel poverty model. The current methodology will not be very good at picking up the impact on fuel poverty of policies designed to influence the non-heating components of domestic fuel consumption - for example improvements in the energy efficiency of appliances owned by low income households, although the presence of low energy lighting is taken into account in the methodology. This would not matter so much if lights and appliances were a relatively small component of overall domestic fuel expenditure. But, it represents a substantial share of the total (estimated at 41%[27]) and one that is very likely to grow over time - to an estimated 46% by 2010 on current trends (see Table 11). **The current methodology reinforces the tendency of government (and others) to focus on SAP[28] improvements as a proxy indicator for progress in tackling fuel poverty, even though space and water heating accounts for only just over a half of total domestic fuel expenditure – a share which is projected to decline in future.**

To be consistent with the treatment of heating costs, there would need to be a 'standard' for non-heating energy services (e.g. for adequate lighting, cooling, and so on). Information on the energy efficiency of key appliances would then be used to estimate the cost of meeting this standard for individual households (so, for example, those with less efficient appliances would need to spend more to achieve the standard). This more detailed modelling of the non-heating side seems to be the direction in which BREDEM-12 is heading and there is a strong case for the fuel poverty model to follow, although this does have major implications for the EHCS in

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between energy usage and dwelling/household size (see Table 9). Thus, we do not agree with their judgement that the adjustment they made retained the "general form of the relationship" in the previous algorithm.

[27] This includes energy used for hobs and ovens, which is covered by a separate BREDEM algorithm.

[28] The Standard Assessment Procedure (or SAP) rating is a measure of a dwelling's energy efficiency. SAP ratings are based on the calculated annual energy cost for space and water heating, but are not designed to take into account the energy efficiency of lights and appliances within dwellings.

terms of data collection – something that ODPM are likely to resist. This issue is discussed further in Section 4.2.

2.5. Proposal 4

BRE's fourth proposal is to use actual household numbers, rather than 'standard' occupancy (i.e. estimated household numbers, based on the size of the property).

2.5.1 Background

The 1996 version of the fuel poverty model employed a modified SAP worksheet as the basis for estimating required heating costs, rather than the BREDEM-12 model used in the 2001 fuel poverty model. The SAP worksheet, which is still used to produce energy efficiency ratings, does not enable the number of occupants to be entered separately.[29] Instead, heat gains and water heating costs are based on modelled or standard occupancy – where the number of occupants is estimated as a function of the dwelling's floor area. The non-heating algorithms are run separately.

As the standard occupancy algorithm was derived in the 1970s, when the average size of households was substantially larger than now, it consistently over-estimates the number of occupants in each dwelling;[30] and, other things being equal, will over-estimate energy usage in so far as this is related to household size.

The BREDEM-12 model enables the number of occupants to be entered separately and so the BRE are proposing to use actual household numbers (in place of standard occupancy) in both the heating and non-heating components of the model. The published estimates for 2001 used standard occupancy throughout the model in order to be consistent with what the BRE believed had been done in the 1996 model.

2.5.2 Discussion

This is clearly a sensible thing to do. Whether the occupants of a dwelling are in fuel poverty or not depends on the fuel requirements of that particular household, which are significantly affected by the actual number of people living there (especially for non-heating purposes).

However, according to Richard Moore, who ran the 1996 fuel poverty model, actual household numbers *were* applied to the non-heating algorithms. Only in the case of space and water heating, which is less sensitive to household size, was standard occupancy used (due to constraints on the 1996 model).[31]

The implication is that the published estimates for 2001 should be lower (by around 0.3m, according to BRE's estimates[32]) if they had been carried out on a basis

[29] This is because the SAP rating is designed to be independent of the household occupying the dwelling.

[30] By 17%, on average, across the whole stock, according to BRE's analysis.

[31] In the analysis of the 1996 EHCS, the fuel poverty heating costs were constructed from the SAP worksheet which assumes standard occupancy patterns (and does not allow actual household numbers to be inputted).

[32] Based on their estimate of the impact of updating the calculation of the number of occupants only (see Table 4 of their paper on "Fuel poverty: updating estimates for the cost of energy", which they presented at the consultation workshop on 27 May 2004).

consistent with the methodology that, as far as can be determined, was used in 1996. Again, poor documentation of the development of the fuel poverty model on handover to BRE contributed to this apparent misunderstanding (more on this in Section 3.9).

2.6. Proposals 5 and 6

The BRE's final proposals are to update (Proposal 5) or to revise (Proposal 6) the method for estimating hot water usage.

2.6.1 Background

The assumption regarding the volume of hot water used is based on work by British Gas using field trial data from the late 1970s,[33] involving the monitoring of 120 dwellings. The formula was subsequently checked in the late 1980s using monitored data from around the mid 1980s, which, according to the BRE, found almost the same relationship between the number of occupants and hot water usage.

It was reviewed again in the work that Energy Advisory Services (now NES Ltd) carried out on behalf of the BRE in 1993, using data from the Electricity Council and was found to match this quite well. However, improvements to other parts of the water heating calculation procedure, principally to deal better with the on-peak and off-peak proportions, were introduced at that time on the basis of the Electricity Council data. Some further revisions have since been made relating to the estimation of tank losses. But the basic formulation, and the assumption about the volume of hot water used, have remained unchanged because there has been no recent evidence available to suggest any appropriate changes.

2.6.2. Discussion

There is very little information available on levels of hot water usage in the UK. What evidence there is suggests that usage levels have increased significantly since the data was collected on which the algorithm was derived - apparently some time in the 1970s, although the source provided by BRE does not give a specific date.

However, there are two partial sources of evidence:

- Trends in overall water consumption (both cold and hot) suggest a rise of around 25% between 1979 and 2002, according to BRE's analysis. Assuming the hot/cold mix remained fairly constant over this period implies a corresponding rise in hot water usage.[34] Looking at the sources quoted by the BRE,[35] the 25% figure looks about right – maybe slightly on the low side,

[33] Pickup, G. and Miles, A. (1979), *Energy conservation – field studies in domestic heating*, Communication 1086, The Institution of Gas Engineers.

[34] It is very hard to assess whether, and if so how, the hot/cold mix is likely to have changed over this period as there have been effects operating in both directions. On the one hand, people are probably washing more frequently; on the other hand, they are probably more likely to have showers, which are more economical on water than baths, and more likely to own 'cold-fill' washing machines. At the same time, it is also likely that people are using more cold water, although this rise may have been tempered in recent years by the installation of water meters.

[35] European Environment Agency (2002), *Environmental signals 2002, Benchmarking the millennium*; Ofwat (2000), *Patterns of demand for water in England and Wales: 1989-1999*.

although BRE have not provided any documentation to show precisely how they arrived at this figure.

- According to a separate note prepared by BRE,[36] analysis of data from the 1998 Energy Follow Up Survey (EFUS) on people's reported use of showers and baths (plus estimates of hot water usage for other purposes, such as hand-washing) produces estimates of hot water usage that are, on average, just over 20% higher than implied by the current algorithm - consistent with BRE's proposed adjustment to this algorithm. However, BRE's analysis implies a very different pattern of consumption between households of different size – lower for smaller households and much higher for larger households i.e. fewer economies of scale than implied by the current or proposed algorithms. If so, the proposed algorithm would only be correct on average. For single person households, it would substantially over-estimate required expenditure on water heating (and over-estimate fuel poverty among this group), whilst continuing to under-estimate hot water usage among larger households (though less so than in the current model) (see Table 12).

One of the advantages of an across-the-board increase of 20% is that this option is already built into BREDEM-12 (which allows the user to adjust hot water usage upwards by 20% or downwards by either 20% or 40% to reflect different levels of usage). The BRE staff who are responsible for BREDEM are reluctant to modify the BREDEM algorithm on the basis of the EFUS analysis alone, preferring to wait until data from the proposed metering study becomes available (not expected until 2006 at the earliest). They have doubts about the reliability of the EFUS analysis, which is based on very limited data and various assumptions and they do not want to make changes to this algorithm that may have to be reversed later on the basis of the metering results. If the adjusted BREDEM algorithm is used, then the estimates of fuel poverty may be biased. But, if a decision is made to modify the structure of the algorithm (to reflect more closely the evidence from BRE's analysis of EFUS data) then the fuel poverty model would have to deviate from BREDEM, which is also problematic.[37]

The current algorithm is almost certainly out-dated, but there is little available information that could be used to produce a more accurate algorithm. This is a significant weakness in the model, given that water heating accounts for around a fifth of households' required fuel expenditure. There is, therefore, a strong case for carrying out a metering survey to measure actual hot water usage in a small representative sample of households. The results should be published.

In the meantime, it seems reasonable to make a fairly crude upward adjustment along the lines suggested by BRE. There is also a case for modifying the *structure* of the algorithm, based on BRE's analysis of EFUS data, which suggests there are fewer economies of scale for larger households than implied by the BREDEM algorithm. This is a difficult call to make,

[36] BRE (2004), *Analysis of hot water use from the 1998 EFUS*, unpublished draft.

[37] Although, in principle, it would be feasible to develop a version of BREDEM for use in the fuel poverty model, this is likely to be resisted because a separate model development and maintenance process would potentially need to be put in place.

because it would mean the fuel poverty model deviating (at least temporarily) from BREDEM.

We have already recommended that BRE carry out a sensitivity analysis to examine the impact on the fuel poverty numbers of using the estimates of hot water usage from their EFUS-based analysis – and this work will be undertaken following the Peer Review. For the sake of simplicity, we think it would be preferable to keep to the current structure of the BREDEM algorithm unless the results are found to be very sensitive to this assumption. In the longer-term, consideration should also be given to establishing a 'standard' for hot water consumption to be more consistent with the treatment of heating costs within the model.

2.7 Impact of Peer Review recommendations on BRE proposals

We have attempted to quantify the combined effect of our recommendations in Chapter 2, although in one important case this is dependent on the outcome of further work. The lower bound estimate assumes that the BRE's estimates of overall domestic electricity consumption on lights and appliances are broadly correct (in which case their proposed algorithm looks about right). The only deviation from the original BRE proposals is that council tax payments (net of Council Tax Benefit) are deducted from household incomes. On this basis, we estimate that around 1.5 million households would be in fuel poverty in 2001 – a little lower than the published estimates, but higher than the modelled impact of BRE's original proposals (1.1 million). This change would have very little impact on the composition of fuel poor households (see Tables 1 and 2).

The upper bound figure assumes that the latest estimates from the Market Transformation Programme are a more accurate representation of current levels of electricity consumption (in which case we have estimated the impact of an across-the-board increase of 20% in the lights and appliances component). In this scenario, the estimated numbers in fuel poverty would be just under 1.8 million – marginally higher than the published estimates.[38]

Both these estimates would be somewhat lower if the structure of the hot water algorithm were modified in line with BRE's recent EFUS-based analysis of hot water usage (though we are unable to quantify this effect without further analysis by the BRE). In addition, any changes in the way the incomes of additional benefit units are measured - following the proposed review by BRE and DWP - may have a small impact on the fuel poverty numbers in future years (probably in an upward direction, though this, too, is difficult to predict in advance).

[38] These are very provisional estimates and would need to be verified by the BRE, using additional data not available to the authors of this report.

Chapter 3: Assessment of overall methodology

3.1 Introduction

This Chapter looks beyond the specific proposals made by BRE to examine the overall methodology for calculating the number of households in fuel poverty in England *within the current definition of fuel poverty*. The key income- and energy-related components of the fuel poverty model are assessed, focusing in particular on whether the assumptions underlying the current methodology create any potential bias in the fuel poverty estimates. The likely direction and possible scale of these effects are summarised in Table 13. This chapter also considers various process issues, such as the way the model is updated and the results validated.

3.2. Income definition

Like others we consulted on this, we believe the definition of income in the fuel poverty model should be as consistent as possible with the government's official (HBAI) income measure, subject to any data constraints. A comparison of the two reveals a number of differences in terms of the items included and excluded:

- HBAI deducts council tax payments (net of council tax benefit), payments to students living away from home, maintenance and child support payments, and contributions to occupational pension schemes.

- HBAI adds in 'near cash' benefits in kind (e.g. free school meals).

- HBAI does not include rent from lodgers.

DWP have undertaken some analysis using the Family Resources Survey (FRS) on behalf of the Peer Review team to help quantify the impact of these definitional differences. Apart from council tax payments and council tax benefit (which were considered separately in Section 2.3), these are all fairly minor items and have a negligible impact on household incomes. In most cases, including or excluding these items increases or decreases the average incomes of each sub-group by no more than £1-2 per week (see Table 14).[39]

Clearly the impact will be significant for some households within each sub-group - for example those who are making child maintenance payments or supporting their children through university (as the figures in Table 14 are only averages). Deducting these payments from the income measure used in the fuel poverty model would push some of these households into fuel poverty, but they are likely to be relatively few in number, partly because both types of payment are closely related to incomes (i.e. the amounts paid will be smaller for those on low incomes, who are most at risk of fuel poverty).

[39] The only minor exception is private pension contributions for the top income group, but these households are very unlikely to be at risk of fuel poverty in any case and so any adjustment would have virtually no impact on the fuel poverty statistics.

Our view is that apart from the treatment of council tax liability these definitional differences are unimportant in this context and can safely be ignored. Data on most of these items is not currently available in the EHCS and we do not think it is necessary to collect any additional income data.

Our own analysis shows that the overall distribution of incomes in the EHCS data (using the "full" income measure) is similar to that found in the HBAI data on a comparable basis, except that the HBAI distribution has a greater proportion of households on very high and very low incomes (see Table 15 and accompanying graph). Differences at the very top of the income distribution will have no impact on the fuel poverty numbers as none of these households will be fuel poor, in any case. But, differences at the bottom of the income distribution are clearly much more significant. This seems to be largely due to the treatment of households with low reported incomes, which is discussed in more detail in the next sub-section, rather than differences in the raw income data.

3.3. Treatment of low incomes

The fuel poverty model imputes a basic minimum income for all families who report an income below the Income Support (or Minimum Income Guarantee) threshold for a family of their size and composition. The reasoning is that very low reported incomes are unlikely to be an accurate representation of these households' 'true' standard-of-living. The assumption made by the BRE team is that households must be under-reporting benefits, receiving income from other sources that is not recorded in the survey, and/or living off their assets.

This assumption could have a very significant impact on the numbers in fuel poverty. In the 2001 EHCS, around 12% of households (in the unweighted sample) and 9% of households (in the weighted sample) were imputed a basic minimum income – equivalent to 1.7 million households. The majority of these - around 1.2 million households - are *not* identified as being in fuel poverty. However, many of these households could be fuel poor if their reported incomes were used in place of an imputed basic minimum.

From discussions with DWP and with Professor Gordon at Bristol University, the current methodology is inconsistent with established standards in the field of income measurement, including the government's own official (HBAI) income measure.[40] Research shows that very low incomes are a real phenomenon for a significant minority of households[41] and should not simply be assumed away. Some of these families are not entitled to claim even though their incomes are low (e.g. because they

[40] See DWP (2004), *Households Below Average Income 1994/95-2002/03*, which is available on the DWP website: www.dwp.gov.uk/asd/hbai/.asp.

[41] As part of reviewing their own income statistics, DWP and others have looked at whether households with the lowest incomes are better off than their reported incomes indicate due to measurement or reporting errors. Recent analysis by the DWP of the expenditure patterns of households (used as a proxy for households' standard-of-living) shows that expenditure increases with income across most of the income distribution, but that households in the bottom few percent of the income distribution did not have the lowest median expenditure. This suggests that families with the very lowest reported incomes may be better off than implied by their reported income, but that this only applies to a relatively small proportion of households at the very bottom of the income distribution.

are full-time self-employed), whilst others are not claiming benefits to which they are entitled. Take-up rates are significantly below 100% in the case of many income-related benefits[42], yet the fuel poverty model effectively assumes 100% take-up amongst those with incomes below the income support threshold.

BRE have carried out sensitivity analyses to examine the possible impact of *not* imputing the incomes of these households – more specifically, how many additional households would be fuel poor if their reported incomes were used in place of the assumed basic minimum. The results are shown in Table 16.

If no imputation of these households' incomes is carried out, the numbers in fuel poverty increase from 1.7 to 2.5 million households. However, this is very much an upper bound estimate as some of these households report being in receipt of income support and/or other 'key' state benefits but appear to under-report the amounts received in benefits (i.e. the reported amounts are lower than a family in their situation ought to be eligible for).

If imputation is only *not* carried out for those households who do not report being in receipt of one of the key state benefits[43], then the numbers in fuel poverty would rise to nearly 2.0 million. This is likely to be a lower bound estimate as there is a large group of pensioners who are receiving only the Basic State Pension (BSP) but are assumed to have an income at least as high as the level of the Minimum Income Guarantee (MIG) at that time. In practice, many pensioners will not have been claiming MIG (which is a means-tested benefit and is set at a level significantly above the BSP); and some pensioners will not even be receiving the full amount of BSP if they do not have a full contributions record (including many single women). Thus, the true impact on fuel poverty of not imputing low income cases is likely to lie somewhere between 2.0 and 2.5 million (i.e. an increase of between 0.3 and 0.8 million households in the number of fuel poor households, though, in our view, towards the lower end of this range).

We recommend that the DTI, Defra and ODPM should, with BRE and DWP, work closely together to review the way incomes are measured within the fuel poverty model to ensure that, as far as possible, it is consistent with the official HBAI series. This review should consider not only the treatment of households on very low incomes, but also the imputation of missing income data[44] and the estimation of net incomes for additional benefit units (as discussed in Section 2.2). Subject to the findings of this review, we believe that reported incomes should be used in place of imputed minimum incomes, except that, as in the HBAI, negative incomes are set to zero.

[42] Estimated take-up rates by caseload (i.e. the number of claimants as a proportion of all eligible households) in 2001/02 were 86-95% for Income Support (for non-pensioners), 63-72% for pensioners' Minimum Income Guarantee, 85-91% for Housing Benefit, 66-72% for Council Tax Benefit, and 51-62% for income-based Jobseeker's Allowance according to the DWP's Take-Up of Income Related Benefits publication).

[43] At least one of following: the Basic State Pension, Income Support, Job Seeker's Allowance, Incapacity Benefit, or the Working Families' Tax Credit.

[44] The FRS uses more sophisticated imputation procedures that could perhaps be used within the EHCS data set.

3.4. BREDEM model

BREDEM-12 is the current annual version of the BRE Domestic Energy Model and is used to predict the annual energy consumption required to achieve an adequate standard of warmth in the home and meet other non-heating energy requirements, based on detailed information about the heating systems and standards of insulation in a dwelling.

BREDEM-12 is widely used and considered to be the best available tool for estimating heating costs and producing energy efficiency ratings. There are more concerns about the non-heating algorithms, which are recognised to be weaker than other parts of the model, and which are discussed elsewhere in this report. This section focuses on the heating side of BREDEM and its application in the specific context of the fuel poverty model.

The model is well validated for homes with gas central heating or a properly installed system of electric storage heaters, which comprise around 90% of the housing stock; on average, predicted running costs closely match actual fuel consumption as recorded in field trials. However, many households at risk of fuel poverty will be living in homes without central heating and/or in homes that are atypical in other ways. The model is not very good at predicting *actual* running costs in these circumstances, because occupants of these dwellings tend to use their heating system in a less predictable manner. But, in theory, the model should produce reasonably accurate estimates of the cost of heating these homes to a pre-defined standard (as in the fuel poverty model), at least on average. These estimates are hard to validate against actual data on fuel consumption because households with inadequate heating or insulation are rarely, if ever, able to spend enough to achieve these standards in practice.

As with any model, some simplifying assumptions have to be made to keep the model manageable. This is not necessarily a problem, although some of the assumptions or conventions applied in these cases need to be examined carefully, especially for 'non-standard' dwellings:

- One of these conventions concerns the definition of primary and secondary heating systems and assumptions about the percentage of the home heated by each. Take, for example, those homes *without* central heating and with fixed gas heaters in some rooms, but not others – up to 4% of occupied dwellings or 900,000 households. In these cases, the model has to assume that a certain proportion of the home is heated by gas and the remainder by on-peak electricity (i.e. plug-in electrical heaters). Within BREDEM-12 it is possible to vary this proportion to reflect reality as closely as possible. However, the default assumptions used in the fuel poverty model are that 90% of the home will be heated by gas if this is considered to be the primary heating system, but only 20% if it is considered to be the secondary system. Estimates of heating costs for these homes could be very sensitive to these assumptions, so it is important that the conventions used to identify the primary heating system do

not create any bias in the results and that these conventions are applied consistently in practice by EHCS surveyors.

- We understand from our interviews with experts in this field that many fuel poor households use electric immersion heaters like a "giant kettle" (i.e. switching them on when they need hot water). This is a very inefficient way of using these systems as it consumes more on-peak electricity. The current model may under-estimate the amount these households are actually spending on water heating if, as has been suggested, the assumptions imply that people are using these systems more efficiently than is the case in practice.

- More generally, the model assumes that people's heating systems are in full working order and that they are being operated efficiently, whereas there is plenty of anecdotal evidence and some research evidence showing that heating systems are often not operated as they should be.[45] It is debateable how far the model could or should allow for lack of knowledge or understanding about how heating systems should be used and, if so, how much difference this would make. As it stands, the model may under-estimate the cost of achieving a satisfactory heating regime in some homes, by assuming away any inefficient practices (some of it due to controls not working properly). Furthermore, the benefits of providing energy efficiency advice, which is designed in part to 'correct' inefficient use of heating, will not be reflected in the fuel poverty statistics, even though this is an important component of the fuel poverty strategy (because the model already assumes that people are using their systems efficiently).

- BREDEM is often used, as in the fuel poverty model, without having all the necessary inputs for the model. Missing items have to be inferred, reducing the accuracy of the running cost estimates. This would not matter in terms of the fuel poverty statistics if the 'errors' were fairly random (i.e. if running costs were just as likely to be under- as over-estimated), but this need not necessarily be the case. Different default assumptions can in some cases lead to quite significant differences in estimated heating costs. It is important, therefore, to examine the sensitivity of the results to the assumptions that were made in applying BREDEM to the EHCS data set.

- There will inevitably be some atypical dwellings, where BREDEM (and indeed any model) is likely to be inaccurate, including types of dwellings that have been built with unusual building materials or construction forms.

In summary, the Peer Review team's view is that BREDEM-12 is an appropriate model to use in the fuel poverty model, but that it would be worthwhile reviewing some of the key assumptions and conventions underlying the model

[45] See, for example, Pett, J. and Guertler, P. (2004), *User behaviour in energy efficient homes*, Phase 2 report for the Association for the Conservation of Energy (ACE). In a survey of 118 housing association tenants, they found that around a quarter of households were using their systems efficiently (i.e. "in a way that corresponds to policy expectations"), half were using their systems reasonably (i.e. "they get results that suit them and their lifestyle") and around a quarter were using their systems inefficiently (i.e. "they did not use their systems effectively and did not get the best value for their lifestyle").

and any bias these may generate in this particular context. This review should look at whether there is likely to be any systematic bias due to assumptions or conventions relating to:

- **the percentage of the home heated by different fuels in homes with fixed gas heaters and without central heating;**
- **the use of electric immersion heaters;**
- **the efficiency of heating systems, including the way they are being operated in practice; and**
- **any data inferred in applying the BREDEM model to the EHCS data set.**

These issues should be fed into the review of BREDEM.

3.5. Heating regimes

The fuel poverty model incorporates three different heating regimes, depending on the characteristics of the household:

- where all household members are either employed or in full-time education, the model assumes all the home is heated intermittently during weekdays (9 hrs/day) and all day at the weekend (16 hrs/day);
- where at least one person is likely to be at home during the day and the home is fully occupied, the model assumes all the home is heated all day (16 hrs/day);
- where at least one person is at home during the day and the property is under-occupied, the occupants are assumed to heat *half* their home all day (16 hrs/day).

In all three cases, the temperature standard is 21^{o}C in the living room and 18^{o}C in the rest of the home.

Some respondents to the consultation and some of those we talked to in our bi-lateral meetings felt the temperature standard should be higher for vulnerable households, especially for older people or people with mobility problems or a long-term illness. They pointed out that the World Health Organisation recommends a higher standard – 23^{o}C – for such households. National Energy Services Ltd (NES) said that, in their experience of working on fuel poverty, older and less mobile householders need warmer homes and that this view is supported by the medical and caring professions. Some respondents also felt that the assumption about half-house heating for under-occupied homes was too "extreme" and that it was impractical or inadvisable for many of these households to heat only half their home.

One way of assessing whether these heating regimes are reasonable is to compare them with survey data on people's actual or reported heating patterns. Of course, the two should not necessarily be the same – indeed, we would probably expect the heating standard to be more generous, as some households may be restricting their use of heating in order to save money:

- BRE's initial analysis of heating patterns using data from the 1998 Energy Follow Up Survey (EFUS) shows that households that are expected to be at home during the day are heating their homes for significantly fewer than the 16 hours assumed in the fuel poverty model, but that people in under-occupied homes appear to be heating more of their home than assumed, possibly compensating for this by having their heating on for fewer hours (see Table 17).

- Our own analysis of 2001 EHCS data shows that households that contain a retired person or a younger adult who is not in employment or full-time education are much more likely to be at home all day, compared with households where everyone is either employed or in full-time education. And, when at home, the majority of households say they usually or always have their heating on during the winter.[46] Retired households are slightly *more* likely to have their heating on all the time when at home than other households. Contrary to the EFUS findings, this supports the distinction in the fuel poverty model between households where everyone is likely to be out of the home during the day and other households (see Table 18).

In the same way, it is possible to compare the temperature 'standard' with temperature readings in people's homes. The latest EHCS data is for 1996 as temperature readings were not taken in the 2001 survey (or in subsequent surveys). In 1996, the median temperature was 19.4^{o}C in the living room and 18.1^{o}C in the hall/passage. The median living room temperature in homes with the highest SAP ratings (19.7^{o}C), in the highest income band (19.6^{o}C), and where occupants described the temperature as "about right" (19.5^{o}C) were still significantly below the standard (see Table 19). On this basis, the temperature standard seems, if anything, to be on the high side for the living room (even for households who are not financially constrained), though reasonable for other parts of the home. Evidence from BREHOMES and more recent, though smaller-scale surveys, suggests that temperatures in people's homes have been rising gradually over time, so the standard may now be more in line with the average temperature in people's homes.

Again using 1996 EHCS data[47], we also compared estimates of required spending on heating with actual or reported expenditure on heating.[48] On average, households were spending less than three-quarters of what they would have needed to spend to heat their homes adequately, according to the fuel poverty model. Even high income households and occupants of high-SAP dwellings (though to a lesser extent) were under-spending relative to the standard, again suggesting that the 'standard' itself may be on the generous side – or at least was in 1996 (see Table 20).

In summary, most of the evidence suggests that the heating regimes and temperature standards are probably quite 'generous'. According to EFUS data,

[46] Although the heating regime applies all year around, it is unlikely that people will need to have their heating on outside the winter period (and the survey only asks them about their heating patterns during the winter months).

[47] Data on fuel expenditure was not collected in the 2001 EHCS.

[48] By limiting this analysis to households who use gas for all their space and water heating, it is possible to identify the amount spent on heating, as opposed to non-heating uses of fuel (although this will include a small amount of gas used for cooking).

heating patterns are substantially shorter, on average, than assumed for households that are at home all day (though EHCS data is more consistent with the model's assumptions). Furthermore, most households (even those on high incomes and in energy efficient homes) under-spend relative to the standard and heat their homes to a lower temperature than assumed, although the gap is likely to have narrowed since the data on which our analysis is based was collected in 1996.

On conservative grounds, it is possible to justify a standard that exceeds current practice. But, on the basis of the data reviewed here, it is difficult to argue that the standard should be raised further, given that the current assumptions already appear to be on the generous side. However, the assumption that half-house heating is adequate for all under-occupied homes should be reviewed, as this does not appear to be supported by BRE's own initial analysis of the 1998 EFUS.

3.6. Fuel price assumptions

The fuel poverty model takes into account the variation in gas and electricity prices between regions and between different payment methods. This allows, for example, for the higher-than-average prices paid by pre-payment customers, including a disproportionate number of fuel poor households.

However, there is also significant variation in gas and electricity prices *within* regions, which is not taken into account in the 2001 fuel poverty model (though it was in 1996). Analysis of fuel price data shows there is as much, if not more, price variation within regions as there is between regions and also more price variation across households using the same payment methods, as between payment methods. For those paying by standard credit, which is the most common method of payment among fuel poor households, the price differential between the lowest and highest cost suppliers in each region was around 26% for gas and typically between 15-25% for electricity (in 2003), depending on the region (see Tables 21-24).

Provided the variation in prices is fairly random, this should not significantly affect the number of households in fuel poverty. Some households that are paying below the average price (for their region and payment method) may be wrongly classified as fuel poor, whilst other households who are paying above the average price may be wrongly classified as not being fuel poor.

But, there is some evidence that certain types of households may be more likely to be paying above the average price. Typically, the 'incumbent' supplier has the highest price[49], so households that have not switched suppliers - about 60% of the market - are likely to be paying more than those that have switched (although some switchers seem to have ended up paying more). Research has shown that pensioners, low income households, and those living in rural areas are less likely to be 'switchers', so we might expect these households to be paying higher-than-average prices for their

[49] Information on the prices charged by regional incumbents and other suppliers is available on the energywatch website (www.energywatch.org.uk).

fuel.[50] Since these types of households are more likely to be in or near to fuel poverty, taking intra-regional price variation into account would be expected to increase the number of households in fuel poverty. An Ofgem report in 2001 showed that, in terms of the incidence of switching, disadvantaged customers (for example low earners and those who pay by pre-payment meter) were catching up with the population as a whole in both the gas and electricity markets, so this issue may be declining in importance over time. Nonetheless, the same report found that certain demographic groups, including pensioner only households, continue to trail behind.[51]

It is very difficult to gauge the likely impact of intra-regional price variation on the numbers in fuel poverty, because there is no information in the 2001 EHCS on the tariffs paid by different types of households. However, the impact is potentially quite significant and merits further investigation. Consideration should be given to collecting data within the EHCS on the actual fuel prices paid by individual households, as in 1996.[52] More work is needed to determine whether these questions are indeed essential.

3.7. Cooking algorithm

BREDEM-12 includes a separate algorithm for the use of gas and electricity for ovens and hobs. (Smaller cooking appliances, such as kettles and toasters, are included in the main lights and appliances algorithm.) This component of the fuel poverty model comprises around 5% of total domestic energy costs.

The "cooking" algorithm has not been revised since at least the 1991 EHCS Energy Report and, as far as we have been made aware, there are no plans to revise it in the near future. It assumes that all households have a gas hob and an electric oven, unless there is no gas supply to the property, in which case all cooking energy is assumed to be supplied by an electric cooker.

The current algorithm implies an average consumption per household that is substantially higher - by around 50% - than estimates from other sources, including the BREHOMES and DECADE models. Furthermore, according to the latest forecasts from DECADE, households' use of energy for hobs and ovens is expected to decline by a further 10% or more over the period between 2000 and 2010 (see Table 25).

The assumption that everyone has a gas hob and an electric oven (except for those without a gas supply) produces about the right overall energy mix; as in the DECADE model, estimated gas consumption accounts for just over half the total in energy terms.[53] However, the BRE algorithm substantially over-estimates the average energy

[50] Waddams Price, C (2004), *Spoilt for Choice? The Costs and Benefits of Opening UK Residential Energy Markets*, CCR Working Paper 04-1, Centre for Competition and Regulation and School of Management, University of East Anglia.
[51] Ofgem (2001), *Experience of the competitive domestic electricity and gas markets*, Research study conducted by MORI.
[52] Information on households' gas and electricity suppliers (and their method of payment, which is already collected) should be sufficient to estimate actual fuel prices for each household.
[53] The mix between gas and electricity is expected to remain broadly constant until 2010 as the effect of people switching from gas to electric ovens is offset by switching from electric to gas hobs.

consumption associated with each of these appliances, compared with the DECADE model which allows for a long-term decline in the frequency of use of ovens and hobs, associated with changes in lifestyle and increased ownership of microwave ovens.[54] We estimate that the overall impact of over-estimating energy consumption for cooking is to increase the fuel poverty estimates by around 70,000.

As the National Right to Fuel Campaign (NRFC) state in their response to the consultation, the model would ideally be based on actual data on the ownership of gas or electric hobs and ovens, rather than assuming that everyone has a dual fuel cooker.[55] We know from the 1996 EHCS[56] that "all gas" cookers were more common among low income households and single pensioners (see Table 26). As these are cheaper to run than dual fuel cookers, the current assumption will over-estimate the cooking costs of those households most likely to be at risk of fuel poverty. This will generate an additional bias towards over-estimating fuel poverty (on top of the effect described above). According to our own analysis of the 1996 EHCS, not using actual data on the ownership of cooking appliances would have increased the number of fuel poor households by around 120,000 in that year, other things being equal.[57]

We, therefore, recommend updating the cooking algorithm to reflect the substantial decline in the average use of these appliances since this algorithm was originally developed. Defra's Market Transformation Programme is currently conducting a special survey of people's cooking patterns, which could be used to inform revisions to this algorithm and feed into a more general review of BREDEM. Consideration should also be given to collecting actual data on the ownership of different types of cookers in future EHCS surveys, although the improvement in accuracy would need to be weighed against the benefits of keeping the questionnaire as short as possible.

3.8. Base data set

3.8.1 Background

The fuel poverty model is based largely on data from the English House Condition Survey (EHCS), which is funded and managed by ODPM. The EHCS provides information on the changing condition and composition of the housing stock in England and the characteristics of households living in different types of housing. The survey is a key tool for monitoring the effectiveness of current housing policies, including policies to tackle fuel poverty. ODPM pass the data on to BRE who carry out most of the modelling and its validation to produce the derived variables needed in the fuel poverty model, including standardised heating costs and household income.

The EHCS interview questionnaire was shortened considerably in 2001, in part to try to encourage a higher proportion of households to take part in the survey, as response

[54] The assumptions in the DECADE model are that the average use of ovens per household declines from 280 uses per year in 1990, to 213 in 2000 and 175 by 2010.

[55] Information on the ownership of ovens and hobs by fuel type was collected in the 1996 EHCS, but the relevant (four) questions were dropped from the 2001 survey.

[56] This data was not collected in the 2001 EHCS.

[57] The effect may be smaller in 2001, because fewer households are close to the fuel poverty threshold and, therefore, at risk of falling into fuel poverty as a result of making this adjustment.

rates were relatively low in 1996 by comparison with other government surveys. Questions that were needed to produce the fuel poverty numbers were retained. However, information that is "nice to know" but not strictly necessary for this purpose (or for housing policy, more generally) has been deleted or cut back, including questions on heating patterns, temperature readings, fuel expenditure, and ownership of cooking appliances.

In 2002, the EHCS moved to a continuous format: fieldwork is carried out all year around, rather than in a concentrated 3-4 month period every five years. The key reason for re-organising the survey in this way was to produce annual estimates in order to monitor progress towards achieving the government's PSA targets, including reductions in fuel poverty.

8,000 paired surveys are achieved each year consisting of a household interview and an inspection of the property. ODPM have decided that this is not a large enough sample to produce independent and robust estimates annually and will instead combine two years of data on a rolling basis. Defra and DTI have decided to follow this advice for fuel poverty and so the next set of estimates will be based on a pooled sample from the 2002/03 and 2003/04 EHCS.

3.8.2 Discussion

Some people we interviewed felt it was important to include supplementary indicators of fuel poverty in the EHCS, such as the temperature in people's homes, the degree of under-spending on fuel, and self-reported fuel poverty. This would require temperature readings and questions about fuel expenditure to be re-instated in the survey.

The ODPM said that temperature readings would impose an unacceptable additional burden on the survey, in particular the need to carry out all interviews during the winter months - and we are inclined to agree. However, we believe that data on *fuel expenditure* could be collected as it is in other surveys, such as the British Household Panel Survey and the Expenditure and Food Survey (formerly the Family Expenditure Survey). This information could be used to identify households that are significantly under-spending on fuel i.e. by comparing actual and required spending on fuel. ODPM have also added some useful questions on self-reported fuel poverty e.g. householders' own perceptions of whether they can afford to heat their own homes and of the adequacy of their heating systems (see Appendix C). These other indicators should be looked at alongside the fuel poverty numbers to help contextualise and interpret changes in the official measure. Chapter 4 presents some analysis of a range of fuel poverty indicators from other large-scale household surveys that have asked similar questions.

3.9. Process issues

3.9.1. Introduction

BRE are responsible for producing the fuel poverty numbers and for maintaining BREDEM. Defra manage the work on BREDEM and the Energy Saving Trust (EST) manage the contract for the fuel poverty model on behalf of Defra and DTI. This work

is overseen by a Steering Group consisting of the EST, Defra and DTI, who agree an annual work programme with BRE and meet monthly to review progress.

Production of the 2001 fuel poverty estimates exposed a number of shortcomings in the process for calculating the numbers in fuel poverty, including the way the model is documented, validated, and updated.

3.9.2. Documentation

When BRE took over from DETR (as then was) responsibility for producing the fuel poverty numbers in 2000, they were put in a difficult situation of having to replicate a methodology that was not well documented. As a result, they have had problems in re-producing the 1996 published estimates and in replicating the 1996 methodology on the 2001 data set (where some significant discrepancies have already been noted). **Parts of the model are documented more fully and DTI have produced a brief summary of the model (re-produced in Appendix B), but this material needs to be brought together in a single source document and any significant gaps filled, including details of data sources, program files, and the derivation of new variables. This document would ensure that the model is easier to replicate in future years and that the assumptions underlying the model are more clearly spelt out. It should include a table describing the basis for the different components of the model and when each of these (and any associated data sets) was last reviewed or updated.**

3.9.3. Co-ordination

Responsibility for different parts of the model is dispersed very widely across different government departments and different parts of BRE, including:

- ODPM: who fund and are responsible for managing the EHCS data set on which the fuel poverty variables are based;

- DTI: who provide most of the analytical input on fuel poverty within government, take the 'lead' in managing the relationship with BRE with the assistance of EST, and also provide the fuel price data that feeds into the model;

- Defra: who are also closely involved in managing work on the fuel poverty model, take the policy 'lead' on fuel poverty, and are responsible for funding and overseeing the development of BREDEM, which is also carried out by BRE (though not by the fuel poverty team);

- BRE: who maintain BREDEM (for Defra), generate the EHCS-based income variables (for ODPM), and run the fuel poverty model (for DTI/Defra). Several divisions of BRE (and BRE Scotland) are involved in this work, including:

    - Les Shorrock, John Henderson, Brian Anderson and others (based in Garston and East Kilbride), who are responsible for maintaining and developing the BREDEM-12 model;
    - Maggie Davidson and Matt Custard who are responsible for producing the derived income variables; and

- John Riley, Jack Hulme and Matt Custard, the core fuel poverty team, who collate the data from different sources and run it through the fuel poverty model.

We believe there is a need for better co-ordination between the various bodies involved in this process. The current set-up has a number of adverse consequences:

- Several of the people we talked to said they felt the fuel poverty model has largely become a mechanical exercise, divorced from an understanding of the policy context.

- Our impression is that no one *within government* now has a detailed technical understanding of the fuel poverty model. Even within BRE, detailed knowledge about specific components of the model seems to be spread quite widely between different parts of the organisation.

- The development of the fuel poverty model is very dependent on developments in BREDEM, which are driven by a different set of priorities and on a different time-table. There appears, at present, to be no formal mechanism whereby proposed changes helpful for the fuel poverty model are factored in to the development of BREDEM, although there is liaison on an ad-hoc basis as issues arise.

- The design of the EHCS is largely driven by the ODPM's priorities and relevant questions relating to fuel poverty have been dropped from the survey, including temperature readings and expenditure data. Whilst this does not affect the ability to generate the fuel poverty numbers, it does make it harder to interpret them.

- Greater co-ordination with the Devolved Administrations would also be helpful in reconciling differences in the way fuel poverty is defined in different parts of the UK.

3.9.4. Updating the model

DTI and Defra have in the past relied on BRE to come up with proposals for updating the fuel poverty model and are dependent on BRE to keep them informed about technological advances. As users of BREDEM, the fuel poverty team in BRE is in turn dependent to some extent on developments in BREDEM, which is the responsibility of different parts of BRE and Defra.

Parts of the model - and the non-heating algorithms in particular - are widely recognised to be very out-of-date. The hot water algorithm is based on data from the 1970s and the lighting and appliances algorithm is based on field data from the early 1980s. Together, these account for around half of domestic fuel expenditure. According to BRE, both these algorithms were last reviewed in 1993 by the Energy Advisory Services based on data from the Electricity Association. It is not clear why it has taken so long to update this part of the model when the evidence suggests that both algorithms have been substantially under-estimating energy consumption for quite some time – and certainly as far back as the previous set of estimates in 1996.

Data on energy consumption from large-scale household surveys has not been used to its full potential. One of the objectives of the 1998 Energy Follow-Up Survey was to help update the BREDEM algorithms, but this does not appear to have been used to inform BRE's proposals. There is also data on energy consumption in the 1996 EHCS and annual data on fuel expenditure in the Expenditure and Food Survey[58] (formerly the Family Expenditure Survey) which could be used to inform the non-heating algorithms within BREDEM.

When the Fuel Poverty Monitoring and Technical Group (FPMTG) was set up in June 2000, part of its role was to help develop the methodology to produce estimates of fuel poverty on an annual basis and identify areas of on-going research and new areas of research that would assist in the monitoring and understanding of fuel poverty. In practice, it has not been closely involved in advising on technical aspects of the methodology and has not met since May 2003.

We recommend that the fuel poverty model is reviewed on a periodic basis by an independent group consisting of experts in income measurement and energy modelling and users of the fuel poverty data set. This group would keep an eye on the development of the fuel poverty model and identify areas where further work would be most useful, which could then feed into planning the work programme. This role could perhaps be played by a specialist sub-group of the Fuel Poverty and Monitoring Technical Group (FPMTG), comprising some members of the FPMTG and several other external specialists. We think this group should meet at least once a year and that the minutes of these meetings should be made publicly available. The initial remit of this group could be to ensure that, where deemed appropriate, the recommendations in this Peer Review report are considered, prioritised and then implemented on a reasonable time-scale.

3.9.5. Validation

There is a distinction between ensuring the methodology is sound and kept up-to-date, which was discussed in the previous section, and checking this methodology is implemented correctly.

All validation of the results is currently done internally within BRE. They have produced documents on the validation procedures they use and DTI are satisfied that these routines will pick up any errors. However, there is very little independent validation of the results generated by the fuel poverty model, except for 'sense checks' of the headline figures (by EST and DTI/Defra).

One approach to validation is for a separate organisation to run the model independently and compare their results; this, for example, is the procedure used in producing the government's official (HBAI) income data set. However, it is an expensive option as, by definition, it involves a lot of duplication of work, and DTI and Defra would need to be convinced that the additional expense involved was absolutely necessary.

[58] This is a large-scale annual survey of over 6,000 households in the UK (of which over 5,000 live in England) with detailed information on household expenditure, including on different types of fuel.

An alternative approach is to encourage more 'user testing' of the data. Allowing greater access to the fuel poverty data set at an earlier stage would help to uncover potential errors or inconsistencies in the data, which can otherwise go undetected, especially when all that most people see are the aggregate estimates.

No one within government has access to (household-level) data on the fuel poverty variables. DTI said they do not have the resources or the software to carry out their own analysis of the data set and are dependent on BRE to carry out any data analysis. And, as discussed below, external access to the fuel poverty data (at household-level) has been very slow in the past and limited to a fairly restricted set of key variables, severely inhibiting external validation of the data by other potential users. **We recommend that access to the fuel poverty data should be improved (discussed more fully in the next section) and that one of the benefits of doing so would be to expose the data and the underlying methodology to greater external scrutiny. We also think it would be beneficial (and relatively inexpensive) for either the DTI or Defra to develop the capability to carry out their own 'in-house' analyses of the fuel poverty data set[59]. This would help in their role as an 'intelligent customer' for BRE's work on the fuel poverty model, as well as providing a potentially useful service for policy customers within government.**

3.9.6. Release of data

There have been delays in obtaining access to the fuel poverty data and the EHCS data set. The 2001 EHCS data set was only released in June 2004 - substantially later than other large-scale household surveys for 2001, which were released between February and August 2003.[60] Up to and including 2001 the EHCS has been carried out every five years, unlike most other surveys, and been managed as a one off survey with a new contractor and a very steep learning curve, which helps to account for the relatively long lead time. Validation work on the 2001 fuel poverty variables (which are included in the public data set) was further delayed in part because this aspect of BRE's work was initially seen as a lower priority than other work-streams. Now that the EHCS has moved to a continuous format, it is expected that the timing of the release of data will be comparable with that for other annual surveys.

The BRE is considered to be rather a 'closed shop' in the opinion of many of the people we consulted as part of this review. Difficulties accessing data contribute to this image: there is a sense that the data set is closely guarded by the BRE and that fuel poverty data is not always freely available. Many of those we consulted felt that more information should be made publicly available and that rules for access should be clarified. Some of them asked for more fuel poverty variables to be released than at present, including a breakdown of required fuel expenditure between space heating, water heating, lights and appliances, cooking, and standing charges, imputed fuel prices, and a more detailed breakdown of household incomes by source and by benefit unit (i.e. between the primary and additional benefit units).

[59] This would require basic training in the use of a statistical software programme, such as Stata or SPSS.

[60] The 2001/02 Family Resources Survey was released in May 2003, the 2001/02 General Household Survey in April 2003, the 2001 Health Survey for England in February 2003, and the 2001/02 Food and Expenditure Survey in August 2003.

DTI and Defra said they were willing in principle to release more variables from the fuel poverty model if there was a demonstrated demand for this and subject to resource constraints, but our impression is that this has in the past been viewed as a relatively low priority compared with other parts of the work programme.

We recommend that the fuel poverty data set should be available in good time – ideally at the same time as, or shortly after, the fuel poverty estimates are published – and that a longer list of derived variables are released (based on consultation with potential users of the fuel poverty data set). The Ministerial Group on Fuel Poverty should review the reasons for delays in releasing the data and consider ways of expediting publication.

3.9.7. Resources

The resources available for modelling, and especially for underpinning analytical work, on fuel poverty should be reviewed. They may be sufficient, although there is not much flexibility if things do not go as planned and there appears to be little scope for undertaking additional work that may arise during the course of the year. The resource issue has been exacerbated in recent years by delays in agreeing funding.

Funding is provided on a year-by-year basis. Although some discussion takes place about what work may be needed in future years, there is no commitment to funding any of this work in advance. **We recommend a longer time horizon – ideally a three year rolling programme, in order to enable greater continuity in the work programme and a longer-term focus.**

Chapter 4: Broader and longer-term issues

4.1 Introduction

The terms of reference for this Peer Review said it should give 'consideration of whether further analytical work is required to give a better understanding of the degree of, and trends in, fuel poverty and its associated problems.' The Government's recent Plan for Action states: "To ensure we remain on track we will continue to monitor progress, manage the risks to achieving the targets and work to improve our understanding of the impact of our plans and policies on fuel poverty."[61] The following analytical issues are amongst those that, in our view, will warrant further attention and debate in the future. Given Ministers' unambiguous commitment to the existing definition of fuel poverty, we fully recognise that some issues discussed below may be of relevance only for the consideration of policy options in the longer term.

This chapter considers some broader analytical issues relating to the measurement of fuel poverty, including standards for non-heating use; the treatment of servicing costs; the potential use of leading indicators of fuel poverty; and the analysis of movements into and out of fuel poverty or 'churn'. Our analysis also highlights a number of more fundamental issues that we believe should be considered further in looking ahead to the longer term. The intention is not to challenge the current definition of fuel poverty, but rather to identify other possible sources of evidence on the scale and incidence of fuel poverty that could be used to help interpret and complement the official fuel poverty statistics. As a result some of our suggestions should be seen as proposals for future analytical work and sensitivity analyses to underpin and to inform future work in this area.

4.2 Standards for non-heating fuel use

The definition of fuel poverty for England is based upon all fuel that a household needs to use for lights and domestic appliances, as well as for space and water heating. The heating and non-heating components of fuel use are calculated separately within the current fuel poverty model (within BREDEM-12) and their treatment is somewhat different.

For heating, required fuel spend is equal to the estimated cost of achieving an adequate level of warmth in each home, based on an official standard. This standard specifies the pattern of heating for different types of households (longer for those likely to be at home all day), the extent of heating (less in 'under-occupied' homes), and a minimum temperature (higher in the living room than in other parts of the home) (see Section 3.5 for more details). The standards are fixed for all households of a given type, though the cost of achieving that standard varies, depending on the size and energy efficiency of their homes. Other things being equal, those living in the least energy efficient homes will need to spend more to achieve the standard and so are more likely to be fuel poor.

[61] Defra, *Fuel Poverty in England: The Government's Plan for Action*, November 2004, p. 5.

For the non-heating components of fuel use, required fuel spend is simply a function of the size of the dwelling and the number of occupants. The algorithms for lights and appliances, and for cooking, are designed to reflect the average level of energy consumption by households of a similar size living in a similar-sized property. This differs from the treatment of heating in two ways. Firstly, it produces an estimate of *actual*, as opposed to *required*, fuel spend. Unlike the heating side, there is no explicit standard underlying the non-heating components of the model (e.g. no definition of what constitutes adequate lighting, cooling, cooking, or other appliance-based services). The implicit standard is effectively determined by what other households are doing on average. Secondly, it does not allow for differences in the energy efficiency of appliances owned by different types of households. If, as seems likely, low income households tend to own older and less efficient appliances, then they would need to spend more to achieve a given standard of non-heating services, but this is not currently reflected in the fuel poverty statistics.

To be consistent with the treatment of heating costs, there would need to be standards for non-heating energy services (e.g. for adequate lighting, cooling, and so on), as well as for heating. Information on the energy efficiency of lighting and key appliances would need to be collected and used to estimate the cost of meeting these standards for individual households (so, for example, those with a less efficient fridge would need to spend more to achieve the 'cooling standard'). This would have significant implications for the design of the EHCS or any such survey needed to collect this information, both in terms of the length of the questionnaire and, quite possibly, the level of expertise required of surveyors and interviewers.

As well as being more conceptually sound, in our view, this approach would mean that improvements in the energy efficiency of appliances owned by low income households, as a result of schemes like the Energy Efficiency Commitment (EEC), would be reflected in the fuel poverty statistics. In the current model, improvements in the energy efficiency of appliances will not have an impact on fuel poverty unless the lights and appliances algorithms are updated - and, even then, only indirectly in so far as this affects the average use across all households. Hence, the benefits of more targeted schemes aimed at low income households will not show up very clearly, if at all.

As argued in a recent briefing note for the Defra's Market Transformation Programme, BREDEM-12 is much more sophisticated in its treatment of heating than its treatment of lights and appliances:

> *"The NHER survey, based on BREDEM-12 has between 120-150 inputs, yet only one deals with the efficiency of lights and appliances, asking about the ownership of low energy lighting within the dwelling. This is certainly not proportionate to their importance, and may be a significant factor in the overall accuracy of the model."*[62]

[62] See the Introduction of *The accuracy of the BREDEM-12 algorithm for lights and appliances*, an unpublished (and undated) briefing note prepared for Defra by Christian Jardine at the ECI, University of Oxford.

The non-heating components of total domestic fuel use are likely to become increasingly important over time, so this argument will apply with greater force in the future. On current trends, we estimate that the share of lights and appliances in total domestic fuel expenditure is expected to rise from 41% to 46% by 2010, based on forecasts of energy use by the Defra's Market Transformation Programme[63] (see Table 11).

BRE are currently exploring ways of modelling the non-heating side in much more detail for the next version of BREDEM-12 and there is a strong case for the fuel poverty model to follow suit. However, there are several constraints on this:

- It would significantly add to the complexity of an already complex model;

- It would require much additional data to be collected in the EHCS. A knock-on effect of the latter is that the earliest these changes could be made is 2006 or 2007. ODPM are likely to resist this, because they have purposefully sought to shorten the EHCS questionnaire in recent years in order to increase response rates and cut costs;

- It would require agreement on what constitutes an adequate level of non-heating (energy-related) services (i.e. lighting, cooking, cooling, washing, and other appliances). Though necessarily subjective, social scientists have developed techniques for making these kinds of judgments. Probably the most relevant in this context is the work of the Family Budget Unit (FBU) who estimated the cost of achieving a 'modest but adequate' living standard for different types of households. This is based on an assessment of the spending requirements for households to sustain a lifestyle that is above the poverty line but well below luxury (including the cost of durable items, where these are owned by the majority of other households).[64]

Our view is that serious consideration should now be given to developing the non-heating component of the fuel poverty model along the lines suggested here. (An alternative approach is cutting it out altogether, in which case fuel poverty activity would focus only on the achievement of affordable warmth. But, this would not be acceptable to Ministers, as it would entail a major definitional change.) The current approach differs from the treatment of heating costs and will not pick up the beneficial impact of several of the key policies already being directed at fuel poor households. This may reinforce the tendency of government (and others) to focus on SAP improvements as a (and, sometimes, perhaps *the*) proxy indicator for progress in tackling fuel poverty, even though this accounts for only just over a half of total domestic fuel expenditure – a share which is projected to decline further.

[63] This assumes no change in the relative price of gas and electricity. If electricity prices rise faster over this period, as anticipated in a recent report by the DTI ("Trends in energy prices between 2003 and 2010" available at http://www.dti.gov.uk/energy/consumers/fuel_poverty/), then the rise in the share of spending on lights and appliances would be even greater.

[64] The FBU use a range of data including national surveys, market research reports, health and good practice standards, information on consumer behaviour, and discussion groups with people who are comfortably off but not rich.. More information is available on the Family Budget Unit website: www.york.ac.uk/res/fbu.

4.3 Servicing costs

The Government's definition of fuel poverty is based on *all expenditure on fuel* by households, including that for non-heating purposes.[65] Yet, in principle, domestic fuel and fuel-related expenditure has three distinct components: (i) that on fuel and electricity; (ii) where applicable, the costs involved in servicing and repairing heating, hot water and other energy-using appliances; and (iii) the capital expenditure to install (or to replace) such equipment. We are not aware of any studies that have explored the latter two topics and their implications - either for estimates of those in fuel poverty or for the design of fuel poverty programmes. We focus in this section only on heating and hot water systems.

None of BRE's six proposed changes to the fuel poverty methodology related to the costs of purchasing or servicing heating and hot water systems, or any other domestic energy-using appliances. The DTI/Defra consultation paper of 26 April 2004 on the fuel poverty methodology did, however, invite responses as to whether central heating servicing costs should be included as part of fuel expenditure (para. 4.1). No consultation responses addressed this issue. It has been raised occasionally in discussions at the Fuel Poverty Advisory Group and amongst specialists, though no agreed position has yet emerged.

Non-fuel operating and maintenance costs for heating and hot water by coal, wood, gas (piped mains gas and LPG), oil and electricity vary. They include an annual boiler check up, more extensive annual central heating system care or 'insurance' schemes, chimney sweeping, and regular maintenance of gas fires, point-of-use water heaters, hot air systems, and oil and LPG storage tanks. In some cases, particularly gas appliances and chimneys, users are recommended (by bodies such as CORGI and the National Association of Chimney Sweeps) to ensure an annual safety check is undertaken, though such checks are not compulsory for individual householders. LPG suppliers invariably include LPG storage vessel maintenance costs in their fuel prices. But, as with oil, LPG heating systems are serviced by appropriate maintenance contractors.

There is also limited data on the number of heating systems in fuel poor (or other) households which are inoperable due to minor or major breakdowns; and thus the need to incur perhaps significant expenditure in their repair or replacement.

Private and social landlords are invariably responsible for the costs of maintaining fixed heating and hot water systems, and such costs are incorporated in rents. However, owner occupiers are themselves responsible for the servicing costs of equipment they have purchased; and for the costs of new and replacement equipment.

For heating systems installed under Warm Front from 2000 to November 2002 by means of a leasing agreement, the maintenance and servicing costs are covered by Warm Front for the 7 year period of their lease. For heating systems installed under Warm Front since November 2002, maintenance and servicing costs are met by Warm

[65] *The Fuel Poverty Strategy*, November 2001, op. cit., p. 107, para. 7.

Front for the first year only.[66] The servicing costs for boilers and central heating systems installed by Warm Front in private rented property are also covered by Warm Front for the first year. In subsequent years, annual servicing is the responsibility of landlords or owner occupiers. This situation is not restricted to fuel poverty grant schemes. Other schemes for example the Energy Efficiency Commitment, Home Repair Assistance Grants, Disability Facility Grants and Local Authority Refurbishment Grants do not provide for the first year as Warm Front does. These place responsibility for annual servicing costs on owner occupiers from time of installation.

No authoritative or comparable sources of information have been identified on the annual servicing costs associated with domestic heating and hot water equipment. An extensive (but by no means comprehensive) web site search by the authors has identified the following indicative annual costs: gas appliance care scheme costs of about £90 for gas fires, wall heaters, water heaters and gas cookers; gas CH system care schemes at about £150-£180; electrical storage heating system cover at about £50-£60; and chimney sweep costs (for two open fires) at about £30-£40.

If these estimates of servicing costs are added to other heating and non-heating fuel costs, then the number of fuel poor households would rise from around 1.7 to 2.3 million. This is likely to be a conservative estimate, because it is based on the lower bound figures (where a range is given); it does not include the cost of servicing certain types of heating system (e.g. fixed electrical heaters); and it assumes that only owner-occupiers face these additional costs (as landlords are responsible for maintaining fixed heating systems in rented properties). [67]

Transco is responsible for dealing with gas leaks and emergencies; provides a free national emergency number; and its engineers will attend any gas leak free of charge. The disabled, chronically sick and pensioners are entitled to registration on the Priority Services Register by their gas and electricity supplier. Those registered are entitled to receive a free, annual safety check of gas appliances and advanced notice of any planned interruptions to their electricity supply. However, this scheme does not include the cost of repairs or of equipment replacement.

We believe there are arguments both for, and against, including the costs of servicing heating and hot water systems.

Arguments for including them are that:

- The estimates of heating costs used in the fuel poverty model (based on the BREDEM-12 model) assume people's heating systems are operating efficiently, so it seems appropriate also to assume that these systems are being serviced adequately and safely - and that this is an integral part of the cost of heating a home;

[66] This practice is the same in Northern Ireland and Scotland, where the first annual service of boilers and central heating systems is carried out free under Government-funded fuel poverty grant schemes, but thereafter servicing becomes the householder's responsibility.

[67] If tenants are assumed to face the same servicing costs (i.e. if landlords pass them on indirectly through higher rents), then the number of fuel poor households would rise to 2.7 million.

- The fuel poverty model is based on the cost of achieving certain heating standards, which should incorporate the cost of servicing and safely maintaining the relevant equipment (including chimneys) in line with manufacturers' and trade associations' recommendations - even if practice does not always match up to these standards.

Arguments against including such servicing costs are that:

- Many people, especially low income households, may not in practice service their heating and hot water systems annually, so this is only a theoretical cost (though see the argument above about safety standards);

- These costs might only be separately identified for owner-occupiers, given that tenants must effectively pay for all or most of these costs within their rent;

- The choice of what might or might not be included is always going to be hard to define, and rather arbitrary. If the costs of servicing heating and hot water systems were included, then what about the costs of maintaining other household appliances (TVs, fridges, washing machines, etc.)? Can a consensus be reached on which additional (essential) appliances should be included? If not, where would this process end?

- Some people choose to take out maintenance contracts when purchasing specific domestic electrical appliances, typically for 3 or 5 years. But some consumer organisations have argued that such extended warranty contracts represent poor value for money;

- Including some, or all, of the above servicing costs would add to the complexity of a model that some would argue is already too complicated and difficult to understand.

The capital costs of new and replacement heating and hot water systems should also be considered more fully. It is often assumed that central heating boilers last for some 15 years or so, though there appears to be no definitive information in the public domain as regards operating lives of domestic boilers - especially for newer, condensing, boilers. The cost of a new condensing boiler is some £1200-1500. The total cost of a replacement condensing boiler, including a new diverter valve, pump, time clock and main thermostat, and flushing of existing radiators and pipe work is some £3,000-£3,200.[68] We have not been able to examine the capital costs of all the major alternative heating and hot water systems as part of this Peer Review, given time constraints.

We recommend that a short but comprehensive study be undertaken for DTI/Defra of the servicing costs of the major heating and hot water systems; of the actual and annualised capital costs of replacement systems; and also of the

[68] Based on the actual costs faced by one author of this Peer Review in summer 2004. Such costs will be lower for bulk purchasing of boilers and central heating systems under schemes such as Warm Front.

likely operating lifetimes of such equipment.[69] The findings should be published. Until such information is available we consider it difficult to advise on which, if any, of such servicing (and/or capital) costs should be incorporated into the fuel poverty model to provide more realistic estimates of total annual domestic expenditure on heating, hot water and other energy-related services.

4.4. Leading indicators of fuel poverty

There is inevitably a lag in the production and publication of the estimates of households in fuel poverty. Particularly at a time of rising real energy prices, we believe it is important that wider use is made of a series of other indicators - particularly those which might be useful in heralding any upturn in fuel poverty. Perhaps the most comprehensive set of such indicators is that published by Ofgem.[70] Amongst the key indicators are those for:

- the number of customers using pre-payment meters (annually, separately for gas and electricity);

- the number of customers re-paying a debt (both pre-payment customers repaying through their meter, and credit customers repaying through a payment arrangement); the relative size of debts for customers who are repaying a debt; the percentage of pre-payment meter customers that are repaying a debt; and the average size of debt for customers in debt (quarterly, for gas and electricity);

- the number of disconnections for debt (annually, for gas and electricity);

- the proportion of households with prepayment meters that reported self-disconnections (occasional); and

- payment methods (quarterly for gas and electricity, by individual supplier).

Annual data on many of these indicators is already published in an Annex of the government's progress reports on the UK Fuel Poverty Strategy. None of these indicators specifically identify households in fuel poverty. In terms of a 'leading indicator', perhaps the most useful is the information on debt, which is published quarterly. **We suggest that Ofgem, the energy suppliers and Energywatch be consulted on ways in which more data on potential 'leading indicators' of fuel poverty might be made available on a quarterly basis; how more of them might be presented on a rolling, cumulative basis to identify trends more clearly; and whether such data specifically for those in fuel poverty might be obtained in future.**

[69] Reliable information on average operating lifetimes is critical given the churn in the boiler stock; and given the Government's statutory obligations regarding the eradication of fuel poverty in England by 22 November 2016, as far as reasonably practical.

[70] See, for example, Ofgem, 'Monitoring Company Performance, Quarter 3 2004 (Social Action Plan Indicators)', Ofgem 266/04.

4.5. Churn

There is considerable movement into and out of fuel poverty (or 'churn') over time, largely driven by changes in households' family and/or financial circumstances. For example, a new job may raise a household's income and help to move it out of fuel poverty or the death of a spouse may lead to a fall in income and push their widow(er) into fuel poverty. In addition, whether or not a household is in fuel poverty may change as people move home. DTI estimate that around 15% of fuel poor households move home each year - and those moving into more (or less) energy efficient dwellings may move out of (or into) fuel poverty.

Movements into and out of fuel poverty that are not part of a national trend (e.g. a general rise in incomes or in fuel prices) are likely to cancel each other out across the whole housing stock and so will not have very much impact on the overall number of households in fuel poverty. However, 'churn' may still be an important policy consideration, if, as would seem appropriate, the greatest concern is for those households who are persistently or recurrently fuel poor over a period of several years.

Previous research by one of the authors of this report[71] shows that for the majority of households that experience 'expenditure fuel poverty'[72], it appears to be a transitory phenomenon. But, cases of persistent expenditure fuel poverty account for a much higher proportion of those households observed to be expenditure fuel poor at any given point in time – of these, nearly half are experiencing persistent expenditure fuel poverty, as defined in that research.[73] The same report found that certain types of households - single pensioners, low income households, and occupants of the least energy efficient homes - are much more likely to be experiencing persistent expenditure fuel poverty than other households that are 'expenditure fuel poor'.

The current fuel poverty statistics do not distinguish between households that are experiencing persistent fuel poverty – who might perhaps be of greatest concern to policy-makers - from those for whom it is a relatively short-term phenomenon. This would require longitudinal data to be collected (i.e. the same households would need to be re-interviewed in successive years) to determine the duration of fuel poverty.

In the 2001 EHCS (and in previous surveys) there was a longitudinal element of the survey - around a quarter of the sample from the previous survey was re-visited in the subsequent survey. But this was discontinued in 2002/03 when the EHCS moved to a continuous format. ODPM will be re-introducing a longitudinal component from 2005/6 onwards, whereby a sample of dwellings from the 2002/03 survey (and

[71] Sefton, T. (2004), *Aiming High: an evaluation of the potential contribution of Warm Front towards meeting the Government's fuel poverty target in England*, a report for the Eaga Partnership Charitable Trust, CASE report 28, London: STICERD, London School of Economics.

[72] Households are defined as 'expenditure fuel poor' if they are spending more than 10 per cent of their total annual income on fuel. This differs from the government's official definition of fuel poverty which is based on an estimate of required (as opposed to actual) fuel expenditure. (The official measure of fuel poverty cannot be replicated within the BHPS, because there is insufficient data on the energy efficiency of people's homes.)

[73] This analysis is based on four years of data from the British Household Panel Survey (1997/98-2000/01 inclusive). Persistent fuel poverty is defined as being 'expenditure fuel poor' for three or more out of these four years.

successive surveys) will be re-visited three years later[74]. This will enable some useful analysis to be carried out of churn; so, for example, it will be possible to identify whether dwellings that are occupied by a fuel poor household in one year are still occupied by a fuel poor household three years later (and whether these are the same occupants as three years previously).

When the first sample of longitudinal data from the continuous EHCS becomes available - probably in 2007/8 - it will be possible to carry out more detailed analysis of movements into and out of fuel poverty (or 'churn'). In the meantime, we would encourage more use to be made of existing data sources. The British Household Panel Survey, which is a large-scale longitudinal survey, includes questions about incomes, fuel expenditure and affordable warmth that could be used to supplement the more detailed, but static, analysis of fuel poverty using the EHCS. The BHPS is already used for a similar purpose in the government's income statistics to examine movements into and out of low income over time.[75]

4. 6. Longer-term issues

We have identified a number of issues relating to the broader concept of fuel affordability that we think it is important for the government to consider carefully alongside the monitoring of progress towards achieving its statutory fuel poverty targets under the Government's definition.

In Section 1.3 we emphasised our view that the overall methodology for calculating the numbers in fuel poverty should be guided by a number of general principles. Amongst these is the need for a sound conceptual framework; use of the best available evidence; consistency with established standards elsewhere; and securing the broad support of the key players in the fuel poverty field. For the longer term we place considerable weight on the desirability of achieving greater convergence with 'mainstream' thinking, particularly in the measurement of poverty and social exclusion.

4.6.1 Concept of affordability

The concept of affordability underlying the current definition of fuel poverty is that fuel payments become unaffordable if they represent more than a fixed percentage of a household's income (10% under the current definition). A similar approach has traditionally been used in a housing context to define an affordable level of housing costs (e.g. in setting rents in the housing association sector).

Whilst there is no unique or correct way of defining affordability, the fixed percentage-of-income approach has a number of limitations that have been highlighted in the housing literature and that are also relevant in a fuel poverty context. Stone[76] has summarised the crux of this argument:

[74] Each dwelling in the longitudinal sample will only be followed up once.
[75] See Chapter 7 of the DWP's "Households Below Average Income 1994/95 – 2002/03".
[76] See Chapter 2 of Stone, M. (2003*), Shelter Poverty: New Ideas on Housing Affordability*, Philadelphia: Temple University Press. The same point is made elsewhere: see, for example, Hancock,

> Since housing costs generally make the first claim on a household's disposable income… when we say that a household is paying more than they can afford for housing, we mean (or logically should mean) that after paying for their housing they are unable to meet their non-housing needs at a minimum level of adequacy. Consider, for example, two households with comparable disposable incomes. Suppose that one consists of a single person, while the other is a couple with four children. Obviously the large household would need substantially more for its non-housing necessities than would the small household to achieve a comparable material quality of life. This implies that the larger household can afford to spend less on housing than can the small household on the same income. Now compare two households of the same size, but different incomes. Both would need to spend about the same amount to achieve the same standard of living in terms of non-housing items. The higher-income household thus could afford to spend more on housing, as a percentage of income as well as in dollars. (p. 34).

In the same way, if comparing two households on a similar income, the larger of the two households will not be able to afford to spend as much on fuel as the smaller household, because it will have greater non-fuel needs. It follows that a fixed percentage-of-income approach to defining fuel poverty will tend to under-state the affordability problem (as it is commonly understood) among larger households in comparison with smaller households. It will also tend to over-state the problem among higher income households in comparison with lower income households.

Empirical analysis suggests that this could have a significant impact on the composition of households identified as having problems paying for their fuel. Firstly, we compare the characteristics of households that are fuel poor with those that are poor (using a widely accepted measure of poverty).[77] This shows, for example, that single person households comprise 56% of fuel poor households, but only 37% of poor households. Single pensioners also make up a much higher proportion of fuel poor households (44%) than of poor households (21%). By contrast, couples with children make up 3% of the fuel poor and 17% of the poor (see Table 27).

We would not necessarily expect the composition of fuel poor households to be the same as that of poor households if, for example, single pensioners were also more likely to be living in the least energy efficient homes. But, this does not appear to be the case: the final column of Table 27 shows that the distribution of low-SAP dwellings (below 30) is in fact very similar to the distribution of poor households.[78]

A second piece of analysis looks at the composition of households reporting problems that we would expect to be closely related to fuel poverty. Many of these indicators have been used in international comparisons of fuel poverty.[79] These alternative

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K. (1993), ''Can Pay? Won't Pay?' Or Economic Principles of Affordability', *Urban Studies*, Vol. 30, No. 1, 1993, pp. 127-145; Kearns, A. (1992), 'Affordability for Housing Association Tenants. A Key Issue for British Social Housing', *Journal of Social Policy*, Vol. 21, No. 21, pp. 525-549.

[77] A household is defined as poor if its net equivalised household income (before housing costs) is below 60% of the median.

[78] The one possible exception is single parents who are under-represented among the least energy efficient homes (given their relatively low incomes), which would help to explain why they comprise a lower proportion of the fuel poor (8%) than of the poor (12%).

[79] See, for example, Healy, J. and Clinch, P. (2002), *Fuel Poverty in Europe: A Cross-Country Analysis Using A New Composite Measurement*, Environmental Studies Research Series Working Papers 02/04,

indicators of fuel poverty reveal a fairly consistent pattern within themselves, but one that differs from that observed in the official fuel poverty statistics (see Table 28).

Larger households, and in particular couples with children, make up a greater proportion of households reporting problems related to inadequate and/or unaffordable heating than are fuel poor under the government's current definition. For example, couples with children account for 3% of fuel poor households, but they comprise 17% of households who say they cannot afford to keep their home adequately warm, 20% of households that report inadequate heating facilities, 22% of those living in cold homes, and 26% of those who say they find it fairly or very difficult to meet the costs of running their home (including costs like heating and fuel). Single pensioners, on the other hand, make up a much smaller proportion of households with these fuel poverty-related problems by comparison with the official measure of fuel poverty.

The evidence presented here suggests that when measuring fuel poverty there may be a significant number of larger households that have problems associated with the affordability of fuel, but who are not officially classified as fuel poor. We would, therefore, recommend giving greater weight than at present to other supplementary indicators of fuel poverty, such as those presented in Table 28, in order to provide a more complete picture of the problem – and, in particular, to help monitor progress towards the eradication of fuel poverty among different types of households.

4.6.2 Equivalisation of incomes

Income equivalisation is closely related to the affordability issue discussed in Section 4.6.1 above, and has similar implications.

The income measure used in the current definition of fuel poverty is total household income (net of income tax and national insurance), including the income of all adult members of the household. Larger households have higher incomes, on average, than smaller households. This is because there are more likely to be two or more adults contributing to the household's income and larger families are eligible for greater amounts of benefit. But larger households also have greater needs: in order to enjoy a comparable standard of living, a couple with two children, say, will need a higher income than a person living alone.

The DWP's official (HBAI) income statistics allow for variations in the size and composition of households by adjusting the incomes of households using an established "equivalence" scale.[80] This adjustment reduces the incomes of larger households relative to smaller ones, so that the two can be directly compared.

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which is available on the University College Dublin website: (http://www.ucd.ie/pepweb/publications/workingpapers/02-04.pdf)

[80] The main equivalence scale used in HBAI is the McClements scale. Couples with children are used as the reference point and assigned a value of one; single persons are assigned a value of 0.61 (i.e. their incomes are divided by 0.61); couples with, say, two children aged 5 and 7, are assigned a value of

The income measure used in the current fuel poverty definition is not adjusted in this way. Professor Gordon at Bristol University, who is an expert on poverty measurement, has argued that household incomes ought to be equivalised in order to provide a fairer comparison between households of different sizes. The impact of equivalising incomes will be to lower fuel poverty among smaller households, especially single pensioners, and increase fuel poverty among large households, especially couples with children.

Table 29 shows that using equivalised incomes in the definition of fuel poverty[81] does not significantly affect the overall *numbers*: there is in fact a small reduction in fuel poverty from 1.7 to 1.5 million households. But, it does substantially alter the *distribution* of the problem. Whereas single person households account for 56% of fuel poor households under the current fuel poverty definition, they account for only 16% of fuel poor households if incomes are equivalised. Many fewer single pensioners and many more couples with and without children are identified as fuel poor following this adjustment.

Even if it makes sense conceptually, a fuel poverty threshold of 10% of a household's *equivalised* income is not very intuitive and may possibly over-compensate in favour of larger households. It would in any case require a significant change in the definition of fuel poverty, which Ministers are not prepared to consider. We therefore do not recommend any action at this stage in terms of the equivalisation of incomes.

Nevertheless, the case for equivalisation reinforces the conclusion of the previous sub-section that the current way of defining fuel poverty will tend to under-state problems of fuel affordability among larger households relative to smaller households. In looking ahead towards 2010 and beyond, further consideration may need to be given to assisting those within this group who may not be able to adequately heat their home, yet are not classified as fuel poor.

4.6.3 Treatment of disability benefits

The income measures used in both the official poverty measure and in the fuel poverty model include various disability-related benefits. As a result, disabled people may appear to be better off than they really are because these benefits are added to their income, but the additional costs they face as a result of their disability are not deducted. About a fifth of all households and a third of older person households contain a disabled person[82], so adjusting for the extra costs of disability could potentially have quite a significant impact on both general poverty statistics and the fuel poverty estimates.

1.42 (i.e. their incomes are divided by 1.42). For full details, see Appendix 2 of the DWP's annual HBAI report, which is available on their website (http://www.dwp.gov.uk/asd/hbai.asp).

[81] Using the McClements equivalence scale, as employed in the official HBAI income measure.
[82] Defined as someone reporting a limiting long-standing illness or disability.

Whilst there is a strong case for adjusting incomes to take into account the additional costs of being disabled, this is not currently done in the official income and poverty statistics because, according to DWP officials, there is not (yet) a robust and widely-accepted method for doing so. However, sensitivity analyses are carried out to explore the possible impact of allowing for the increased needs associated with disability, using a modified equivalence scale.[83] This is not an option in this context, because incomes are not equivalised in the fuel poverty model (see previous sub-section).

An alternative approach, which could also be applied to the official DWP poverty statistics, would be to deduct from households' incomes certain disability-related benefits, including the Disability Living Allowance (DLA) and Attendance Allowance (AA). The rationale is that these benefits are specifically designed to compensate for the additional costs of being disabled and, on this basis, do not make these households financially better off than non-disabled people who are not receiving this additional source of income.

The two most recent pieces of academic research in this field conclude that the extra costs associated with being disabled (e.g. for special equipment, additional heating, and higher transport costs) are substantial.[84] This research finds that firstly, many people who are disabled (and incur additional costs as a result of their disability) are not receiving any benefits either because they are not eligible or because they are not claiming benefits to which they are entitled; and, secondly, for many who are receiving disability-related benefits, the amounts are less than would be needed to meet the estimated costs associated with their disability. On the basis of these findings, the adjustment described above (i.e. deducting DLA and AA from household incomes) would be on the conservative side: in most cases, and on average, it would still under-estimate the 'disposable' incomes of disabled people.

In 2001, only 7% of households in receipt of either DLA or AA were officially fuel poor – less than the average rate of fuel poverty in the UK (at just over 8%). If the value of these two benefits were deducted from their incomes, this proportion would rise to over 20% and the overall numbers in fuel poverty would rise from 1.7 to 1.9 million.[85]

We believe that the additional costs of being disabled should be recognised in some way within the fuel poverty statistics (and, indeed, in other poverty statistics, though this is beyond the remit of this report) - as this is one of the vulnerable groups highlighted in the UK Fuel Poverty Strategy. In our view, omitting these benefits from the income measure would provide a more accurate assessment of the affordability of fuel costs among households containing a disabled person (see section 4.6.1). A pragmatic and conservative adjustment

[83] The 1996 HBAI Methodology Review recommended the use of an additional equivalence scale, which includes an element for increased needs associated with disability (which are reported in the sensitivity analyses in Appendix 2 of the HBAI report). This modified scale increases the needs of households containing a disabled individual by ten per cent per disabled adult. This figure is arbitrary but is designed to show whether particular results are sensitive to this assumption.

[84] See Smith, N. et al (2004), *Disabled people's cost of living: 'More than you would think'*, York: Joseph Rowntree Foundation; and Zaidi, A. and Burchardt, T. (2003), *Comparing Incomes when Needs Differ: Equivalisation for the extra costs of disability in the UK*, CASE Paper 64, London: STICERD, London School of Economics.

[85] This is a provisional estimate by the Peer Review team.

would be to deduct from household incomes the value of certain key benefits that are specifically designed to compensate for these additional costs, including the Disability Living Allowance and Attendance Allowance.

We suggest that the impact of such an adjustment is examined as part of the work on affordability and included as a sensitivity analysis of the fuel poverty figures to be published alongside the 'headline' statistics. This is because Ministers are not prepared to consider changes in the current definition of fuel poverty at this time.

4.6.4 Treatment of housing costs

The treatment of housing costs was a recurring issue in the consultation responses and in our discussions with key stakeholders for this Peer Review and, therefore, one we felt needed to be addressed in this report. It was also a major issue in the earlier consultation on the proposals for new HEES/Warm Front in 2000.[86] The main 'headline' measure of fuel poverty uses "full income", which is essentially a before-housing-cost income measure. DTI/Defra also publish figures based on a "basic income" measure, which excludes Housing Benefit and ISMI, but not rents or mortgage payments as in a conventional after-housing-cost measure of income.

Several respondents to the consultation argued that using after-housing-cost (AHC) incomes would be more appropriate for some of the following reasons:

- Whether or not a household is in fuel poverty cannot be determined without reference to the dwelling that household is currently occupying. It follows that the housing costs associated with living in that property are fixed and should not, by this argument, be included in the income measure that is used to determine whether someone is fuel poor;

- Low income households, who are the most important group in the context of fuel poverty, often have little choice about the housing they live in. This is another reason for arguing that these costs are largely unavoidable and so should not be included in the 'disposable' income available to meet people's fuel bills;

- Large regional differences in rents for similar properties make comparisons of before-housing-cost (BHC) incomes potentially misleading. For example, a council tenant in London living on the same income (but with higher rent) as a council tenant in Newcastle upon Tyne, will have less income available to spend on fuel – but this is not reflected in the current definition of fuel poverty. An AHC income measure would ensure a more equitable comparison between households living in properties of comparable quality, but facing widely varying housing costs;

[86] See *The Fuel Poverty Strategy*, DTI, November 2001, Annex D, paras. 8-13, pp. 107-108. Footnote 9 on p. 108 acknowledges that the definition excluding housing costs, chosen by the Government for fuel poverty target setting, 'is not consistent with the approach taken for the wider analysis of low income.'

- Trends over time in BHC incomes can be misleading if rents are rising in real terms. The incomes of many low income households will rise (as they receive greater amounts of Housing Benefit to match the increase in rents), even though they are no better off than previously.

On the other hand, an AHC income-based measure of fuel poverty could potentially include some relatively well-off households with large mortgages. In practice, however, it has been estimated by NEA that relatively few households would fall into this category; in the sample they looked at, only about 2% of those households with gross incomes above £18,000 were spending more than 10 per cent of their income on fuel after housing costs (and would, therefore, be fuel poor using an AHC income-based of fuel poverty).[87]

If a 10 per cent affordability threshold were used for both the AHC and BHC income-based measures, there would also be significantly more fuel poor households under the AHC measure, not all of whom would necessarily have difficulties adequately and affordably heating their homes. However, this need not be the case if, as might be appropriate, a higher threshold (i.e. greater than 10%) were adopted for the AHC measure.

Using an after-housing-costs (AHC) measure of income could have a significant impact on the regional distribution of fuel poverty. According to analysis by Richard Moore, a Visiting Fellow at Warwick University, Inner London would move from having the lowest to among the highest rates of severe fuel poverty (households needing to spend over 20% of their income on fuel) under an AHC definition. It could also affect the distribution between different types of households and between tenures, as housing costs vary significantly across these dimensions: for example, a greater proportion of pensioners own their property outright and have relatively low housing costs by comparison with other households.

In their official income statistics, the DWP give equal prominence to poverty measures based on AHC and BHC incomes. On grounds of consistency, there is also a strong case for publishing both a BHC- and AHC-based measure of fuel poverty.[88] Six out of sixteen respondents to the consultation expressed their support for an AHC measure of fuel poverty (even though this was not one of the issues raised in the consultation paper).

The "basic income" measure is somewhat of an 'oddity' from the past, developed in 1991 because no data was collected in that year on Housing Benefit and ISMI. This approach was re-produced in subsequent surveys for the sake of consistency over time. A consistent "full income" series is now available from 1996 so, we believe, the argument for continuing with the "basic income" measure on this basis is weak.

The main benefit of looking at both an AHC and BHC income-based measure of fuel poverty would be a better understanding of the *distribution* of fuel poverty between different regions and/or types of household, rather than the overall scale

[87] A brief summary of these findings is provided in the NEA's Fuel Poverty Focus for November 2001. The data is from a small sample of households in the London Borough of Camden.

[88] It should be borne in mind that DWP use a poverty measure relative to the median, which is therefore different for the AHC and BHC income measures.

of the problem. If a 10 per cent affordability threshold were used for both the AHC and BHC income-based measures, there would be significantly more fuel poor households under the AHC measure, though this would not necessarily be the case if a higher threshold were adopted for the AHC measure.

We recommend that further work is carried out to develop an after-housing-cost measure of income that approximates as closely as possible the definition used in the official HBAI income statistics. This should include an assessment of whether a higher affordability threshold should be applied to an AHC income-based measure of fuel poverty and an examination of the incidence of fuel poverty among different groups. Assuming a suitable and useful AHC measure of fuel poverty can be developed, we suggest that an analysis of this measure is published annually as a sensitivity analysis of the fuel poverty figures. This should focus on differences in the composition of households and properties between the AHC and BHC measures of fuel poverty.

4.7. Other issues

Respondents to the consultation on the fuel poverty methodology were encouraged to use their responses to comment more broadly on the approach to measuring fuel poverty, as well as on the six specific proposals put forward by the BRE. Many of the broader issues that were raised in the consultation responses have already been addressed in this report and indeed the responses helped to identify and prioritise the issues we have focused upon in Chapters 3 and 4.

However, we have not covered all these issues in the preceding discussion, partly because of time constraints on the Peer Review and partly because we felt that some of these propositions were either impractical or invalid. The main omissions are listed below, although we accept this list may not be comprehensive:

- One response argued that water bills should be included in the definition of fuel poverty on the basis that they are not an optional payment. This would allow for an assessment of the impact that high water prices are having upon the fuel poor;

- Another respondent argued that all dwellings should be assessed as if they were occupied by a vulnerable single pensioner. The rationale is that if the housing stock can deliver affordable energy to a single vulnerable pensioner – the "worst case scenario" – then it can deliver affordable energy to all vulnerable households, thus ensuring that the housing stock is "future-proofed" against fuel poverty;

- Two respondents argued that energy prices are effectively 'subsidised' (e.g. through reduced rates of VAT, absence of pollution charges) and that the value of this subsidy should be treated in the same way as state benefits (i.e. added to people's incomes, rather than deducted from energy prices). They argued that at some stage the cost of clean energy will force energy prices upwards and that the current fuel poverty figures understate the true situation and defer a substantial proportion of fuel poverty to be addressed in the future;

- One respondent argued that Winter Fuel Payments should be deducted from households' fuel bills rather than added to their income, as is currently done, because these payments are made to help meet their fuel bills.

Chapter 5: Summary and recommendations

This Chapter summarises the Peer Review team's recommendations under the three headings corresponding to the different stages of this review. As well as listing these recommendations, Table 30 sets out our views on whether any proposed changes should be made in the short-, medium-, or long-term and their likely impact (if known) on the fuel poverty estimates.

5.1. Discussion of BRE proposals

The first stage of this Peer Review investigated BRE's six specific proposed changes to the fuel poverty model and provided advice on whether and in what form we think these should be implemented.

Proposal 1

As proposed, we think it is sensible to make use of new data on the incomes of additional benefit units to generate a more accurate measure of household incomes. However, there are a number of technical issues that we think need to be examined more thoroughly by BRE in close consultation with the DWP: the extent of missing data (although this seems to be less of a problem with more recent surveys); methods for the imputation of incomes where data is missing; and assumptions made in converting banded gross incomes into point estimates of net income. In addition, this review should consider the treatment of benefit units with low reported incomes (see below).

Proposal 2

Our view is that it is inappropriate to count Council Tax Benefit (CTB) as part of household income without also deducting the tax it is designed to cover. Deducting council tax payments (net of CTB) would also be consistent with the government's official (HBAI) income measure and with international best practice in the measurement of household incomes.

Proposal 3

The evidence presented in this report broadly supports the proposed changes to the lights and appliances algorithm, but with some important provisos:

- Further work should be undertaken to reconcile different estimates of overall domestic electricity consumption, including the two series published by DTI. The average level of consumption predicted by the proposed algorithm is broadly consistent with the BRE series, but still significantly lower than that implied by the ECI/MTP series. If the latter is found to be the more reliable source, this could be taken into account relatively easily by using the option available within the BREDEM-12 model to apply a 20% across-the-board increase in the use of lights and appliances (as is already being proposed for the hot water algorithm).
- Greater use should be made of data from large-scale household surveys to validate and update this and other BREDEM algorithms.

- Consideration needs to be given to how forthcoming revisions to the lights and appliances algorithm will be incorporated into the fuel poverty model.
- There is, in addition, a much more fundamental question about whether there should be standards for non-heating fuel use in the same way as there is for heating. We return to this below.

Proposal 4

We agree that actual household numbers should be used in the fuel poverty model in place of imputed or standard occupancy, because households' fuel requirements are significantly affected by the actual number of people living there, especially for non-heating purposes.

However, this proposal does not represent a significant change from what we understand was done in the 1996 fuel poverty model, where we have been told that actual household numbers were already applied to the non-heating algorithms. Poor documentation of the model contributed to this apparent misunderstanding.

Proposals 5 and 6

The current algorithm is clearly out-dated, but there is very little information that could be used to produce a more accurate algorithm. This is a significant weakness in the model, given that water heating accounts for around a fifth of households' required fuel expenditure. There is, therefore, a strong case for carrying out a metering survey to measure actual hot water usage in a small representative sample of households, as proposed. The results of this study should be published.

In the meantime, it seems reasonable to make a fairly crude adjustment along the lines suggested by BRE – an across-the-board increase of 20%. There is also a case for modifying the *structure* of the algorithm, which may over-state the consumption of smaller households and under-state that of larger households (according to a recent piece of analysis by the BRE). For the sake of simplicity, though, we think the current structure of the BREDEM algorithm should be retained unless the results are found to be very sensitive to this assumption.

Overall impact of Peer Review examination of BRE's six proposals

Our provisional estimates suggest that our recommendations would increase the number of fuel poor households in 2001 from 1.1 million (BRE's estimate of the impact of their proposals) to between 1.5 and 1.8 million.

The lower bound figure deviates from BRE's original proposals in that council tax payments are deducted from household incomes (net of Council Tax Benefit). The upper bound figure additionally assumes an across-the-board increase of 20% in the energy use of lights and appliances – in line with the latest estimates of domestic energy consumption by Defra's Market Transformation Programme.

5.2 Assessment of overall methodology

The second stage of this Peer Review assessed the overall methodology for calculating the number of households in fuel poverty within the current definition, including the key income- and energy-related components of the fuel poverty model.

Definition and measurement of incomes

We recommend that BRE and DWP review some of the assumptions underlying the measurement of incomes in the fuel poverty model to ensure that, as far as possible, these are consistent with 'best practice' in this field. This review should consider the treatment of households on low incomes (below income support thresholds) and the imputation of missing income data, as well as the issues identified earlier in the discussion of BRE's first proposal. Subject to the findings of this review, we recommend that reported incomes be used in place of imputed minimum incomes and that greater use is made of hot-deck imputation methods to capture the variability in incomes found in actual income data.

BREDEM model

BREDEM-12 is a central component of the fuel poverty model and, in our view, the best available model to use for this purpose. Nevertheless, we recommend that a review is carried out to examine whether there is likely to be any systematic bias in the fuel poverty estimates due to the following assumptions or conventions within the BREDEM model:

- the percentage of the home heated by different fuels in homes with fixed gas heaters and without central heating;
- the use of electric immersion heaters;
- the efficiency of heating systems, including in the way they are being operated; and
- any data inferred in applying the BREDEM model to the English House Condition Survey data set.

These issues should be fed into the review of BREDEM.

Heating regimes

The evidence presented here suggests that most households (even those on high incomes and in energy efficient homes) under-spend relative to the standard assumed in the fuel poverty model and heat their homes to a lower temperature and for fewer hours than assumed (although the gap has probably narrowed since the data on which our analysis is based was collected in the mid- to late-1990s).

Whilst it is possible to justify a standard that exceeds current practice, we think it is difficult to argue that the standard should be raised further, given that the current assumptions already appear to be on the 'generous' side. However, the assumption that half-house heating is adequate for all under-occupied homes should be reviewed, as this does not appear to be supported by BRE's own initial analysis of reported heating patterns.

Fuel price assumptions

The fuel poverty model takes into account the variation in gas and electricity prices between different payment methods and between regions, but not the substantial variation between different suppliers *within* regions.

It is very difficult to gauge the possible impact of intra-regional price variation on the fuel poverty estimates, although it is likely to increase the numbers. The impact is

potentially quite significant if, as was the case, low income households have benefited less from the deregulation of gas and electricity markets. Consideration should be given to collecting information on households' gas and electricity suppliers in order to determine the actual fuel prices paid by individual households.

Cooking algorithm

We recommend updating the cooking algorithm to reflect the substantial decline in the average use of these appliances since this algorithm was originally formulated. Defra's Market Transformation Programme is conducting a special survey of people's cooking patterns, which could be used to inform these revisions. Consideration should also be given to collecting data on the ownership of different types of cookers to use in this algorithm.

Base data set

The design of the English House Condition Survey (EHCS) is largely driven by the ODPM's priorities and relevant questions relating to fuel poverty have been dropped from the survey, including temperature readings and expenditure data. Whilst this does not affect the ability to generate the fuel poverty numbers, it does make it harder to interpret them.

We recommend that data on households' fuel expenditure is collected in future surveys (though not temperature readings). This information would be useful in identifying households that are significantly under-spending on fuel (relative to the standard) as a supplementary indicator of fuel poverty. ODPM have recently added some useful questions to the EHCS on 'self-reported' fuel poverty, including householders' own perceptions of whether they can afford to heat their own homes and of the adequacy of their heating system. These supplementary indicators should be presented alongside the fuel poverty numbers to help contextualise and interpret changes in the official measure.

Process issues

Production of the 2001 fuel poverty estimates exposed a number of shortcomings in the process for calculating the numbers in fuel poverty, including the way the model is documented, validated, and updated. We, therefore, recommend that:

- Documentation of the fuel poverty model is brought together in a single source document and any significant gaps filled. This would ensure that the model is easier to replicate in future years and that the assumptions underpinning the model are more clearly spelt out.
- Co-ordination between the various bodies involved directly or indirectly in the management and development of the fuel poverty model is improved in order to alleviate some of the adverse consequences identified in this report.
- The fuel poverty model is monitored by an independent group consisting of experts in income measurement and energy modelling and users of the fuel poverty data set, possibly operating as a specialist sub-group of the Fuel Poverty Monitoring and Technical Group. This group, which we suggest should meet at least once a year, would keep an eye on the development of the fuel poverty model and identify areas where further work would be most useful, which could then feed into planning the work programme.

- Either the DTI or Defra develop the capability to carry out their own 'in-house' analyses of the fuel poverty data set. This would help in their role as an 'intelligent customer' for BRE's work on the fuel poverty model, as well as providing a potentially useful service for policy customers within government.
- The fuel poverty data set is made available in good time – ideally at the same time as, or shortly after, the fuel poverty estimates are published – and that a longer list of derived variables is released, including a breakdown of required fuel expenditure between space heating, water heating, lights and appliances, cooking, and standing charges, imputed fuel prices, and a more detailed breakdown of household incomes by source and by benefit unit. The Ministerial Group on Fuel Poverty should review the reasons for delays in releasing the data and consider ways of expediting publication. One of the benefits of improving public access to the fuel poverty data set would be to expose the data and the underlying methodology to greater external scrutiny.
- The time horizon for funding of development work on the fuel poverty model is extended – ideally to a three year rolling programme. This would enable greater continuity in the work programme and a longer-term focus.

5.3. Broader and longer-term issues

The third stage of this Peer Review considered some broader analytical issues relating to the measurement of fuel poverty and also highlighted a number of more fundamental issues that we believe should be considered further in looking ahead to the longer term.

Standards for non-heating fuel use

Our view is that consideration should now be given to developing standards for the non-heating components of the fuel poverty model (e.g. cooking, cooling, lighting). The current approach is not consistent with the treatment of heating costs and is unable to capture the beneficial impact of several of the key policies already being directed at fuel poor households. This reinforces the tendency of government (and others) to focus on SAP improvements as a proxy indicator for progress in tackling fuel poverty, even though space and water heating accounts for just over a half of total domestic fuel expenditure - a share which is projected to decline in the future.

Servicing costs

We recommend that Defra/DTI commission and publish a short but comprehensive study of the servicing costs of the major heating and hot water systems, the actual and annualised capital costs of replacement systems, and the likely operating lifetimes of such equipment. The findings of this study should inform decisions about which, if any, of such servicing and capital costs should be included in the fuel poverty model.

Leading indicators of fuel poverty

We suggest that Ofgem, the energy suppliers and Energywatch be consulted on ways in which more data on potential 'leading indicators' of fuel poverty, in particular fuel debt, might be made available on a quarterly basis, how more of them might be presented on a rolling/cumulative basis to identify trends more clearly, and whether such data specifically for those in fuel poverty might be obtained in future.

Churn

When the first sample of longitudinal data from the continuous English House Condition Survey (EHCS) becomes available - probably in 2007/08 - it will be possible to carry out more detailed analysis of movements into and out of fuel poverty (or 'churn'). In the meantime, we think that greater use might be made of existing data sources, such as the British Household Panel Survey (BHPS), to help analyse the extent of churn and, in particular, to identify those households most likely to be experiencing persistent fuel poverty. This could be used to supplement the more detailed, but static, analysis of fuel poverty using the EHCS.

Concept of affordability

A fixed percentage-of-income approach to defining fuel poverty may exclude many larger households that have problems associated with fuel poverty, but who are not officially classified as fuel poor. We would, therefore, recommend giving greater weight than at present to other supplementary indicators of fuel poverty, such as those presented in Table 28 and those discussed in the previous section, in order to provide a more complete picture of the problem – and, in particular, to help monitor progress towards the eradication of fuel poverty among different types of households.

Equivalisation of incomes

One way of adjusting for differences in the size and composition of households is to equivalise household incomes. Though it makes sense conceptually, a fuel poverty threshold of 10% of a household's *equivalised* income is not very intuitive and may possibly over-compensate in favour of larger households. It would in any case require a significant change in the definition of fuel poverty, which Ministers are not prepared to consider at this stage. We therefore do not recommend any action at this stage in terms of the equivalisation of incomes.

Nevertheless, the case for equivalisation reinforces the conclusion under the previous heading that the current way of defining fuel poverty will tend to under-state problems of fuel affordability among larger households relative to smaller households. In looking ahead towards 2010 and beyond, further consideration may need to be given to assisting those within this group who may not be able to adequately heat their home, yet are not classified as fuel poor.

Treatment of disability benefits

We believe that the additional costs of being disabled should be recognised in some way within the fuel poverty statistics as this is one of the vulnerable groups highlighted in the UK Fuel Poverty Strategy. In our view, omitting these benefits from the income measure would provide a more accurate assessment of the affordability of fuel costs among households containing a disabled person. A pragmatic and conservative adjustment would be to deduct from household incomes the value of certain key benefits that are specifically designed to compensate for these additional costs, including the Disability Living Allowance and Attendance Allowance.

We suggest that the impact of such an adjustment is examined as part of the work on affordability and included as a sensitivity analysis of the fuel poverty figures to be published alongside the 'headline' statistics. This is because Ministers are not prepared to consider changes in the current definition of fuel poverty at this time.

Treatment of housing costs

We recommend that further work is carried out to develop an after-housing-cost measure of income that approximates as closely as possible the definition used in the official HBAI income statistics. This should include an assessment of whether a higher affordability threshold should be applied to an AHC income-based measure of fuel poverty and an examination of the incidence of fuel poverty among different groups. Assuming a suitable and useful AHC measure of fuel poverty can be developed, we suggest that an analysis of this measure is published annually as a sensitivity analysis of the fuel poverty figures. This should focus on differences in the composition of households and properties between the AHC and BHC measures of fuel poverty. The main benefit of looking at both an AHC and BHC income-based measure of fuel poverty would be a better understanding of the *distribution* of fuel poverty between different regions and/or types of household, rather than the overall scale of the problem.

Appendix A:

List of Peer Review consultees

22 July	John Riley, Maggie Davidson Matt Custard, Jack Hulme	Building Research Establishment
5 August	Professor David Gordon William Baker	University of Bristol Centre for Sustainable Energy
6 August	Stephen Balchin, Simon Lunn	Department for Work and Pensions
11 August	John Sparrow	H M Treasury
18 August	Richard Moore	University of Warwick, National Right for Fuel Campaign
20 August	Terry McIntyre, Barbara Rose	Office of the Deputy Prime Minister
20 August	Peter Matejic	Department of Trade and Industry
24 August	Dyfrig Hughes, Mike Tofts	National Energy Services
25 August	Pam Wynne, John Mason	Department for Environment, Food and Rural Affairs
26 August	Ken Double	Energy Saving Trust
6 September	Kevin Lane	Future Energy Solutions
9 September	Brenda Boardman	Environmental Change Institute, University of Oxford
14 September	Bill Wilkinson, William Gillis Nick Merleau-Ponty	Energy Audit Company National Energy Action
29 September	Jake Chapman	Independent Consultant (co-author of BREDEM-12 report)
11 October	John Riley, Maggie Davidson Jack Hulme, Matt Custard Les Shorrock, John Henderson	Building Research Establishment
10 November	Alan Christie	Department for Environment, Food and Rural Affairs

Appendix B: Description of 2001 fuel poverty model

The 2001 fuel poverty model is composed of four component models, the outputs of which are combined in the fuel poverty model and used to derive the figures for fuel poverty.

Figure 1 diagrammatically represents the 2001 fuel poverty model showing each of the component models.

All of the component models read in data from the 2001 English House Condition Survey. In addition to these data, the fuel price model reads in data from the DTI and from SALKENT Ltd.

Data sources

During 2001 the English House Condition Survey (EHCS) was conducted on behalf of the Office of the Deputy Prime Minister. It was a national survey based on a sample of around 17,000 dwellings. The main purpose of this survey was to collect information on the housing stock in England for use by ODPM, but additionally it is used to produce estimates of the number of households in fuel poverty on behalf of DTI and Defra. The Building Research Establishment have developed the fuel poverty model, and carry out analyses from this on behalf of the Government.

Fuel costs model

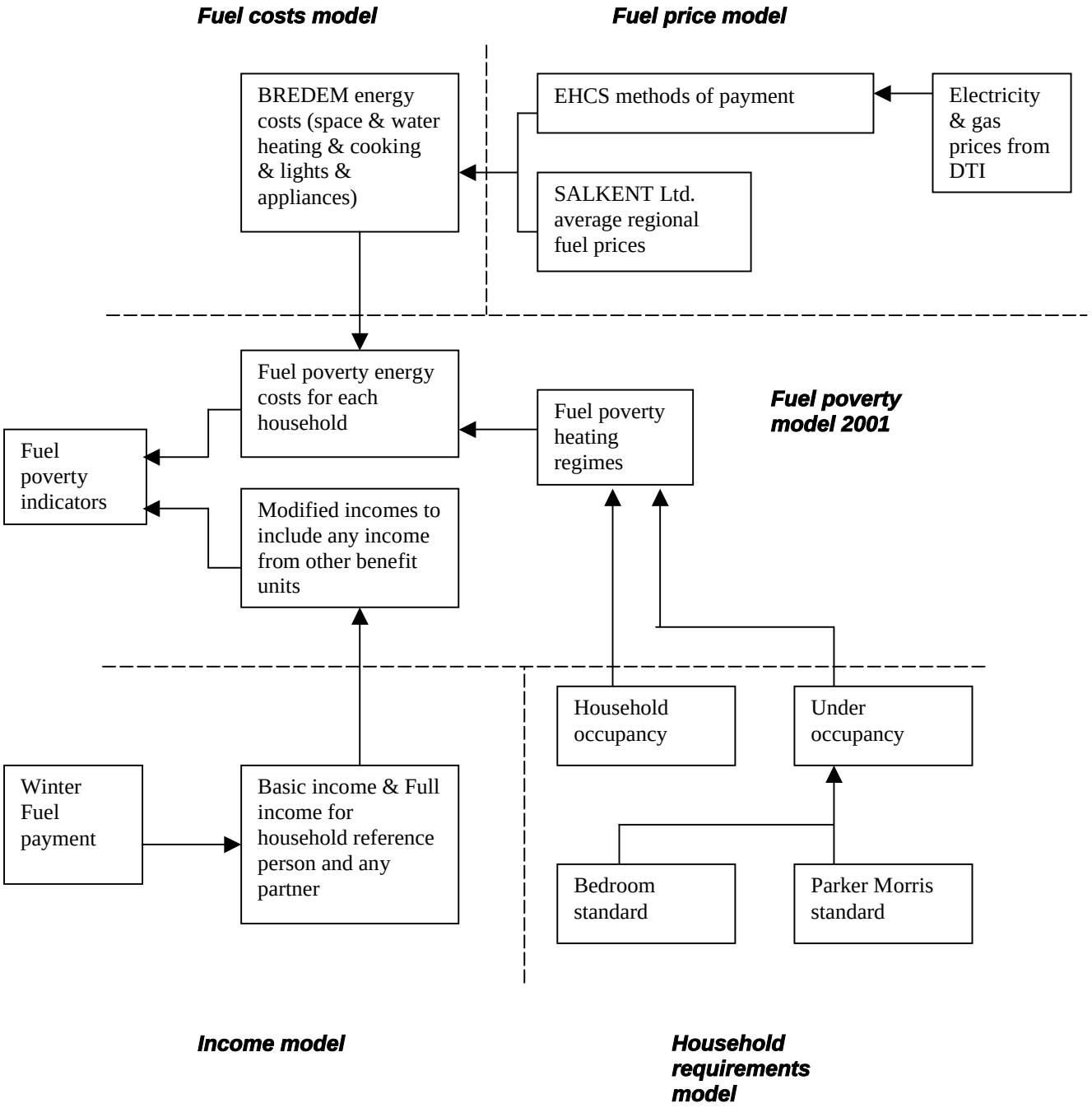
Household heating costs are calculated using the BREDEM-12 energy model. This model estimates energy consumption in dwellings, including estimates for space heating, water heating, cooking and lights & appliances. The model can accommodate household specific heating regimes and fuel prices. Estimates for the energy consumed from cooking and lights & appliances (non heating energy consumption) are derived from algorithms based on floor area and the number of occupants in the household. The BREDEM-12 algorithms have been tested and validated against simulation models and experimental data.

Fuel price model

The EHCS collected detailed information about the methods of payment used for mains gas and electricity from each household. The fuel price model maps regional data on the standing charges and unit fuel prices for each of the fuels onto the EHCS data according to the regional location and, where appropriate, the method of payment used by the household. The regional fuel price data were derived from the following data sources:

- DTI surveys of domestic prices. These are available in “Quarterly Energy Prices” at www.dti.gov.uk/energy/inform/energy_prices/index.shtml
- SALKENT LTD Comparative Domestic Heating Costs, United Kingdom and the Republic of Ireland.

Figure 1 – Schematic diagram of the 2001 fuel poverty model



Income model

The EHCS collects detailed information about the income of the Household reference person and any partner from different sources (wages, pensions, benefits, savings and investments and other sources e.g. rent from property). Respondents are asked separately about each source and which, if any, state benefits they receive. This information is collated and modelled to produce total net income for the primary benefit unit. Less detailed information is collected about the income of any other benefit units in the household and the net income from all such units is calculated. It also collects information on housing benefit, ISMI, Mortgage Payment Protection Insurance and Council Tax Benefit which are all modelled separately. Information on Council Tax Benefit was collected for the first time in 2001 and this information is still being validated. The EHCS does not collect information about receipt of the Winter Fuel Payment. This has, however, been modelled separately and is included in the net income.

Definitions

For England, households are defined as fuel poor if, in order to maintain a satisfactory heating regime, they are required to spend more than 10% of their income on all household fuel use.

Incomes

Two definitions of income are used. The first, used for targets, is based on net income including Housing Benefit and Income Support for Mortgage Interest (ISMI).

The second is based on income excluding Housing Benefit and ISMI.

For both definitions it is the net income of the whole household i.e. it includes income from the household reference person, and any partner, and any other occupants. It is the income net of tax and National Insurance.

The first income should include Council Tax Benefit, but at this stage it does not, for the reasons given above in the “income model” section.

Fuel costs

The fuel costs include the costs of fuels and the associated standing charges used within the home for space heating, water heating, lighting, cooking and household appliances.

Heating regimes

A satisfactory heating regime is considered to be one where the main living area is at 21°C, with 18°C in other occupied rooms. It is assumed that heating is available for 16 hours per day for households likely to be at home all day (e.g. retired households), and 9 hours per day for households in work or full time education. It is assumed that the whole house is heated except where the household is under-occupied, when it is assumed that half of the house is heated. (See section 3.5 for further information).

Underoccupancy is defined in terms of the 1968 Parker Morris standard and the bedroom standard. The Parker Morris standard gives a minimum floor area for a home depending upon the number of occupants as shown in the table below:

Number of occupants	1	2	3	4	5	6	7
Minimum floor area (m^2)	33	48.5	61	79	89.5	97	114.5

Under the bedroom standard a separate bedroom is allocated to each cohabiting couple, any person aged 21 or over, each pair of young persons aged 10 to 20 of the same sex and each pair of children under 10 (regardless of sex). Unpaired young persons aged 10 to 20 are paired with a child under 10 of the same sex or if possible, allocated a separate bedroom. The calculated standard for the household is then compared with the actual number of bedrooms available for its sole use. Bedroom includes bedsitters, boxrooms and bedrooms, identified as such by the informant even though they may not be in such use. It has been assumed that all homes where the floor area is over twice the minimum set down in the Parker Morris standard, and the number of bedrooms are in excess of the bedroom standard, are under occupied.

Vulnerable households

A household is considered vulnerable if it meets one or more of the following criteria:

(1) One or more members of the household aged 60 or more
(2) One or more children under 16
(3) Any member of the household having a limiting long-term illness or disability.

Appendix C:

Extract from 2002/03 and 2003/04 EHCS questionnaires

This section seeks the views from the householder being interviewed on their home. Data are output at household level in the attitudes.sav spss file.

ASK ALWAYS:

For each of the following, can you tell me how effective you think they are in your home?
SHOWCARD

Hmhtwtr (EH6A) ***Attitudes.sav***

[*] How effective is the hot water system?

Hmheatng (EH6B) *Attitudes.sav*

[*] (How effective is) ... the heating?

Hmisltn (EH6C) *Attitudes.sav*

[*] (How effective is) ... the insulation and draught proofing?

ASK ALWAYS:

Hmmtcsth *Attitudes.sav (new 2003/04)*

SHOWCARD
[*] How easy or difficult is it for you to meet your heating/fuel costs?

(1) Very easy
(2) Fairly easy
(3) Neither easy nor difficult
(4) Fairly difficult
(5) Very difficult
(9) Not answered

ASK IF: *Someone is home in the winter (Hmwintdk = 0)*

Hmheaton *Attitudes.sav*

During the cold winter weather, can you normally keep comfortably warm in your living room?
(1) Yes
(2) No
(8) Question not applicable
(9) Not answered

ASK IF: *cannot keep comfortably warm in living room in winter (Hmheaton = 2)*

Hmhtno *Attitudes.sav*

Is this because ...
RUNNING PROMPT

(1) it costs too much to keep your heating on
(2) or because it is not possible to heat the room to a comfortable standard? (includes heating equipment that is broken or under repair)
(3) BOTH OF ABOVE (SPONTANEOUS ONLY)
(4) Neither
(8) Question not applicable
(9) Not answered

Appendix D

Statistical Tables

Table 1: Impact of BRE and short-term Peer Review proposals on estimates of fuel poverty for 2001

Proposed methodology changes:	Number of households in fuel poverty after BRE proposals (millions)	Number of households in fuel poverty after short-term Peer Review team proposals (millions)
Baseline (published estimates)	**1.7**	**1.7**
Proposal 1	1.4	1.4
Proposal 2	1.6	2.0
Proposals 1+2 (combined)	1.3	1.7
Proposal 3	1.9	1.9-2.2
Proposal 4	1.4	1.4
Proposal 5	1.8	1.8
Proposals 3+4+5 (combined)	1.6	1.6-1.9
Proposals 1+2+3+4+5 (combined)	**1.1**	**1.5-1.8**

Source: BRE's two papers presented at the May 2004 consultation workshop: "Modelling incomes for fuel poverty" and "Fuel poverty: updating estimates for the cost of energy".

BRE proposals:
(1) using EHCS data on income of additional benefit units;
(2) including Council Tax Benefit;
(3) updated lights and appliances algorithm;
(4) using actual household numbers;
(5) increased hot water use;
(6) this is an alternative to proposal (5) and is not modelled here as it is dependent on a new survey being carried out, the outcome of which is needed before the impact of this proposal can be determined.

Peer Review proposals (where different to BRE proposals):
(2) including Council Tax Benefit AND deducting council tax payments;
(3) updated lights and appliances algorithm as proposed by BRE (lower bound estimate) or with 20% across-the-board increase (upper bound estimate);

Table 2: Impact of proposals on composition of fuel poor, 2001

	Current	BRE proposals: 1	2	3	4	5	1-5	Short-term Peer Review recomm-endations
Household type:								
Younger couple	6	5	6	6	7	6	6	6
Older couple	13	13	13	13	13	13	13	13
Couple with children	4	3	4	4	5	4	5	5
Lone parent	8	8	7	8	9	8	8	9
Other multi-person	14	4	14	13	16	13	5	4
Single aged under 60	16	19	16	16	16	16	20	18
Single aged 60+	40	47	40	40	34	40	43	44
Tenure:								
Owner-occupied	65	65	67	65	64	65	64	65
Private rented	15	15	16	14	17	15	17	15
Local authority	16	16	14	16	16	16	16	16
RSL	4	4	3	4	4	4	4	4
Region:								
North East	6	7	6	6	6	6	7	6
Yorks & Humbs	14	14	14	14	15	14	14	13
North West	16	17	16	16	17	16	17	17
East Midlands	9	10	9	9	9	9	10	10
West Midlands	13	13	13	13	13	13	12	13
South West	12	12	12	12	12	12	13	12
Eastern	8	7	8	8	8	8	8	8
South East	13	13	13	13	13	13	13	13
London	9	8	8	9	8	9	7	8
Under occupancy:								
Not under occupying	53	48	51	53	59	53	53	54
Under occupying	47	52	49	47	41	47	47	46
SAP rating:								
SAP <30	39	41	42	37	42	39	46	42
SAP 30-50	43	43	43	44	42	43	42	44
SAP >50	18	16	15	20	16	18	12	14
Income group:								
Bottom 20%	70	65	68	69	76	69	69	68
2nd quintile	23	26	24	23	18	23	23	24
3rd quintile	6	7	6	6	4	6	6	7
4th quintile	1	2	2	1	1	1	2	1
Top 20%	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Source: own analysis using 2001 English House Condition Survey and data provided by BRE.
BRE proposals: (1) using EHCS data on income of additional benefit units; (2) including Council Tax Benefit; (3) Updated lights and appliances algorithm; (4) using actual household numbers;
(5) increased hot water use; Peer Review recommendations (based on lower bound estimates in Table 1): as for (1-5), but with council tax payments deducted from household incomes.

Table 3: Impact on fuel poverty of the treatment of incomes of households with additional benefit units

	2001 published estimates	BRE proposal (using data on incomes of additional benefit units)	Using FRS-based correction factors	Only counting income of primary benefit unit
Number of households ('000s)				
All households	**1,722**	**1,444**	**1,530**	**1,815**
1 adult	962	962	962	962
1 adult, 1+ child	118	118	118	118
2 adults	434	302	330	450
2 adults 1+ children	57	44	45	60
3 adults	80	9	36	109
3 adults, 1+children	18	4	14	26
4+ adults	37	6	20	69
4+adults, 1+children	15	0	6	21
Proportion of households (%)				
All households	**8.4**	**7.0**	**7.5**	**8.9**
1 adult	17.5	17.5	17.5	17.5
1 adult, 1+ child	8.6	8.6	8.6	8.6
2 adults	6.7	4.6	5.1	6.9
2 adults 1+ children	1.3	1.0	1.0	1.4
3 adults	6.2	0.7	2.8	8.5
3 adults, 1+children	3.0	0.7	2.2	4.3
4+ adults	6.3	1.0	3.4	11.8
4+adults, 1+children	7.5	0.0	3.1	10.0

Source: own analysis using 2001 English House Condition Survey and additional data provided by the Building Research Establishment.

Table 4: Correlation between incomes of primary and additional benefit units

Income of additional benefit units:	Under £150pw	£150-300pw	£300-400pw	Over £400pw	*No. of cases*
Income of primary benefit unit:					
Under £150pw	40%	30%	13%	18%	*502*
£150-300pw	40%	31%	13%	16%	*795*
£300-400	31%	32%	15%	22%	*424*
£400pw+	35%	30%	12%	23%	*1,432*
All households	**36%**	**31%**	**13%**	**20%**	***3,153***

Source: 2001/02 Family Resources Survey/ Households Below Average Incomes (HBAI) data set.

1. Based on sample of 3,153 households with two or more benefit units. Results are weighted using grossing factors provided in the FRS data set.

Table 5: EHCS data on incomes of additional benefit units, 2001

	No information[1]	Incomplete information[1,2]	Full information	Number of cases[3]
Number of additional Benefit units in household:				
One	45%	-	55%	2,288
Two	37%	22%	42%	672
Three	43%	25%	32%	143
Four or more	47%	32%	21%	78
Total	**43%**	**6%**	**50%**	**3,181**

Source: BRE analysis of 2001 English House Condition Survey.

1. Cases where either no data is available or the respondent did not know or refused to answer the question about the usual income of other benefit units.
2. Where data is available on the income of some, but not all, of the additional benefit units in the household (for households with two or more additional benefit units).
3. Out of a total sample of 16,750 households.

Table 6: Proportion of additional benefit units with missing income data by type of benefit unit, 2001 EHCS

Percentage of benefit units with missing income data[1]	Second benefit unit	*Number of cases*
Relationship to primary benefit unit:		
Living with parent/ parent-in-law	57%	*2,254*
Living with son/ daughter	61%	*295*
Living with other relative	59%	*217*
Living with non-relative	61%	*415*
Family type:		
Single	56%	*2,931*
Couple	69%	*95*
Single with children	78%	*104*
Couple with children	80%	*51*
Work status:		
Employed	54%	*1,931*
Full-time student	47%	*447*
Unemployed/ inactive	81%	*523*
Retired	57%	*272*
Age of head of benefit unit:		
Under 30	54%	*2,104*
30-44	67%	*548*
45-64	73%	*281*
65 or over	53%	*248*
Income of primary benefit unit:		
Less than £100pw	64%	*154*
£100-150pw	65%	*409*
£150-200pw	63%	*430*
£200-300pw	59%	*723*
£300-400pw	55%	*507*
£400pw+	52%	*958*
All second benefit units	**58%[2]**	***3,181***

Source: own analysis using 2001 English House Condition Survey.

1. Unweighted percentages.
2. This figure is based on the published data set and is higher than in Table 5 (50% of missing cases). The reason is that there are 394 cases where BRE have since re-sequenced the benefit units in order to match the benefit unit numbers assigned in the household grid to those assigned in the income of other benefit units (so that the household reference person is always in the first benefit unit). According to BRE, this reduces somewhat the proportion of missing cases from 58% to 50%.

Table 7: Comparison of EHCS and HBAI income data on additional benefit units

Income bands:	Percentage of households with gross incomes in each band Second benefit unit:		Third benefit unit:		All additional benefit units[1]:	
	HBAI	EHCS	HBAI	EHCS	HBAI	EHCS
Less than £100	30	29	33	41	25	23
£100-149	13	12	13	12	11	14
£150-200	13	13	13	13	11	13
£200-300	22	23	22	19	20	20
£300-400	12	10	12	6	13	10
£400+	10	13	7	9	20	20
Percentage of all households	18	18	5	5	18	18
Observations	*3,153*	*1,341*	*708*	*355*	*3,153*	*1,237*

Source: own estimates using 2001 English House Condition Survey and 2001/02 Family Resources Survey.

1. Combined income of all additional benefit units in households with two or more benefit units. The number of EHCS cases is lower than for second benefit units, because some households with three of more benefit units have income data for the second benefit unit, but incomplete information on the incomes of other additional benefit units.

Table 8: Total electricity consumption for lights and appliances[1]

	Total UK consumption (GWh)	Average consumption per household (GJ/yr)
ECI/ MTP figures[2]:		
1971	42,185	8.0
1976	51,805	9.4
1981	58,037	10.1
1986	67,543	11.2
1991	76,329	12.0
1996	82,789	12.4
2001	89,246	13.0
2010 (forecast)[3]	103,842	13.9
DTI figures[4]:		
1991	73,118	11.5
1996	74,991	11.2
2001	78,302	11.4
BRE algorithms[5]:		
2001 (current algorithm)	-	8.8
2001 (proposed algorithm)	-	11.0

1. ECI/MTP estimates and BRE figures are for the UK, whereas estimates based on the BRE algorithms are for England. All estimates include cooking appliances.
2. These are estimates produced by the Environmental Change Institute (ECI) and more recently by the Defra's Market Transformation Programme and are taken from Table 3.10 of the DTI's Energy Consumption in the UK publication, which is available on the internet. (http://www.dti.gov.uk/energy/inform/energy_consumption/index.shtml). Figures are converted into GJ (1 tonne of oil equivalent= 41.9 GJ) and then divided by the total number of households in the UK in that year (24.755m in 2001).
3. Forecast is based on the MTP's reference case scenario. These are the latest figures supplied on 9th November 2004 by Christof Marx at AEA Technology (as part of the Market Transformation Programme).
4. Figures from Table 3.7 of the DTI's Energy Consumption in the UK (see footnote 2), based on DTI analysis of BRE data.
5. Weighted average use of electricity implied by the BREDEM-12 algorithms. Calculated by applying the current and proposed BREDEM-12 algorithms (for "lights and appliances" and "cooking") to all households in the 1996 and 2001 English House Condition Surveys. Only the electricity component of the "cooking" algorithm is included here. As in the fuel poverty model, households are assumed to have a dual fuel cooker (gas hob and electric oven), except for those without a gas supply (who are assumed to have an electric hob and oven).

Table 9: Estimated use of energy for lights and appliances (incl. cooking)

Median usage by sub-group	Using 1996 English House Condition Survey (EHCS) [1] **Consumption of electricity (relative to median for all h/holds)**			Using 2000/01 Family Expenditure Survey (FES)[2] **Spending on electricity (relative to median for all h/holds)**		
	1996 EHCS[3]	1996 EHCS using new algorithm[4]	1996 EHCS using old algorithm[4]	2000/1 FES[5]	2001 EHCS using new algorithm [6]	2001 EHCS using old algorithm [6]
All households	**100**	**100**	**100**	**100**	**100**	**100**
Floor area:						
Less than 60m^2	74	69	61	-	-	-
60-75m^2	92	87	84	-	-	-
75-100m^2	102	100	100	-	-	-
Over 100m^2	133	139	150	-	-	-
No. of bedrooms:						
One	58	64	54	62	75	70
Two	79	82	77	81	86	83
Three	103	103	104	105	105	106
Four	131	145	157	129	130	137
Household size:						
One	65	69	60	71	76	71
Two	95	92	90	95	95	94
Three	113	113	117	119	112	115
Four	134	142	154	129	133	140
Five	152	167	185	136	152	163
Tenure:						
Owner-occupied	108	103	104	105	102	103
Private rented[7]	-	-	-	87	95	94
Local authority	78	85	80	72	92	89
RSL	65	78	71	79	95	93
Income group[8]:						
Bottom quintile	90	93	91	85	102	102
2nd quintile	92	93	91	95	95	94
3rd quintile	92	103	104	103	101	101
4th quintile	108	105	106	103	103	105
Top quintile	123	101	101	110	99	99
Family type[9]:						
Pensioner couple	94	98	98	95	97	96
Single pensioner	62	70	62	69	77	72
Couple with children	134	141	152	124	132	139
Couple no children	113	96	95	110	100	101
Single with children	92	105	106	103	105	106
Single no children	75	71	63	76	80	75

Source: own analysis using 1996 and 2001 English House Condition Surveys and the 2000/01 Family Expenditure Survey.

Notes on Table 9:

1. Based on sub-sample of 1,812 households with full electricity data, who are not using electricity for space or water heating (i.e. where all electricity consumption is for lights and appliances).
2. Based on sub-sample of 3,937 households in the FES and 12,776 households in the 1996 EHCS with gas central heating, who it can be assumed are using little or no electricity for space or water heating i.e. where all (or nearly all) electricity consumption is for lights and appliances.
3. Actual annualised consumption of electricity (converted into GJ) using data from EHCS fuel sub-sample. Variable used is eannch.
4. Imputed electricity consumption for lights and appliances AND cooking, using the current ("old") and proposed ("new") BREDEM-12 algorithms.
5. Reported FES expenditure on electricity (converted into £ per year), including standing charges and expenditure on slot meters (less rebates). Variables used are b175, b222, d020203, and b173.
6. Imputed expenditure on electricity for lights and appliances (including cooking) using BRE's proposed algorithms and DTI's price schedule (by region and payment method). Includes average standing charges. Medians are shown for the sub-sample of households with gas central heating to be consistent with the FES data.
7. The sample of private sector tenants in the 1996 EHCS is too small to produce reliable estimates for this tenure.
8. Based on net equivalised household incomes.
9. Based on the family type of the primary benefit unit.

Table 10: Correlates of energy use for lights and appliances – results from regression analysis[1]

Annual consumption of electricity in GJ/year, including for cooking

Regression variables[2]:	(1) Current form of algorithm	(2) Modified form of algorithm	(3) As (2), plus family type	(4) As (3), plus other controls
Size of dwelling/ household				
Floor area X h/hold size	0.024***			
Floor area		0.091***	0.090***	0.081***
H/hold size		1.874***	1.615***	2.012***
Family type (relative to couple with children)				
Pensioner couple			-1.381**	-1.063
Single pensioner			-1.982***	-1.223
Single with children			-0.547	0.306
Single without children			-0.274	0.029
Income group (relative to middle incomes)				
Bottom income quintile				-0.401
2nd income quintile				-0.074
4th income quintile				1.347***
Top income quintile				1.739***
Presence of vulnerable persons				
Disabled person in h/hold				0.211
Infant in h/hold				-1.883***
Constant	7.702***	0.764*	1.947**	1.282
Observations	1738	1738	1738	1738
R-squared	0.32	0.36	0.37	0.39

Source: own analysis using 1996 English House Condition Survey

Standard errors in brackets:

significant at 10%; ** significant at 5%; *** significant at 1%.

1. Based on sub-sample of 1,738 households with gas central heating, who it can be reasonably be assumed are using little or no electricity for space or water heating i.e. where all electricity consumption can reasonably be assumed to be for lights and appliances (including cooking).
2. The reference household is a couple without children; in the middle income group; and not containing a disabled person or infant.

Table 11: Forecast of domestic energy consumption: 2000-2010

	Energy consumption			Fuel expenditure[1]		
	% **2001 (FP model)[2]**	% **2000 (MTP[3])**	% **2010[4] (MTP)**	% **2001 (FP model)[2]**	% **2000 (MTP)**	% **2010[4] (MTP)**
Consumer electronics	-	3.3%	5.3%	-	8.0%	12.4%
Cooking (electric)	-	2.8%	3.2%	-	6.9%	7.6%
Cooking (gas)	-	1.4%	1.5%	-	0.8%	0.8%
Wet appliances	-	2.4%	2.3%	-	5.9%	5.3%
Cold appliances	-	3.2%	2.5%	-	7.9%	5.9%
Domestic lighting	-	3.3%	3.6%	-	8.1%	8.4%
Domestic ICT	-	0.1%	0.7%	-	0.3%	1.6%
Miscellaneous	-	1.4%	1.7%	-	3.5%	3.9%
Total lights and appliances	**13%[5]**	**18%**	**21%**	**37%[6]**	**41%**	**46%**
Water heating	17-18%	-	-	14-15%	-	-
Space heating	70%	-	-	49-50%	-	-
Space and water	**87-88%**	**82%**	**79%**	**63-65%**	**60%**	**54%**
Total domestic energy	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Source: based on latest estimates from the Market Transformation Programme (November 2004).

1. Energy consumption is broken down by fuel type and then weighted using the relative price of different fuels in 2000 (from Table 3 of the BRE's Domestic Energy Fact File 2003). Estimates for 2010 assume that the *relative* prices of different fuels remain the same as in 2000.
2. These are the estimates from the 2001 fuel poverty model taken from Figures 1a and 1b of the BRE paper: "Fuel poverty: updating estimates for the cost of energy", which they presented at a workshop on the 27 May 2004 to discuss the proposed changes to the fuel poverty methodology.
3. The Market Transformation Programme is a government initiative that helps inform policy decisions relating to the environmental impact of products. As part of their work, they produce estimates of current and expected future energy use by sector. The figures presented here are the latest estimates supplied by Christof Marx on 9th November 2004.
4. Based on the reference scenario.
5. Figures presented here are the sum for lights and appliances and cooking. Estimates incorporate all BRE's proposed changes to the methodology.
6. Includes standing charges.

Table 12: Estimates of hot water usage

Average usage per household (litres per day)	Unadjusted BREDEM algorithm[1]	Adjusted BREDEM algorithm[2]	1998 EFUS-based estimates[3]
Number of occupants:			
One	63	76	52
Two	88	106	104
Three	113	136	156
Four	138	166	196
Five	163	196	220
Six or more	201	241	274
Average[4]	**99**	**119**	**122**

Source: BRE's draft summary report, "Analysis of hot water use from the 1998 EFUS" (unpublished).

1. Based on BREDEM-12 algorithm for hot water demand: 38 + (25 x N), where N is the number of occupants.
2. As above, but increased by 20% for all households.
3. Figures for usage per person are taken from the amended version of the table in Appendix 2 of BRE's report (see source above) and multiplied by the number of occupants. A factor of 6.53 is used for households with six or more occupants, based on the average number of occupants for households in this category.
4. Weighted average across all households, based on the proportion of households of different sizes in the 2001 EHCS.

Table 13: Potential biases in current methodology

Description of potential bias	*Direction of bias in current fuel poverty estimates*	*Likely scale of effect*
Differences between EHCS and official (HBAI) definition of household income	Ambiguous	Negligible
Imputation of basic minimum income for all households with incomes below income support levels	Downwards	Potentially quite large
Assumptions and conventions in the BREDEM model for estimating required heating costs.	Mostly ambiguous (though downwards in assuming away inefficient use of heating systems)	Difficult to predict
Heating regimes that may be on the 'generous' side in terms of the heating patterns and temperature standards assumed.	Upwards (except possibly for under-occupied homes)	Depends on judgements about appropriate standards.
Fuel price assumptions that do not take into account price variations within regions	Downwards (assuming those most at risk of fuel poverty are likely to be paying above-average prices)	Small-medium effect?
Out-of-date cooking algorithm that substantially over-estimates the use of ovens and hobs and does not take into account differences in the types of appliances owned by low income and pensioner households	Upwards	Small-medium effect?

Source: see discussion in Sections 3.2-3.7.

Table 14: Impact of differences in income definition between HBAI and fuel poverty model

Total household income (unequivalised) (£ per week)	**Baseline: Unadjusted household income**	Effect of adding back in: Council tax liability	Parental contributions to students	Maintenance and child support payments	Occupational pension scheme contributions	Effect of deducting: Benefits in kind (e.g. free school meals and TV licenses)	Rent from lodgers
Family type:							
Pensioner couple	**362**	380	362	362	363	361	362
Single pensioner	**218**	230	218	218	218	217	218
Couple with children	**614**	632	616	615	621	614	614
Couple without children	**582**	600	586	583	590	582	582
Single with children	**285**	297	285	287	286	282	285
Single without children	**465**	479	466	468	465	465	466
Income group:							
Bottom quintile	**124**	136	125	125	125	123	124
2nd quintile	**236**	249	236	237	237	235	236
3rd quintile	**357**	372	358	359	360	357	358
4th quintile	**526**	542	527	527	529	525	526
Top quintile	**1028**	1048	1032	1030	1037	1028	1029

Source: analysis carried out by the Department of Work and Pensions using 2002/03 Family Resource Survey/ HBAI data set.

Table 15: Comparison of the overall income distribution for the 2001 EHCS and 2001/02 HBAI[1,2]

Median income by decile group[3] (£ per week)	EHCS 2001	HBAI 2001/02
Bottom 10% of incomes	110	93
2nd decile	147	146
3rd decile	186	188
4th decile	227	235
5th decile	278	288
6th decile	337	350
7th decile	406	424
8th decile	493	515
9th decile	610	648
Top 10% of incomes	827	966
Median income	307	317
Mean income	383	415

Source: own analysis using 2001 English House Condition Survey and 2001/02 HBAI data set (based on the Family Resources Survey).

1. In order to make the figures comparable with the English Household Condition Survey, the HBAI figures are presented for households living in England, rather than individuals living in Great Britain (as in the official income statistics).
2. EHCS figures are based on the "full income" measure. HBAI figures are based on net unequivalised household incomes before housing costs.
3. Households are divided into ten groups, based on their net household income, adjusted for differences in household size and composition.

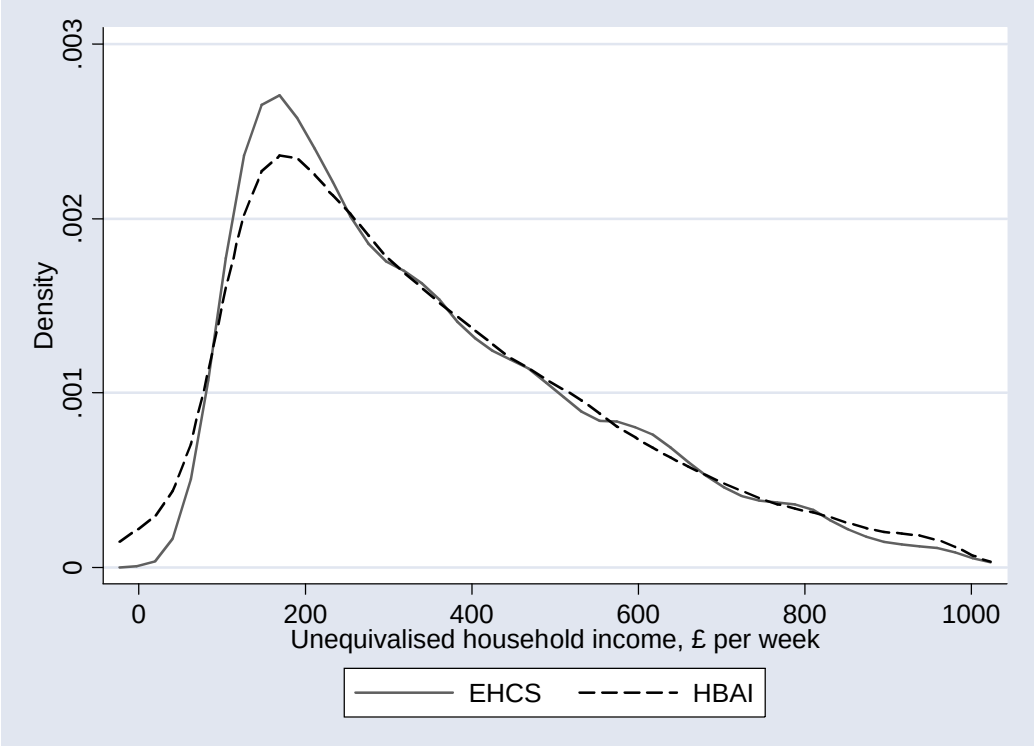


Table 16: Impact on fuel poverty numbers of not imputing low income cases

		Number of households in fuel poverty:		
	Total number of households	Current situation	No imputation of low income cases	No imputation of 'set to missing' cases
Type of low income flag:				
Not low income	18,773	1,181	1,181	1,181
Set to missing, will impute group mean	338	32	305	305
Set to IS basic	1,296	485	944	485
Set to IS basic plus disability premiums	104	24	70	24
Total	**20,510**	**1,722**	**2,501**	**1,995**

Source: BRE analysis using 2001 English House Condition Survey.

1. All low income cases are imputed. The "set to missing" category are imputed the mean income for households in the same socio-economic group and employment status. The other two categories are imputed the calculated income support amount for a family unit of their type and composition.

Table 17: Heating patterns and extent by household type, 1998 EFUS

	Employed: All household members employed or in full-time education	At least one adult member not in employment, fully occupied	At least one adult member not in employment, low occupancy
Heating pattern: (average number of hours per day that heating is on during the winter)			
Weekday	9.8	9.8	7.3
Weekend	10.3	10.2	8.5
Heating extent:			
Average proportion of rooms heated	85%	85%	85%

Source: BRE (2002), Use of space and water heating systems in England in 1998, A summary report presenting data produced by the BRE Housing Centre on behalf of Defra, unpublished.

Table 18: Weekday heating patterns by household type, 2001 EHCS

	All household members employed or in full-time education	At least one non-retired adult not in employment or full-time education	At least one retired person	**All households**
When is someone is regularly at home:				
All day	23%	75%	85%	**53%**
Evenings + morning or afternoon	11%	7%	5%	**8%**
Evenings only	55%	11%	5%	**30%**
Other	12%	6%	6%	**9%**
When is heating on if someone is at home:				
Always	46%	47%	54%	**49%**
Usually	30%	26%	27%	**28%**
Sometimes	23%	24%	18%	**21%**
Never	1%	3%	1%	**2%**
No. of hours at home (hrs/day):				
EHCS-based estimates[1]	9.9	14.2	15.0	**12.3**
No. of hours heating is on (hrs/day):				
- EHCS-based estimates[2]	7.9	11.3	12.5	**10.0**
- fuel poverty model assumptions	9.0	16.0	16.0	**12.5**

Source: own analysis using 2001 English House Condition Survey.

1. Assumes a minimum of 2 hours (7-9am), plus 3 hours if in from 9am-12am, plus 2 hours if in from 12-2pm, plus 3 hours if in from 2-5pm, plus 6 hours if in on weekday evenings. Assumes 16 hours if in all day/ all the time (i.e. 7am-11pm). The EHCS does not ask householders if they have their heating on between 11pm-7am (and, if so, for how long), presumably on the assumption that heating is not required during this period.
2. Equal to the number of hours that someone is regularly at home multiplied by 25% if heating is "rarely on", 50% if heating is "sometimes" on, 75% if heating is "usually" on, and 100% if heating is "always" on. The maximum is assumed to be 16 hours if someone is at home "all day" and the heating is "always" on.

Table 19: Recorded temperatures in people's homes, 1996[1]

	Median temperature in °C	
	Living room	Hall/ passage
All households	**19.4**	**18.1**
Household type:		
Younger couple	19.4	18.1
Older couple	19.9	18.6
Couple with children	19.6	18.5
Lone parent	19.7	18.0
Other multi-person	18.3	17.2
Single aged under 60	18.4	17.3
Single aged 60+	19.2	17.9
Tenure:		
Owner-occupied	19.5	18.3
Private rented	18.1	16.7
Local authority	19.2	17.6
RSL	20.0	18.8
SAP rating:		
SAP <30	18.8	17.0
SAP 30-50	19.4	18.2
SAP >50	19.7	18.4
Income group[2]:		
Bottom 20%	19.2	17.6
2nd quintile	19.3	17.8
3rd quintile	19.3	18.4
4th quintile	19.7	18.3
Top 20%	19.6	18.2
Householder's assessment of temperature in these rooms:		
Too cold	17.6	15.6
About right	19.5	18.5
Too warm	20.8	[20.6][3]
Heating standard: (as assumed in the fuel poverty model)	**21.0**	**18.0**

Source: 1996 English House Condition Survey.

1. Based on sub-sample of 2,180 dwellings (for living room) and 2,382 households (for hall/passage) where a temperature reading was taken and where the householder said the temperature in that room was about the same as usual.
2. Based on net equivalised household incomes.
3. Small sample size of less than 50.

Table 20: Required spending relative to reported spending on space and water heating[1]

	Median expenditure (£ per year)		
	Reported spend on heating[2]	Standardised heating costs[3]	Reported spend as % of required spend
All households	**352**	**485**	**73%**
Household type:			
Younger couple	359	505	71%
Older couple	343	509	67%
Couple with children	393	493	80%
Lone parent	359	448	80%
Other multi-person	329	446	74%
Single aged under 60	291	435	67%
Single aged 60+	284	417	68%
By size of household:			
One	291	423	69%
Two	336	485	69%
Three	374	487	77%
Four	392	506	77%
Five	416	533	78%
By income group[4]:			
Bottom quintile	343	466	74%
2nd quintile	331	462	72%
3rd quintile	370	479	77%
4th quintile	347	474	73%
Top quintile	384	538	71%
By SAP rating:			
<40	381	597	64%
40-50	344	504	68%
50-60	346	428	81%
60+	326	379	86%
By occupancy:			
Infant at home during day	369	459	80%
Elderly (60+) at home during day	324	487	67%
Hoh or partner at home during day	374	497	75%
Hhold at work or studying during day	330	460	72%

Source: own analysis using 1996 English House Condition Survey.

1. Based on sub-sample of 1,426 households from the fuel survey who use gas for all their space and water heating requirements (i.e. where gas bill represents their total spending on heating).
2. Using data from fuel sub-sample (only households with complete gas data).
3. Estimates provided by the Building Research Establishment.
4. Based on equivalised household income.

Table 21: Variation in domestic electricity prices within regions, 2003[1]

Area:	Credit: Price differential: £/year	Credit: Price differential: % of average[2]	Direct debit: Price differential: £/year	Direct debit: Price differential: % of average[2]	Pre-payment: Price differential: £/year	Pre-payment: Price differential: % of average[2]
Birmingham	205-244	16%	213-236	10%	235-264	11%
Canterbury	214-279	27%	206-263	25%	219-281	25%
Ipswich	203-247	19%	193-234	19%	220-270	21%
Leeds	221-281	25%	199-243	19%	236-276	16%
Liverpool	224-271	18%	217-268	20%	248-298	19%
London	216-254	15%	206-254	20%	242-278	14%
Manchester	215-264	21%	207-240	15%	228-296	27%
Newcastle	220-312	37%	205-295	37%	233-284	19%
Nottingham	214-239	11%	203-236	15%	229-281	21%
Plymouth	241-277	13%	229-275	18%	258-303	17%
Southampton	219-286	26%	214-271	24%	232-284	19%

Source: DTI's Quarterly Energy Prices June 2004.

1. As we went to press, more recent data for 2004 has become available at http://www.dti.gov.uk/energy/inform/energy_prices/index.shtml]
2. Difference between the lowest and highest cost supplier as a percentage of the weighted average for each area.

Table 22: Variation in electricity prices between regions and payment methods, 2003[1]

Area:	Average bill (£/yr) Credit	Direct debit	Pre-payment	**Price differential between payment methods[2] (%)**
Birmingham	238	228	254	11%
Canterbury	241	229	244	6%
Ipswich	226	217	239	10%
Leeds	239	229	254	10%
Liverpool	261	253	268	6%
London	249	241	253	5%
Manchester	235	225	252	11%
Newcastle	250	242	269	11%
Nottingham	228	216	247	13%
Plymouth	269	259	269	4%
Southampton	255	240	273	13%
UK average	**250**	**238**	**266**	**11%**
Price differential between regions[3] (%)	**17%**	**18%**	**13%**	

Source: own analysis using Tables 2.2.3 and 2.3.3 from the DTI's Quarterly Energy Prices June 2004.

1. As we went to press, more recent data for 2004 has become available at http://www.dti.gov.uk/energy/inform/energy_prices/index.shtml]
2. Difference between lowest and highest cost payment method (i.e. direct debit and pre-payment) as a percentage of the mid-point of this range.
3. Difference between the lowest and highest cost regions as a percentage of UK average.

Table 23: Variation in domestic gas prices within regions, 2003[1]

Area:	Credit		Direct debit		Pre-payment	
	Price differential		Price differential		Price differential	
	£/year	% of average[2]	£/year	% of average[2]	£/year	% of average[2]
Birmingham	251-340	27%	245-301	19%	291-396	31%
Canterbury	251-335	26%	245-302	19%	283-395	33%
Ipswich	251-335	26%	245-301	19%	286-395	33%
Leeds	251-335	26%	245-302	20%	272-393	36%
Liverpool	251-335	26%	245-301	19%	277-399	37%
London	251-335	26%	245-302	19%	282-393	33%
Manchester	251-335	26%	245-301	19%	277-399	37%
Newcastle	251-335	26%	245-304	20%	280-395	34%
Nottingham	251-335	27%	245-302	20%	281-393	34%
Plymouth	251-335	26%	245-301	19%	282-394	33%
Southampton	250-335	26%	245-302	19%	286-393	31%

Source: DTI's Quarterly Energy Prices June 2004.

1. As we went to press, more recent data for 2004 has become available at http://www.dti.gov.uk/energy/inform/energy_prices/index.shtml]
2. Difference between the lowest and highest cost supplier as a percentage of the weighted average for each area.

Table 24: Variation in gas prices between regions and payment methods, 2003[1]

Area:	Average bill (£/yr)			**Price differential between payment methods[2] (%)**
	Credit	Direct debit	Pre-payment	
Birmingham	324	291	335	14%
Canterbury	324	293	335	13%
Ipswich	321	291	334	14%
Leeds	319	287	333	15%
Liverpool	317	289	334	14%
London	320	294	335	13%
Manchester	317	289	334	14%
Newcastle	318	290	334	14%
Nottingham	312	290	334	14%
Plymouth	322	292	335	14%
Southampton	322	295	342	15%
UK average	**320**	**292**	**336**	**14%**
Price differential between regions[3] (%)	**4%**	**3%**	**3%**	

Source: own analysis using Tables 2.2.3 and 2.3.3 from the DTI's Quarterly Energy Prices June 2004.

1. As we went to press, more recent data for 2004 has become available at http://www.dti.gov.uk/energy/inform/energy_prices/index.shtml]
2. Difference between lowest and highest cost payment method (i.e. direct debit and pre-payment) as a percentage of the mid-point of this range.
3. Difference between the lowest and highest cost regions as a percentage of UK average.

Table 25: Estimates of energy consumptions for cooking[1]

GJ/yr per household	Electricity	Gas
BREDEM algorithm (2001)[2]	1.42	1.95
BREHOMES (2001)[3]	1.00	1.16
DECADE[4]		
- 1990	1.12	1.48
- 2000	0.91	1.17
- 2010	0.82	1.05

Sources: 2001 EHCS, DTI's "UK Energy Consumption Statistics", and the Environmental Change Institute's "Carbon futures for European households".

1. Hobs and ovens only.
2. Weighted average energy consumption per household in England, based on applying BREDEM-12 algorithm to household-level data from the 2001 English House Condition Survey: where gas is present, 0.85+0.17N for electricity and 1.49+0.3N for gas; where gas is not present, 1.7+0.34N for electricity and no gas. N represents the number of people in the household
3. Total energy consumption figures are from Table 3.7 of the DTI's UK Energy Consumption in the UK publication (600k tonnes of oil equivalent for electricity and 693k tonnes for gas). These are converted into GJ/yr and divided by the number of households in the UK in that year (25,033k).
4. Total energy consumption figures are from Table 2.2 (for electricity) and Table 2.3 (for gas) of the Environmental Change Institute's report, "Carbon futures for European households" (ECI, 2000). Again, these are divided by the number of households in the UK in the relevant years.

Table 26: Ownership of gas and electric cookers, 1996 EHCS[1]

% of households	All electric[2]	Electric/gas[3]	All gas[4]
All households	**36**	**17**	**46**
By income group[5]:			
Bottom quintile	31	7	60
2nd quintile	38	10	52
3rd quintile	37	11	51
4th quintile	36	26	37
Top quintile	38	31	31
By household type:			
Younger couple	35	28	35
Older couple	37	12	50
Couple with children	34	22	43
Lone parent	31	14	55
Large adult household	35	7	56
One person under 60	41	17	42
One person aged 60 or more	38	7	54
By region:			
North East	38	14	47
Yorks & Humbs	36	15	47
North West	35	20	45
East Midlands	35	17	48
West Midlands	30	14	53
South West	50	14	33
Eastern	40	14	45
South East	38	24	38
London	26	17	57
By tenure:			
Owner-occupied	34	22	43
Private rented	44	11	44
Local authority	37	3	60
Registered Social Landlord	50	2	48

Source: own analysis using 1996 English House Condition Survey.

1. Based on sub-sample of 2,997 households in the 1996 EHCS with complete data on ownership of hobs and ovens by fuel type. Results are weighted using grossing factors provided as part of the data set. No such data was collected in the 2001 EHCS.
2. Electric oven and hob.
3. Mostly electric ovens/ gas hobs, though also includes some gas ovens/ electric hobs.
4. Gas oven and hob.
5. Based on equivalised household income.

Table 27: Composition of poor and fuel poor by household size and family type, 2001

	Proportion of poor households[1] (%)	Proportion of fuel poor households[2] (%)	Proportion of households in the least energy efficient homes (SAP <30) (%)
Household size:			
One	37	56	35
Two	32	30	37
Three	12	8	13
Four	9	4	11
Five or more	9	2	5
Family type[3]:			
Pensioner couple	14	12	15
Single pensioner	21	44	23
Couple with children	17	3	16
Couple without children	14	7	19
Single with children	12	8	7
Single without children	23	26	20
All households	**100**	**100**	**100**

Source: own analysis using 2001/02 Family Resources Survey and 2001 English House Condition Survey.

1. The poverty line is 60% of the median net equivalised income, using the HBAI's before-housing-cost (BHC) income measure. To be consistent with the EHCS figures, the unit of analysis here is the household, rather than the individual (as in most HBAI analyses) and are based on the sub-sample of households living in England.
2. Based on the Government's present definition of fuel poverty.
3. Based on the family type of the primary benefit unit.

Table 28: Breakdown of fuel poor households by household size and family type using various indicators of fuel poverty

Percentage of households in each category (%)	Fuel poor (1996)	Fuel poor (2001)	Lacks central heating	Fairly or very difficult to meet costs of running home	Cannot afford to keep home adequately warm	Lacks adequate heating facilities	Problem with damp walls or floors	Problem with rotten windows or floors	Cold homes[1]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Household size:									
One	52	56	39	29	46	37	30	32	32
Two	30	30	34	27	24	30	29	29	35
Three	10	8	13	17	13	16	18	16	14
Four	5	4	9	16	8	10	14	16	14
Five or more	3	2	5	11	8	7	9	8	5
Family type:									
Pensioner couple	13	12	15	9	8	7	6	9	14
Single pensioner	39	44	21	13	22	14	16	17	20
Couple with children	6	3	14	26	17	20	25	25	22
Couple no children	6	7	15	11	8	17	21	19	18
Single with children	11	8	9	16	13	11	9	9	6
Single no children	24	26	26	25	31	30	23	22	21
All households	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Number of cases	*2,902*	*1,517*	*1,082*	*3,188*	*401*	*1,523*	*2,301*	*2,594*	*770*

Sources:
(1) and (9): 1996 English House Condition Survey.
(2) - (4): 2001 English House Condition Survey.
(5) - (8): Waves 6-11 of the British Household Panel Survey (covering the period 1996/97-2000/01). The family type variable is not yet available for wave 11, so this breakdown is for waves 6-10 only.

1. Below 18^0C in the living room, excluding cases where occupants said the temperature was colder than usual.
2. Based on family type of primary benefit unit.

Table 29: Impact of equivalising incomes on the composition of fuel poor households, 2001

	No. of fuel poor households ('000s)		*% of fuel poor households in each category*	
	Using unequivalised final income (i.e. current measure)	Using equivalised final income[1]	Using unequivalised final income (i.e. current measure)	Using equivalised final income[1]
By household size:				
One	962	241	56	16
Two	514	488	30	32
Three	136	303	8	20
Four	69	246	4	16
Five or more	42	263	2	17
By family type[2]:				
Pensioner couple	206	265	12	17
Single pensioner	752	285	44	18
Couple with children	60	298	3	19
Couple no children	121	207	7	13
Single with children	132	173	8	11
Single no children	451	314	26	20
All households	**1,722**	**1,542**	**100**	**100**

Source: own analysis using 2001 English House Condition Survey.

1. Using McClement's (BHC) equivalence scale.
2. Based on the family type of primary benefit unit.

Table 30: Summary of Peer Review recommendations

	Recommendations	Impact on fuel poverty estimates (compared with published estimates)	Time-scale[1]
BRE PROPOSALS			
Proposal 1: to use new data on incomes of additional benefit units in place of correction factors	Agree, though recommend further analysis of the quality of raw data and derivation of net incomes.	Reduction of around 0.3m (possibly less if alternative imputation methods are used).	Short/ medium-term
Proposal 2: to add Council Tax Benefit to household incomes	Agree, though council tax payments should also be deducted.	Increase of 0.3m compared with published estimates (or 0.4m compared with BRE proposal).	Short-term
Proposal 3: to update the lights and appliances algorithm	Agree, but with following provisos: - Further work needed to reconcile different estimates of overall domestic electricity consumption. (If ECI/MTP series is the most reliable, then further adjustment may be required); - Greater use should be made of survey data to validate/update algorithm in future; - Consideration to be given to how future revisions to algorithms will be incorporated; - More fundamental question of whether standards should be set for non-heating fuel use (see below).	Proposed algorithm would increase fuel poverty by around 0.2m. A 20% across-the-board increase on top of this would increase fuel poverty by an additional 0.3m (our provisional estimate).	Short/ medium-term (except for last recommendation, which is for the longer-term)
Proposal 4: to use actual household numbers in place of standard occupancy	- Agree, but this is not very different to what was already being done in 1996.	Decrease of 0.3m (though published figures do not appear to be consistent with 1996 methodology).	Short-term
Proposals 5 and 6: to update the hot water algorithm	In the short-term, agree that an across-the-board increase of 20% is a reasonable first step (proposal 5), subject to the results of sensitivity analysis (using results from recent BRE paper on hot water usage). Also agree that metering study should be carried out to inform longer-term revisions to this algorithm (proposal 6).	Interim adjustment increases fuel poverty by around 0.1m.	Short-term (for interim adjustment). Metering study should be commissioned as soon as possible given the long lead-time.

	Recommendations	Impact on fuel poverty estimates (compared with published estimates)	Time-scale[1]
OVERALL ASSESSMENT OF METHODOLOGY			
Definition of incomes	No significant changes, other than treatment of council tax payments (see above).	Negligible (except for council tax payments).	Short-term
Measurement of incomes	Recommend a joint BRE/DWP review of income measurement, covering the treatment of low reported incomes and imputation methods for missing data.	Provisional estimates by BRE suggest an increase of 0.3-0.8m (probably towards the lower end of this range).	Medium-term
BREDEM model	Recommend brief review of some of the key assumptions and conventions in BREDEM and in its application to EHCS data.	Mostly ambiguous (though downwards in assuming away inefficient use of heating systems).	Medium-term
Heating regimes	Assumption that half-house heating is adequate for under-occupied homes should be reviewed.	Probably a small increase (if this assumption is dropped or modified).	Medium-term
Fuel price assumptions	Should consider collecting EHCS data on fuel supplier(s) to help determine actual fuel prices by individual households (as in previous surveys).	Hard to predict, though using actual (rather than average) prices would probably increase fuel poverty.	Medium-term
Cooking algorithm	Recommend using recent MTP survey to update the cooking algorithm to reflect the substantial decline in oven use since this algorithm was formulated. Should also consider collecting EHCS data on ownership of different types of ovens/ hobs	A (relatively) small reduction in fuel poverty of perhaps 0.1-0.2m.	Medium-term
Base data set	Recommend collecting EHCS data on fuel expenditure by fuel type to identify households that are significantly under-spending on fuel.	No impact on official measure.	Medium-term (to be included in next EHCS)
Process issues	Recommend various changes to the way the fuel poverty model is documented, validated, and updated, including better documentation, specialist sub-group of the Fuel Poverty Monitoring and Technical Group (FPMTG) to advise on model development, faster and more extensive release of fuel poverty data, and longer-term funding.	n/a	Short/ medium-term

	Recommendations	Impact on fuel poverty estimates (compared with published estimates)	Time-scale[1]
BROADER AND LONGER-TERM ISSUES			
Standards for non-heating fuel use	Consideration should be given to developing standards for non-heating components of the fuel poverty model.	Depends on what the standards are.	Medium/long-term
Servicing costs	Recommend Defra/DTI commission a short study of servicing and replacement costs of major heating and hot water systems to inform decisions about which, if any, should be included in the fuel poverty model.	Including servicing costs would increase fuel poverty by 0.6m or more.	Medium/long-term
Leading indicators of fuel poverty	Suggest that Defra/DTI consult on ways in which better data on fuel debt and other 'leading indicators' might be made available on a more regular basis.	No impact on official measure.	Medium-term
Churn	Suggest greater use might be made of other data sources to identify those most at risk of persistent fuel poverty.	No impact on official measure.	Medium-term
Concept of affordability	Recommend giving greater weight to other supplementary indicators of fuel poverty, including 'self-reported' measures, alongside the official measure.	No impact on official measure.	
Treatment of disability benefits	Recommend carrying out sensitivity analysis to examine impact of deducting disability-related benefits from household incomes to be published alongside the 'headline' fuel poverty statistics.	Excluding major disability benefits would increase fuel poverty by around 0.2m.	Short-term (for sensitivity analysis); long-term (for definitional change)
Treatment of housing costs	Recommend that further work is carried out to develop a suitable After Housing Cost (AHC) income-based measure of fuel poverty to be published annually as part of the sensitivity analyses of the fuel poverty figures.	Ambiguous (depending on where the affordability threshold is set for an AHC income-based measure of fuel poverty). Main focus should be on differences in the composition of fuel poor households (compared with the official "full income" measure).	Short-term (for sensitivity analysis); longer-term (for replacing "basic income" measure).

1. This is a guideline as to when we think each recommendation should be implemented. **Short-term**: to be implemented (or considered) in time for the next set of fuel poverty estimates in Spring 2005; **medium-term**: to be implemented (or considered) in the next year or two (though unlikely to be in time for the next set of estimates); **long-term**: to be implemented (or considered) within the next five years.