Rising Fuel Prices:

the challenge for affordable warmth in hard to heat homes

Executive Summary

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The website for the project *Rising Fuel Prices, the challenge for affordable warmth in hard to heat homes* is www.ukace.org/research/fuelprophet

Here you can download, read or use:

- Fuel Prophet
- User Guide (on-line or download)
- Summary Report
- Research Report

You can also give feedback to the ACE research team, inform us of changes to key measures (including price and improved data on lifetimes, maintenance costs etc), and let us know of new technologies and your experience of them.

There will also be news of project developments as they occur.

The Association for the Conservation of Energy is very grateful to the Eaga Partnership Charitable Trust for their continued support of our work on the "Affordable Warmth in Hard to Heat homes" agenda.

We are also deeply indebted to our Steering Group and other stakeholders who gave their time and expertise to this project.

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EXECUTIVE SUMMARY

The primary purpose of the Rising Fuel Prices project is to inform UK fuel poverty strategists and enable social housing providers to plan affordable warmth strategies in the context of increasing fuel prices. Specifically, the aim is to equip housing providers and expert commentators with a publicly available tool, Fuel Prophet, that indicates treatments of hard to heat homes which are both cost-effective and eliminate fuel poverty, taking into account various, fluctuating fuel price conditions.

Rising Fuel Prices focuses on 'hard to heat' or 'hard to treat' homes for two main reasons. First, hard to heat homes are generally expensive to heat, making them an even bigger priority for tackling fuel poverty through improving energy efficiency. Second, they are expensive to treat and while improvements are often not regarded as cost-effective, this may change when faced with rising fuel prices. Despite previous work (Pett, 2002 and 2004) which raised awareness of the scale of this issue, policy makers have not addressed the problem that improving these homes to an appropriate standard will cost less money than demolishing and rebuilding them.

Various elements of this problem have been tackled in work by others, focusing on fuel price increases and scenarios, hard to heat homes, fuel poverty, or energy modelling. This project is unique as it addresses all four elements. Rising Fuel Prices has produced a tool that takes account of changes in the cost-effectiveness of energy efficiency measures[1], indicating which are best suited to alleviating fuel poverty in hard to heat homes in times of fuel price uncertainty.

Defining cost-effectiveness of measures

One of the most difficult areas to establish was the precise meaning of 'cost-effectiveness' when applied to the selection of measures to address energy efficiency in dwellings. Defra (and programmes supported by EST), use payback, i.e. the number of years to recover the cost of installation from the savings in fuel costs. For the EEC, the definition used is simple cost-effectiveness, i.e. the amount of money saved over the life of the measure compared with the cost of the measure. This can also be discounted, so that pounds saved in the future are worth less than pounds saved now. In business, this concept of net present value (NPV) is often used, which considers the net value of savings, discounted at an appropriate rate, over the life of the measure. During the development of the project a number of other concerns arose, so that both payback and NPV approaches were deemed necessary, with both end of life (EOL) NPV and cumulative NPV being provided.

The principal difference in outcome between these two approaches is the weaker cost-effectiveness of longer-life measures under the payback mechanism, and improved attractiveness under NPV calculations.

Broader issues such as the wider benefits of health improvement, urban regeneration, employment and economic renewal are not considered in the benefits of improving the energy efficiency of the dwellings or the reduction in fuel poverty. Only NPV, payback and the effect on reducing fuel poverty are addressed in this project.

Fuel Price scenarios

The initial approach to this problem was to consider a 'ready-reckoner' approach, i.e. to use a sliding scale of price increases so that users could set their own levels of increases

[1] For the purposes of this project 'energy efficiency measures' include insulation, heating and micro-generation technologies which reduce fuel bills when installed. These are referred to as 'measures' in this report.

or decreases. This was identified as both impractical and unrealistic, therefore a set of fuel price scenarios were developed for a thirty-year period (this being the maximum product lifetime amongst the measures considered), based on well-established fuel and economic scenarios. These incorporate the DTI forecasts for fuel prices in the early years.

Six fuel price scenarios are available:

1. base case – moderate increase in demand, rising prices
2. high prices – higher demand and prices than base case
3. very high prices (a) – fuel poverty eliminated
4. very high prices (b) – record levels of winter fuel poverty; summer mortality due to heat
5. low prices – similar price to base case in short term but access to cheap gas in longer term
6. very low prices – plentiful fuel and weak global markets; personal carbon allowances

Development of Fuel Prophet

The development of the model, called Fuel Prophet, covers four issues:

- Development of the base buildings
- Selection of appropriate measures and combinations of measures
- Development of the cost-effectiveness methodology and indicators
- Selection of fuel poverty and other indicators

The approach adopted was to limit the buildings modelled to a series of theoretical or 'base buildings' that satisfied our main objective: these were primarily hard to heat homes in social housing and are listed in Table 1.

Table 1: Base Building Summary

Base Build	**Detached** (100m^2)	**Semi-detached** (85m^2)	**Terrace** (74m^2)	**Flat** (60m^2)
Wall / Heating type	Solid / gas Solid / electric Solid / coal Cavity / gas Cavity / electric	Solid / gas Solid / electric Solid / coal Cavity / gas Cavity / electric	Solid / gas Solid / electric Solid / coal Cavity / gas Cavity / electric	Solid / gas Solid / electric

Measures to be modelled were selected according to three categories: building fabric including insulation measures to improve heat retention, heating systems to improve fuel efficiency, and micro-generation to reduce fuel. It was considered useful for the model to allow the application of these in any reasonable combination. Savings from these measures were calculated using Builder™, based on the BREDEM model. Solar, wind and CHP are not modelled in Builder™ and so assumptions were made based on information from manufacturers and trade associations

Table 2: Measures modelled, by type

Building fabric	Heating system	Renewable electricity
Loft insulation	Gas combi condensing boiler	Solar PV
Wall insulation: cavity	Ground source heat pump	Micro wind turbine
Wall insulation: internal	Air source heat pump	
Wall insulation: external	Oil condensing boiler	
Draught stripping	Wood pellet boiler	
Compact fluorescent lights	Solar hot water	
Double glazing	Micro CHP	
Primary pipe insulation		
Insulation package L		
Insulation package C		
Insulation package E		
Insulation package I		

Four insulation packages are shown in Table 2. These were introduced as there are measures that are cost-effective in the sense they are relatively inexpensive to install, but the effect on yearly energy bills is negligible when adopted in isolation. The packages each include loft insulation to 270 mm, draught sealing, and compact fluorescent lights fitted throughout the house, with variations adding wall insulation:

- INSL – Loft insulation only, no wall insulation
- INSC – Cavity wall insulation
- INSE – External wall insulation
- INSI – Internal wall insulation

U-values for relevant measures were either calculated by the Builder software, given the material construction, or were entered manually using values from the EST best practice guidelines. Data from the EST and other secondary sources were used to verify the calculations where possible.

The model simulates 21 measures or measure 'packages'. Decisions had to be made on treatment of various issues especially regarding prices, product specifications, maintenance costs and product lifetimes, all of which give rise to levels of uncertainty and the potential for changing assumed values as the markets change. The decisions adopted are visible in the model and can be amended by the user to take account of local robust data - especially price considerations.

The wide range of grants and discounts available often depend entirely on the proposed project, making it impossible to estimate. The user can add their own grants and discounts or to adjust the installation costs to match their estimates more closely.

Fuel Poverty Indicators

In England, the minimum income of a household is considered to be £5000 per annum if all benefits are taken. Theoretically, fuel poverty should be eradicated if the energy bill of all dwellings is £500 or less. Therefore, year on year saving to the occupier is graphed and can be compared to a fuel poverty line set to be 10% of the minimum income expected, currently £500. A line is also provided at £800 to take account of the wider definition of income within the UK Fuel Poverty Strategy.

User Guide

A description of the use of Fuel Prophet is described in the research report. A user guide has been developed to enable housing association users in particular to apply the model. This is available to download from the project website as well as being designed into the instructions on the site itself.

Preliminary findings using the Fuel Prophet

The model is far more advanced than the original concept and requires extensive testing to be confident that the first indications analysed below apply to all base buildings, under all fuel price scenarios and under all methods of indicating cost-effectiveness. Analysis presented in this report is limited to general effects relating to house type, wall type and fuel type, then further comment is based on the semi-detached, solid wall, electric base building variant, unless otherwise explicitly stated.

Key preliminary findings

The method used has indicated that, on the whole, fuel prices will have a significant impact upon the ability of different measures to improve the energy efficiency and, reduce the fuel costs in Hard to Heat and other homes. However there is one vital caveat: Despite their fuel savings being more heavily discounted, **insulation measures generally remain most cost effective, in terms of NPV, under all scenarios modelled: the choice of measure installed next, will depend on fuel prices**

- Uncertainty is further removed as the hierarchy of measures (in NPV) remain quite stable, even when the costs of some measures relative to others change quite drastically (e.g. +/- 30%).
- The major finding is that not only are remarkable savings in fuel bills achievable (over 50%) by installing cost-effective measures, but these bills remain much more resistant to fuel price fluctuations over time. This *'fuel proofing' can be seen as a key strategy* for alleviating fuel poverty during periods of rising fuel prices.
- In certain situations, specific measures are likely to be more appropriate for removing people from the risk of fuel poverty than more cost-effective ones due to the amount of reduction in fuel used.
- The long lifetime of many insulation measures (e.g. 30 years) means that their overall value is under-represented when combined with shorter-lived measures. This is relevant when considering wall insulation compared with shorter-term measures such as boilers (15 years). This may be a failure of the model but also reflects the current policy approach to decision making using payback versus whole life costing approaches.

Generic findings

- Between terraced, semi detached, and detached houses, given the same initial wall and heating type, and the same fuel price scenario, the cost-effectiveness of one measure relative to another does not change.
- Within the same house type, with differing wall and/or heating, the cost-effectiveness of a particular measure will change because each base building has a different initial fuel bill. For example, loft insulation is more cost-effective in a semi detached house with electric storage heating (high fuel bill) compared to a semi detached house with gas central heating (lower bill).
- A solid wall, on gas, mid-level flat should not be classed as hard to heat, because its fuel bill is below £500 and it has a SAP of 70.
- Installing a measure in a more efficient house is less cost-effective. This implies that the priority for measures should be the least efficient dwellings.
- Cavity and internal wall insulation are very cost-effective.

- Loft insulation is the second most cost-effective insulation measure with the second most significant savings. Topping up loft insulation from 100 mm to 270 mm has a much smaller effect. However it is considerably cheaper so payback is better.

Specific issues requiring further testing

- The external wall insulation package has the longest payback period and the lowest final NPV, but has been costed at full price rather than at marginal cost. It responds best to the fuel price scenario because it achieves the greatest savings. If the very high fuel price scenarios were realised, payback could be achieved in 15 years and the final NPV (after 30 years) is the same as that of the loft insulation package.

- The cost-effectiveness of the insulation packages fall into the following hierarchy (best to worst).
    - Insulation package with Internal wall insulation (INSI) (for solid wall dwellings)
    - Insulation package with Cavity wall insulation (INSC) (for cavity wall dwellings)
    - Insulation package with Loft insulation only (INSL) (both)
    - Insulation package with External wall insulation (INSE) (for solid wall dwellings)

- For a solid wall semi-detached house with electric heating, where there is to be no change to the heating, the insulation package with internal wall insulation is preferred, unless the condition of the walls means that refurbishment work is required anyway, in which case the cost of external wall insulation should be revised and the ranking reviewed.

- Improving the efficiency of the heating system is the single most effective measure for reducing fuel bills, all other things being equal. This can be considerably more expensive than insulation, however, if the building is off the gas network and without a central heating system already.

- If all fuel types are available, the most cost-effective heating solution using currently available data is micro-CHP followed by condensing combi-boiler, ground source heat pump (GSHP), air source heat pump, and biomass boiler.

- An oil condensing boiler only pays back under high and very high (b) fuel price scenarios, and it does not take a dwelling out of fuel poverty, even in combination with a full insulation package. This initial finding has significant implications for the new Warm Front grants.

- Solar hot water does not typically pay back its installation costs and the savings are small.

- Photovoltaic panels (PV) and micro wind turbines (MWT) are the only two renewables considered since solar hot water is classed as a heating system. As currently modelled, the installation cost of PV is over 4 times higher than MWT (£6700 cf. £1500) but does not produce 4 times the electricity (1500 kWh cf. 1000 kWh). However, without significant financial assistance, neither option is cost-effective. ROCs have not been included in the model.

- Under the highest fuel price scenario, the standard package of wall insulation and combi condensing boiler does not take people out of fuel poverty – it will be necessary to install further measures within the next 10 years. For an off gas house, this target cannot be reached without using new technology and renewables.

- The cost of installing a new (non-gas) heating system in a cavity wall building is the same as in a solid wall building, but as the building is initially more energy efficient, it reduces its cost-effectiveness substantially. With the effects of discounting also considered, no heating measure in a cavity wall building which includes a central heating system will pay back in its 15 year lifetime. The only exception is a ground source heat pump which can function for 28 years and achieves payback only after 20 or more years, depending on the fuel price scenario.

- A cavity wall, on gas building is not classed as hard to treat, but is the easiest base building to reduce energy costs below £500 a year in order to 'fuel poverty proof' the household. The simplest and most affordable action is to install a cavity wall insulation package and a condensing combi-boiler.
- Initial results indicate that introducing cost-effective measures can lead to dramatic reductions in energy bills and therefore specific measures offer very considerable solutions for those in fuel poverty presently.
- Changes in fuel prices *do* tend to alter the *relative* appeal of specific measures; (in terms of NPV and fuel savings) but successful integration will repel the effects of higher prices over time i.e. fuel bills are lower *and* more resistant to price fluctuations over time. This effect is a measure of 'fuel proofing' houses, reducing occupiers' exposure to high fuel prices.

Future model development

The two specific target audiences for the project are social housing providers and fuel poverty/energy efficiency policy researchers. However during the course of the project a number of other users and more details of the key groups have been identified. These can be divided into those needing the outputs for research and issues of policy, and those selecting measures for homes.

Fuel Prophet is currently in the form needed by the policy group and is available to download as an Excel spreadsheet. The underlying assumptions, data sets and calculation functions are accessible, and some of these will be open to manipulation.

The needs of the housing group centre on use of the model to derive outputs needed to inform investment decisions. The intention is to make Fuel Prophet simpler and more accessible. This is to be achieved through a website with simple inputs and easily accessible features.

The website is accessible from the ACE Research website:

www.ukace.org/research/fuelprophet

Conclusions

The aim of this project was to construct a method by which decision makers could identify the long term implications of choices to improve energy efficiency of dwellings in their care, in order to help remove the occupants from fuel poverty, under conditions of fluctuating fuel prices. As usual with ambitious projects, more questions have been raised by the findings. On the one hand a useful model has been developed that will aid social landlords and energy policy researchers to consider the implications of investment decisions based on two approaches to 'cost-effective' measures for hard to heat homes. On the other hand, the question "Why would social landlords want to do this?" has been raised and a further set of indicators that would be of more interest to them uncovered.

The method used has indicated that on the whole measures such draft stripping and loft and cavity wall insulation should always be installed first; the measures to follow will depend on fuel price projections. The model shows the disadvantage placed on long-life measures when considering the value of each type for reducing fuel use. Further work is needed to analyse the effects under all the conditions presented in this model, and as such a stream of projects may follow from this one. It is believed to be a sound platform for such work and feedback from stakeholders is always welcome.