

Evaluation of solid wall insulation in fuel poor households in the private sector

Final Report to eaga Charitable Trust

Prepared by: Nick Banks and Vicki White | October 2012



3 St Peter's Court
Bedminster Parade
Bristol BS3 4AQ

0117 934 1400
www.cse.org.uk
info@cse.org.uk

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Contacts for further information

Centre for Sustainable Energy

3 St. Peter's Court
Bedminster Parade
Bristol
BS3 4AQ

www.cse.org.uk

Nick Banks: nick.banks@cse.org.uk

eaga Charitable Trust

PO Box 225
Kendal
LA9 9DR

www.eagacharitabletrust.org

Naomi Brown: eagact@aol.com

1 Executive Summary

Whilst the technical challenges of solid wall insulation (SWI) are widely acknowledged, there has been little exploration to date of the human barriers to uptake. These are likely to be substantial, given the disruption involved and the impact of measures on building appearance. To help address this knowledge gap, CSE, with funding from eaga Charitable Trust, has undertaken a thorough evaluation of a pilot solid wall insulation scheme, 'Freedom From Fuel Poverty' (FFFP). The scheme was funded by Bath and North East Somerset Council and ran from August 2009 to December 2010.

This study comprises a qualitative evaluation of the experience of 11 households receiving the SWI measure. The evaluation was scheduled to run for at least one full heating season, to allow householders to experience the impacts of the insulation over a winter period. However due to delays in measures being installed through the scheme, work was not completed on some houses until early 2011. Consequently, the study was extended to run until spring 2012. An interim evaluation report was published in June 2011, with this full and final report completed in July 2012.

This final report presents the findings from the evaluation, with recommendations for practitioners, policy makers and others interested in the uptake of SWI systems. Our findings and associated recommendations are of three general types:

- Comfort and coping strategies amongst low income households living in homes with very poor fabric standards;
- The impact on comfort and lifestyle from installation of SWI;
- Householder experience of the installation process itself.

Key findings are presented in boxed format in the body of the text so that they are contextualised. Recommendations are presented and discussed in the final part of the report. Both are summarised below.

1.1 Comfort and coping

Our study found a rich variety of behaviours, habits and practises as householders struggled to maintain comfort in homes that all had poor insulation standards, were usually leaky and sometimes had very poor heating systems. Comfort seeking strategies often involved heating the body, rather than the space. In extreme cases these strategies severely compromised lifestyle, restricting activity within the home. In one instance, even heating the body using sleeping bags was insufficient so that the household was forced to leave the home altogether and spend parts of the day in warmer spaces. We also found that some strategies involving adjustments to heating controls or remedial efforts to prevent draughts sabotaged the design intent of the building, for example by blocking ventilation points or using thermostats as on-off switches. Although the logic of these practises was entirely understandable in the context of a home with a very poor fabric, prone to draughts, cold spots and sudden fluctuations in temperature, it was evident that these practises potentially resulted in further energy wastage or other undesirable and unintended consequences, such as increased condensation and damp.

Recommendation 1. Householders develop integrated clusters of habits, behaviours and beliefs in their efforts to maintain comfort. In homes with very poor fabric and control systems, some of these may be actively wasteful of energy. These modes of practise are supported by wider normative beliefs around what is expected, modern, desirable etc. Consequently, policy makers

should anticipate that SWI, an intervention having significant multiple impacts on the home's thermal performance, will not only make households warmer - it will have potentially transformative effects on many aspects of lifestyle and even the beliefs underpinning certain energy consuming habits. This is likely to be particularly evident in households adopting extreme comfort seeking behaviours as a result of living in under-heated homes.

1.2 Impacts of SWI

All households noticed changes to their comfort, lifestyle and even health as a result of the measure. Households often described their homes as “warming up more quickly” where heat was considered to be dispersed more “evenly” throughout the home, and the property thought to “hold the heat” for longer.

Although all noticed improvements to their comfort, in some instances the transformation was “massive” whilst in others effects were more subtle. In particular, in cases where the home was previously deliberately under-heated because of concerns about fuel cost, we found that most or all potential ‘savings’ from SWI were taken in improved comfort. Other households in this study heated their home to desired comfort levels prior to the measure (regardless of cost – they would not ‘go cold’) and therefore experienced the additional service provided by the SWI in more complex ways. In some instances there was even a sense that the home had become uncomfortably warm following SWI and therefore a downward adjustment of temperature settings had been required. In all instances where households heated their home to comfortable levels prior to the measure, our study found behavioural responses to SWI which should deliver energy savings.

Recommendation 2. Unlike some energy efficiency and micro-generation measures, impacts of SWI on “liveability” and comfort in the home are noticed by householders and can be profound, especially where homes are under-heated prior to the measure. Scheme designers and policy makers should maximise awareness of these multiple benefits as part of social marketing strategies supporting mass rollout of SWI systems.

The study highlights that comfort taking from energy efficiency interventions is a continuum: even in fuel poor households all potential savings from the measure will be taken as comfort in only a minority of cases. The majority will fall somewhere between the two extremes of 100% comfort taking and 100% bill savings. Whilst the Golden Rule approach to calculating eligibility for Green Deal finance means both ‘comfortable’ and under-heated households will be able to access the same level of finance, the actual impact of SWI at any one property may be very different and difficult to predict. Wide disparity in comfort taking amongst fuel poor groups could result in situations whereby otherwise identical households have a very different experience of the Green Deal finance, even with the ECO subsidy. The occupancy assessment is fundamental in ensuring under-heating is acknowledged in the context of an offer for Green Deal finance.

Recommendation 3: In formulating Green Deal policy these findings highlight the importance of considering what constitutes a “saving” against the counterfactual case i.e. a situation where the household is either comfortable or is under-heated prior to the SWI measure. Given dramatically different rates of comfort taking amongst fuel poor groups the finding presents a case for deeming SWI savings and setting ECO subsidy rates accordingly. The occupancy assessment and duty of care

is fundamental in ensuring under-heated households do not suffer fuel debt as a result of taking up Green Deal finance where savings are not going to be realised.

The study found that the SWI systems markedly reduced the sense of draughtiness. This is, of course, a positive outcome. However, because of very poor fabric standards in some properties, we found a number of undesirable practices had developed to counteract draughts, specifically taping up or blocking off controlled ventilation points. In all likelihood these practises will continue post SWI installation out of habit or lack of awareness that the remedial measure is no longer appropriate.

It is known that SWI will increase the moisture content of the air as it will tend to be warmer as a result of the measure, therefore it is particularly important in this instance that controlled ventilation points are allowed to operate as intended in order to avoid a marked increase in condensation problems on cold bridges.

Recommendation 4: Because of a) unanticipated potential effects of SWI such as increased likelihood of condensation formation, and b) various maintenance aspects which differ from conventional external wall treatments e.g. painting and susceptibility to damage from point loads, we feel that SWI systems should come with a user guide, “living with your new insulation”, and/or a requirement to give verbal advice to the householder once the system is installed. This should mitigate potential issues and allow householders to get the best from the systems.

By making the home more comfortable, warmer and liveable a range of impacts on health, social dimensions and lifestyles of the households were found. Several respondents reported improvements to their general wellbeing as a result of the measure with fewer coughs, colds and flu events. Households were also more disposed to spend time at home and to bring others to their home.

The SWI also had a number of unanticipated benefits such as making the home quieter and having a noticeable impact on occupants' sense of comfort in summer months: homes were thought to be cooler and more comfortable. This may reduce or eliminate the need for supplementary cooling using fans and other devices and therefore modest energy savings may result. A final major benefit that had not always been anticipated was in the marked improvement in appearance of the property (both on the outside with external wall insulation and inside with internal wall insulation) and the reduced maintenance requirement. This particular aspect was heavily praised by scheme participants.

Recommendation 5: Because of its impact on the appearance of a property, solid wall insulation lends itself to marketing as a ‘home improvement’ measure to a much greater extent than other energy efficiency measures which may be invisible. Branding it this way should enhance its appeal to householders and better portray the nature and cost of work involved, which can be extensive compared to other insulation measures.

1.3 The installation process itself

One of the key challenges of the scheme was in identifying and reaching the target audience (i.e. the fuel poor). Even once identified and targeted with the offer, the take up of measures was very slow. This was linked to the unusually high grants being offered – the ‘too good to be true’ notion – and the low income status of the target audience meant they were particularly risk averse. Having council endorsement of the scheme was important here, particularly in reassuring the older customers on the scheme.

Recommendation 6: Amongst low income and consequently risk-averse groups some sort of official endorsement of the scheme, for instance by a local authority, should be in place as this could be critical to uptake.

Several different approaches were used in marketing the scheme including advertising in local papers and taking referrals through the Energy Saving Trust advice centres. The most successful marketing technique, however, proved to be a doorstep flyer drop by a Bath and North East Somerset (B&NES) Council Officer in an area where solid wall insulation was being installed in some social housing. The directness of this approach, combined with the ‘first hand’ experience of householders in seeing the work carried out on neighbouring properties appeared fundamental to uptake of the grant offer in this area.

Recommendation 7: Our findings suggest that an area-based approach to future solid wall insulation could be effective. The high visibility of SWI could be exploited as a motivating and reassuring factor in promoting uptake (see recommendation 5). This could be maximised by the use of information boards/leaflets at sites where work is in progress.

The FFFP scheme specifically set out to test the effectiveness of solid wall insulation and solar installations in helping hard-to-treat households in fuel poverty. However, it was fully acknowledged by scheme managers that these did not always represent the most cost-effective energy efficiency measures.

Recommendation 8: Future schemes should be designed such that the most cost-effective measures are applied in sequence, and the householder is lifted out of fuel poverty at minimum cost. However, the order of measures would also need to make sense from a practical point of view– i.e. replace windows at the same time as external wall insulation, fit radiators at the same time as internal wall insulation, etc. This would require multiple trades on site as well as significant project management of the works on a house-by-house basis.

In particular the FFFP scheme highlighted that there may be numerous unforeseen additional costs to SWI (structural or survey related). When considered in addition to the known high costs of the

SWI measure itself (and the relatively small financial savings), then SWI status as a “*next most cost effective measure*¹” is unlikely to meet requirements for the Green Deal Golden Rule.

Recommendation 9: Green deal providers should consider the value of installing packages of measures in combination, to deliver additional savings/revenue (e.g. from FIT) to subsidise the costs of the more expensive measures that won't deliver the Golden Rule on their own.

An issue raised by several customers in this evaluation related to onsite and overall scheme management. SWI necessitates a number of different trades being on-site to complete different elements of the work. Onsite management is a key factor in ensuring each element is delivered in a timely and orderly manner, and that the finish is to both the customer and contractors satisfaction. This is particularly relevant to SWI, which, much like cavity wall insulation in its early days seems to create an uncertainty with customers who feel that the potential risks do not outweigh the benefit.

Recommendation 10: Ensuring contractors have formal processes for onsite project management with a single point of contact for the SWI recipient will make a significant difference to the customer journey in many cases. While smaller companies might argue this sort of structure can be restrictive, being contractually bound to a process should help fulfil all the necessary project requirements.

Participants in this study all had very different experiences of the actual installation process. This was due to: the diverse mix of property types; the different SWI systems applied; and timing of the works (two were unfortunate in coinciding with a spell of very cold weather which caused significant delays). Householders described varying levels of ‘mess’ during the installation process. Their perception and experience of the level of disruption was not just a factor of what they had actually endured, but also their expectations; understanding of the nature of work involved; tolerance to and prior experience of living with building works; and whether they perceived the disruption to be inevitable and acceptable, or unnecessary and avoidable. The latter was the key reason behind any negative experiences reported and related mainly to mess that could (in the householders’ eyes at least) have been avoided by simple measures and a little more care and attention (e.g. builders simply tidying up at the end of the day). These kinds of issues are not unique to the installation of SWI, but apply to any substantial building or home improvement works. Having visited the householders over a year after they experienced the SWI installation, any inconvenience incurred at the time was, on the whole, far outweighed by the benefits they were now enjoying with a warmer, more comfortable and better looking home.

Recommendation 11: The perceived level of disruption associated with solid wall insulation is considered a key barrier to its uptake². The findings from this study suggest this need not be the case. The experience of participants here suggest all were expecting and prepared for some level of disruption and their actual experience was well within these expectations.

¹ Extra help where it is needed: A new Energy Company Obligation. DECC 2011.
http://www.decc.gov.uk/assets/decc/what%20we%20do/supporting%20consumers/green_deal/1732-extra-help-where-it-is-needed-a-new-energy-compan.pdf

² E.g. see, ACE, 2011. Scaling the solid wall. Report to Consumer Focus.

1.4 ...and the final result

In the main, this qualitative study has found uniformly positive attitudes to both the experience of installation of SWI and its subsequent impacts on comfort and lifestyle. With the exception of one case, all participants stated that they would recommend the measure (both external and internal solid wall insulation) to others, whilst expounding clear and tangible benefits to comfort, financial savings, health and the appearance of the home. These findings must be seen in context of a sample which was offered the measure for free. Nonetheless, it seems clear that SWI offers multiple benefits and that the disruption entailed by the installation process itself need not, if carefully managed, be an undue restraint on mass SWI rollout. The study has identified a number of ways in which the unique characteristics of SWI may be harnessed to this effect.

"We're just feeling a lot more comfortable in here and it was just a bit depressing before. Now at least you know when you do put your heating on it's making a difference and the children haven't been so ill." (C24)

Health benefits...

"Until it was done, you don't realise how cold it was and how warm it was. That's the thing, because when we had that hot weather, I said to my husband, [who used to really suffer from the heat] 'it's not so hot in here anymore', and he said, 'no, it's lovely'". (C.34)

Potential bill savings...

"I've not had to have the heating on for two weeks now. So even when it has felt cold I haven't put the heating on at all which has been brilliant so hopefully I'm going to save an absolute packet on my heating bills." (C53)



...and a lick of paint for the interior

"We thought that maybe it would make the rooms look a lot smaller but it doesn't...we haven't noticed the loss of space at all. In a way it kind of makes them look a bit bigger. I don't know whether it's because they're painted white or whether the windows look deeper set, so it just makes the room look a bit bigger." (C.24)

Warmer...

"I'm just very, very happy. It's beyond what I thought it was going to be. I thought, well it might be just a little bit warmer, but it's completely different" (C.32)

...And Cooler



Looks nicer...

...A facelift for the exterior



Quieter...

"I'll tell you something else; it's not so noisy either. We can't hear the things outside so much. It's insulated the walls so we don't hear so much traffic." (C. 34)

2 Introduction

2.1 Background

The UK faces a major challenge over the next decade in tackling fuel poverty. Schemes to reduce fuel poverty and carbon emissions have typically been focused on cavity wall insulation as their main technical solution but, of the 24.5 million homes in the UK, almost nine million (36%) have no cavities. Whilst solid wall insulation (SWI) work has been undertaken in the social housing sector, there has been very little experience of promoting, funding or managing schemes for private housing, let alone evaluating their impact. The Community Energy Saving Programme (CESP) and Pay as You Save (PAYS) pilots for whole house refurbishment provide more experience of the costs and technological solutions required to tackle private solid-walled housing. However, neither programme has a specific focus on tackling fuel poverty – indeed the loans provided through the PAYS pilots were often targeted at able-to-pay groups – and there has been no detailed evaluation.

The delivery and financing of energy efficiency, sustainable energy and fuel poverty objectives in the UK's housing stock is undergoing a significant change. The Energy Act 2011 represents the most recent Government legislation designed to support household emission reductions and fuel poverty objectives. It provides for some of the key elements of the Government's Climate Change Plan, namely Electricity Market Reform, mandatory energy efficiency standards in the Private Rented Sector, the Green Deal and the Energy Company Obligation (ECO). The Energy Act provides specific powers to ensure the ECO works alongside the provision of Green Deal finance for those householders containing vulnerable people on low incomes and in hard-to-treat housing.

The Green Deal, (launched in autumn 2012), together with the Energy Company Obligation, will replace the existing CERT commitment and Warm Front scheme as the Government's new flagship initiative to underpin the installation of energy efficiency improvements in the domestic sector. It sets out a framework to enable private firms to offer consumers energy efficiency improvements to their homes, community spaces and businesses at no upfront cost, and recoup payments through a charge in instalments on the energy bill (tied to the property not the householder). The *expected* financial savings must be equal to or greater than the costs attached to the energy bill, known as "the golden rule". Where the Golden Rule is not met (if costs of the work outweigh the savings), or people need extra financial help, energy companies will be able to offer additional support to top up the loan under the ECO:

"The key focus of the new energy company obligation will be on those householders who cannot achieve significant energy savings without an additional or different measure of support. For example, this includes vulnerable and low-income households and those living in harder to treat properties, such as solid walled properties" (DECC, 2012³)

The Energy Company Obligation therefore has two key elements offering support for: (1) lower income and vulnerable households where the Green Deal is less likely to work (under the 'Affordable Warmth Group'); and (2) 'hard to treat' properties where recommended measures are less likely to meet the Golden Rule (under the 'Carbon Saving Obligation').

³ Department of Energy and Climate Change (accessed October 2012): http://www.decc.gov.uk/en/content/cms/tackling/green_deal/green_deal.aspx

2.2 'Freedom from Fuel Poverty'

In 2009 Bath and North East Somerset Council (B&NES) launched a new, pilot grant scheme - *Freedom from Fuel Poverty* (FFFP) - aimed at providing free solid wall insulation, solar hot water or solar photovoltaic systems to people living in fuel poverty. The scheme, managed by the Centre for Sustainable Energy (CSE), initially aimed to fully fund solid wall insulation measures in 14 eligible homes in the area. Due to higher than expected installation costs, this had to be reduced to eleven households. Although modest in scale, the scheme was particularly innovative in aiming to install external and internal solid wall insulation systems into privately owned homes of varying construction types.

Whilst the technical challenges of solid wall insulation are widely acknowledged, there has been little exploration to date of the human barriers to uptake. These are likely to be substantial, given the disruption involved and the impact of measures on building appearance (external insulation) and room size (internal insulation). If the householder experience of solid wall insulation retrofit is not properly understood, there is a risk that national solid wall insulation schemes will be undermined, especially if a lack of sensitivity to householder needs translates into growing resistance to such schemes. This is particularly pertinent given the direction UK Government energy efficiency policy is moving in, as discussed above.

To help address this knowledge gap, CSE, with funding from eaga Charitable Trust, undertook a detailed and thorough evaluation of the FFFP scheme. To ensure sufficient time to experience any impacts of the insulation, on both thermal comfort within the home and on household energy bills, the evaluation was scheduled to run for at least one full heating season. Due to delays in measures being installed through the scheme, work was not completed on some houses until early 2011. As such, the evaluation study was extended to run until Spring 2012. An interim report was published in November 2011. A final round of interviews with participating households was conducted in May 2012. This final evaluation report builds on the interim report, but also incorporates additional findings and results from the final round of interviews.

2.3 Aims

The main aims of the evaluation were to:

- Describe the impact that solid wall insulation can have on fuel poverty, home energy use and carbon reduction;
- Describe the experience of solid wall insulation schemes from the householder's perspective, identifying the issues and obstacles that will affect wider roll-out;
- Encourage other insulation scheme providers to learn and apply lessons from this scheme.

2.4 Objectives

The main objectives of the study were to:

- Assess the impact of the measures on participating households' interior temperatures, fuel costs and carbon emissions;
- Describe the impact of the measures on householders' behaviour including effects on the use of heating systems and room occupancy, and indirect effects such as changes in daily routines, social life, spending patterns and the strategies employed to cope on a low income;

- Assess the impact of the measures on the relative cost of fuel within household budgets (and therefore on fuel poverty status), taking account of any changes in coping strategies and other household needs;
- Describe the impact of the measures on householders' comfort, health and quality of life;
- Describe householders' experience of, and attitudes to the measures, before, during and after installation and their assessments of the costs and benefits of the scheme;
- Identify issues that may enable or inhibit wider delivery of SWI schemes;
- Collate, publicise and disseminate findings, promoting best practice in delivering grant schemes for SWI in private sector homes.

Throughout the report key findings are labelled ("F"), numbered and highlighted in boxes. Similarly, recommendations are numbered and presented in bold text.

3 Methodological approach

This is a wholly qualitative study. Its aim is not to seek statistically robust evidence through large sample sizes but to gain a richly detailed understanding of the experience of a small number of households having solid wall insulation installed. Our approach is described below. This covers the process of household recruitment to the scheme, household eligibility assessment, installation of measures and final evaluation. The first two of these were administered by the Freedom from Fuel Poverty scheme managers, but all findings have been made available for inclusion in this evaluation⁴.

1. Recruitment of households

Households were recruited to the scheme via referrals and local advertising in Bath and North East Somerset. Full participation in the evaluation study was a condition of recruitment. The incentives for households were considerable as the entire package of measures was provided at no cost. All households referred to the scheme underwent an initial telephone survey to establish eligibility. Eligible households then had a full site survey, upon which recommendations for measures were based.

2. Household energy surveys and SAP assessments

Each participating household was subject to detailed surveys of the energy performance and fabric condition of the home to give a SAP rating before and after the installation of the measures. Recommendations for measures were made based on the site survey and a quote for works drawn up for approval by B&NES. Once approved, any necessary planning applications were submitted for the works, and, once consented, the contracted installer agreed a start date with the client.

3. Analysis of household fuel consumption and bills

CSE collected data on actual (based on household utility bills and on-site meter reads) and theoretical (SAP-based) household energy consumption and related costs before and after the installation of measures. This, combined with data on household income, was used to assess changes in fuel poverty status and carbon emissions resulting from the scheme. In addition, internal temperature loggers were installed in all households once measures were in place.

4. Qualitative investigation of behaviour, attitudes, experience

Four⁵ sets of face-to-face interviews were conducted with all householders participating in the insulation scheme⁶. Interviews were conducted in the customers' home, and all were audio recorded and transcribed.

Pre-installation interview

The first interview was carried out once a start date for work had been agreed, but prior to the installation of any measures. This initial interview took a broad view of householders' lives, describing their strategies for keeping warm in winter, the trade-offs they make between heating and other living costs, the effects of cold interiors on their well-being, their attitudes to energy-saving and their expectations of the changes that the measures will bring. Householders were also

⁴ A full report on the delivery of the scheme is available at:

http://www.cse.org.uk/downloads/file/freedom_from_fuel_povert_final_report.pdf

⁵ An additional round of interviews was carried out due to delays with completing some installations and to ensure all households had experienced the measure for at least one full heating season.

⁶ Only properties that had insulation work carried out were included. Two of these also had photovoltaic panels fitted. Seven properties receiving only PV or solar hot water were not included in this evaluation.

asked to complete a short questionnaire (Annex I) in order to gain an indicative measure of pre-installation knowledge, attitudes and behaviour. Each interview lasted approximately 30 to 60 minutes.

Post-installation interview

The second round of interviews, conducted very soon after the installation of measures was completed, explored the householders' experience of the installation process and any specific problems encountered. Interviews were conducted within one month of the certificate of completion of works being received by CSE.

Final impact evaluation interview

The final round of interviews to explore the impact of the measures on all aspects of householders' lives, including changes to behaviour, health, well-being and household finances over the winter period, was initially scheduled to take place in Spring 2011, to allow customers to experience a full heating season with the insulation. However, due to delays in the installation process (largely weather-related), some households did not have the work completed until early 2011, thus would have had only a limited time to experience any impact on thermal comfort and energy bills. The final round of interviews was therefore delayed to Spring 2012.

However, recognising the policy relevance of this study, an "intermediate" final interview was conducted with all households in June 2011 to feed-in to an interim report, published November 2011. This interview focused on exploring any changes in how householders heat their home, their level of comfort and any other impacts of the insulation work. The questionnaire conducted in the first interview was also repeated and data from the internal temperature loggers downloaded for analysis. Devices were then reset and left with the customer for retrieval at the final interview in 2012.

Analysis and results

As noted above, a full report on the Freedom from Fuel Poverty scheme was produced by the scheme managers⁷. Whilst we do not wish to duplicate the presentation of material, some of the findings from their report are presented here, to provide a complete overview of all measured impacts of the scheme.

Whilst some quantification of results is presented in this report, it is important to bear in mind the nature of this pilot scheme and evaluation, in terms of both scale (n=11) and target audience (fuel poor households). Whilst findings are based on only a small and specific sample, and therefore not considered generalisable to the population as a whole, we do not feel this detracts from the importance of lessons learned and the recommendations that stem from each customer's experience: the methodology employed has generated a wealth of data (summarised below) about each household participating in the scheme and all elements have been drawn upon as far as possible in writing this final evaluation report.

⁷ Freedom from Fuel Poverty Final Report. December 2010.
http://www.cse.org.uk/downloads/file/freedom_from_fuel_povert_final_report.pdf

Table 1. Summary of data collected

Data	Description
Householder socio-demographics	Including age, income, number of occupants, collected in the initial telephone survey and provided by the scheme managers.
Pre- and post-SAP ratings	Providing an overview of the energy efficiency and physical characteristics of all properties before and after measures.
Pre- and post- fuel poverty status	Based on income and SAP assessments.
Costs of measures installed	Provided by the scheme managers, including costs of the measures themselves and all costs associated with surveys, planning etc.
2x Householder questionnaires	Assessing perceived level of comfort, burden of bills etc before and after measures.
4x Householder interviews	Including pre-, immediate post-installation, interim final and final interviews. Covering heating regimes, thermal comfort within the home, managing energy bills, expectations and experience of the measures.
Internal temperature data	Showing hourly internal temperature profile (post-installation only).
Fuel bills	A complete review of householder's energy bills over the last couple of years and most recently available.
Meter readings	Derived from fuel bills and taken by the interviewer at each visit to the house.
Photographs	Of the property before, after and in some instances during the installation of measures.

4 The scheme and the households

To provide context for the discussion that follows, a brief description of the Freedom from Fuel Poverty Scheme and participating households is provided here. Annex II provides an overview of the complete process in the Freedom from Fuel Poverty Scheme, from customer application to the installation and sign-off of measures. Table 2 summarises household types and a timeline of events at each property. For anonymity all customer names have been omitted. Customer reference numbers used in this report have been retained from the FFFP scheme manager's report⁷ to enable direct comparability between the two.

4.1 Scheme criteria

The FFFP scheme was initially targeted at customers suffering from 'severe fuel poverty'⁸. The aim was to lift households out of fuel poverty by fully funding innovative thermal efficiency improvements and renewable energy measures over and above the standard measures available through the existing fuel poverty scheme managed by CSE ('Warm Streets'). The focus was therefore primarily on solid wall insulation and/or solar thermal installation.

However, the scheme struggled with very low take up for a number of months, which was apportioned mainly to the 'severe fuel poverty' criteria. As a result, this was relaxed and scheme eligibility was extended to, firstly, those simply in fuel poverty (10%+ of their full income spent on heating) and latterly to 'vulnerable' occupants of solid wall dwellings, mobile homes and other hard-to-treat homes with a low energy efficiency rating (for full details of the scheme criteria please refer to the scheme managers report)⁹.

Given the change in scheme criteria, not all households participating in the scheme were in fuel poverty (based on the SAP survey). Customers 1, 2, 10, 11, 20 and 53 were fuel poor according to the official definition. Customers 24 and 34 were not based on theoretical spend on fuel, but according to their actual spend. Customer 24 has oil central heating, the cost of which is often underestimated in SAP-based cost assessments. Customer 34 appeared to be heating their home to their desired needs (above 21°C at times) and had reasonable income levels to cover this.

4.2 The households

As previously noted, only households receiving solid wall insulation were included in this evaluation (some households had solar PV or solar thermal only). As table 2 shows, two of the properties in the scheme were Park Homes, four were 'non-traditional' build (three steel-framed and one 'Cornish') and the remaining five 'normal' solid wall properties (though there were no Victorian properties as might be expected in a SWI scheme). This represents some particularly unique and hard-to-treat building types, which is important in considering the results presented here, particularly on costs of work involved and timescales for installation.

⁸ A household is defined as being in 'severe fuel poverty' if required to spend more than 20% of their total income on all household fuel use, in order to maintain a satisfactory heating regime and cover other normal heating costs.

⁹ http://www.cse.org.uk/downloads/file/freedom_from_fuel_povert_final_report.pdf

Table 2. Description of participating households and timeline of events

Customer ID	Occupancy	Property type	Main heating fuel	Insulation	applied to scheme	initial survey	measures approved	work started	work complete	N months app. to finish	N months start to finish
C1	Single, female, retired	Park Home	Electric	External	Oct-09	Oct-09	Jan-10	Apr-10	Jul-10	9	3
C2	Single, male, retired	Park Home	Oil	External	Oct-09	Oct-09	Jan-10	Apr-10	Jun-10	8	2
C10	Single, male, retired	1950's Semi	Mains gas	Sempatap	Dec-09	Jan-10	Apr-10	May-10	May-10	5	0.25
C11	Single, female, retired	Mendip stone, mid-terrace	Mains gas	External, back only	Dec-09	Jan-10	Jun-10	Jul-10	Nov-10	11	4
C20	Single, female, retired	1930's Semi	Calor gas	External	Dec-09	Jan-10	Sep-10	Oct-10	Feb-11	14	4
C22	Couple, retired	1930's, Detached bungalow	Mains gas	External & PV	Jan-10	Feb-10	Jun-10	Sep-10	Dec-10	11	3
C24	Young family	Mendip stone, end-terrace	Oil	Mainly internal & PV	Jan-10	Feb-10	May-10	Jul-10	Aug-10	7	1
C32	Single, male, not working	1940's steel frame, Semi	Mains gas	External	Feb-10	Mar-10	Jul-10	Nov-10	Feb-11	12	3
C34	Couple, retired	1940's steel frame, Semi	Mains gas	External	Feb-10	Feb-10	Aug-10	Nov-10	Dec-10	10	1
C36	Single, female, retired	1940's steel frame, Semi	Mains gas	External	Feb-10	Mar-10	Aug-10	Nov-10	Dec-10	10	1
C53	Single-mum, young family	'Cornish house', Semi	Mains gas	External	Apr-10	May-10	Nov-10	Jan-11	Jul-11	15	6

Some other key characteristics to note about individual participating households include:

Customer 10, who is elderly and partially sighted, was on a fixed tariff for his gas and electricity. As such, costs were less of a consideration and constraint for him. Having said that, this customer was still careful with his heating use and concerned about what might happen to his tariff in the future if he were to use his heating to excess.

Customer 24 had only moved into their home the previous September (2009). Therefore whilst they had experienced a full winter season in the property, which was an incredible struggle in terms of energy bills and comfort, prior to measures being installed, there is a lack of complete 'before' data on fuel consumption.

Similarly, **customer 53** only moved into her property in the April (2010), applied to the scheme almost immediately and work commenced the following February. Thus, again, the customer had experienced most of a heating season before measures were installed, but there is lack of data on consumption.

5 Comfort in the home

A state of thermal comfort results when householders are able to control their internal environment and their personal situation to their satisfaction. Behaviours and habits such as thermostat settings, choice of clothing or seating position will arise and be maintained to meet the need for thermal comfort. But, as this study and an extensive literature have shown, the sensation of comfort is complexly determined. It is a function of physical characteristics of the internal environment; the physical characteristics of the individual themselves; and a range of psychological and social factors, such as beliefs about what is a “normal” or healthy temperature for a living room.

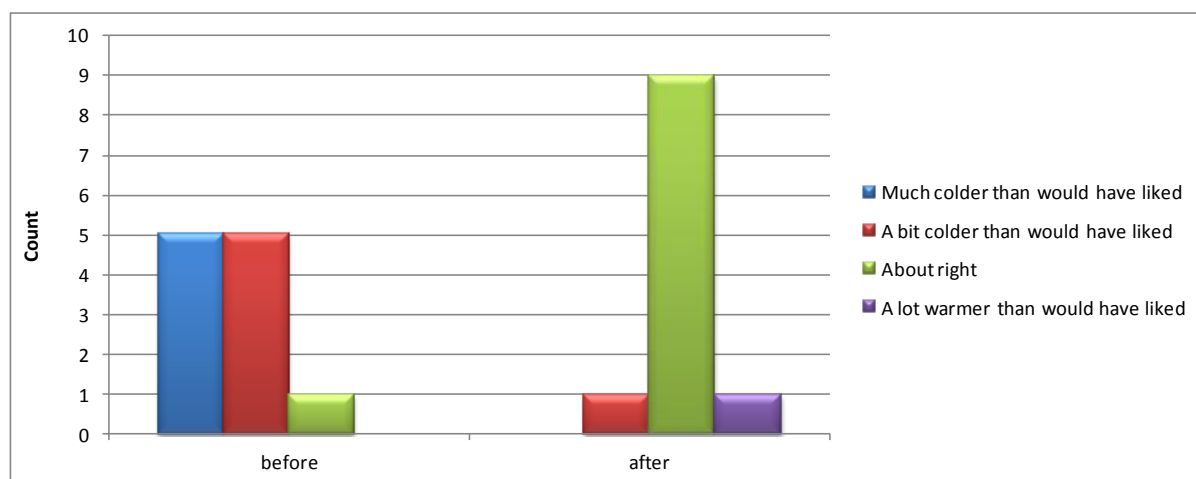
Maintenance of comfort within the home must also be understood in the context of its cost. Where the cost of maintaining a preferred level of warmth is considered excessive, the household may:

- be forced to compromise comfort (i.e. be cold);
- adopt coping strategies which maintain comfort but may compromise other aspects of lifestyle (such as going to bed early);
- or adopt an unsustainable approach in the reallocation of financial resources to pay for fuel (i.e. at the detriment to other budgetary demands or getting into debt).

In practice, households, particularly those on a low income and living in poorly insulated properties, adopt a combination of these behaviours to achieve thermal comfort as best they can.

The majority of households participating in this study described the overall level of warmth in their home as colder than they would have liked in the previous winter prior to insulation, but on the whole ‘about right’ following installation of the measures (Figure 1).

Figure 1. Householders’ perception of internal temperature, before and after measures



But what does “about right” mean in practice? How is this state maintained and how is it differentiated from conditions before the SWI systems were installed? In order to understand the multiple impacts of the SWI intervention, the study firstly explored householder behaviours and control strategies for maintaining comfort in the home, and the underlying beliefs guiding them prior to the measure being implemented. Our findings are described below.

5.1 Control of heating systems

In seven of the eleven cases, central heating systems were controlled by a room thermostat linked to a timer/clock. Some used this control system to heat their home to the desired temperature, for the desired periods, whilst others “*would have liked the home warmer*” (C11), but, because of cost constraints, restricted their heating. Indeed, actions to limit the use of heating systems because of concerns about the cost were evident in the majority of participating households (Table 3). In addition to turning the heating down, many would employ a combination of restricting heating both spatially (i.e. heating only certain rooms) and temporally:

“We didn’t always put the bedroom ones on [radiators], the back ones. I mean mid-day we’d put this one [gas fire] on and sort of put the radiators on later really...No way could you set it to come on in the morning and keep it on all day.” (C20 single, female, retired)

Table 3. Actions to limit use of heating because of concerns about the cost (pre-installation)

	N
Turned heating off, though preferred to have it on	2
Turned the heating down, though preferred it to be warmer	5
Turned the heating down or off in some rooms but not others	5
Only heated and used one room for periods of the day	3
Used less hot water than would have preferred	3

In households without thermostatic and timer control, particular behaviours had arisen suited to the idiosyncrasies of the individual heating system and the circumstances of the householder. For example, one customer (C10) had no room thermostat and consequently regulated internal temperature by manually adjusting the flow temperature from his boiler:

“I adjust it frequently. I have no room thermostat as such but I can adjust the boiler and so I adjust the temperature to suit myself by controlling the boiler temperature. Of course having been an engineer in the past I’m quite happy to do that sort of thing.” (C10 single, male, retired)

In contrast, another (C22) had no timer but did have a thermostat resulting in a similarly “manual” approach to temperature regulation. In this instance, the heating was allowed to run 24/7 but the thermostat was used as an on/off switch – turned up when heating was required and turned down when no heating was needed.

Several other households described how they used the thermostat as an on/off switch, rather than setting it to a comfortable level and allowing it to remain at that setting. Whilst this practise may result from a misunderstanding of the operation of thermostats, it is quite possible that the poor building fabric standards and constrained income of households in the study are also influential.

As discussed, comfort in the home is influenced by a complex mix of factors in addition to internal air temperature. A poorly insulated space with a leaky fabric will be prone to fluctuations in the radiant temperature of the walls, air movement caused by convection currents, and to draughts. All will impact on sense of comfort, which could prompt thermostat adjusting behaviour. For example, although the internal air temperature may feel acceptable, a draught or a localised cold area of wall may create a sensation of chill or cold. As a result the occupant may feel that the thermostat should be adjusted upwards.

At times of more extreme cold a variety of additional strategies were employed. Some would turn up the thermostat: *“But if it’s really cold then obviously I crank it up a bit more. But I don’t want it on a higher setting and to then forget about it, so I put it on 16 and if I feel warm enough that’s it and if not I put it up to 18. A couple of times I have had it up to 20 when we had that really bad cold. It was really cold then.”* (C32 single, male, not working)

Although turning up the thermostat when the weather is colder than normal seems to make intuitive sense, in fact it is evidently a waste of fuel if one feels comfortable at lower temperatures. Again it is possible that the very low thermal performance standards found in homes in the study resulted in this practice. Customers noted the rapid loss of heat from their properties. Therefore, unless the heating period was extended, higher internal temperatures resulting from a raised thermostat setting in periods of exceptional cold would result in a home that felt warmer for a longer period: more heat energy driven into a space over a given period will take longer to dissipate through the (poorly insulated) fabric.

F1⇒ A poorly insulated and leaky fabric will necessitate a variety of control strategies in the struggle to maintain comfort. Some of these may inadvertently sabotage the design intent of the home, for example, blocking ventilation points or using thermostats as on-off switches. This may result in energy wastage or undesirable and unintended consequences such as increased condensation.

One customer (C32) had a further strategy for exceptionally cold weather. He would turn radiators in non-essential spaces off or down rather than up. In a thermostatically controlled environment this is a logical response to an overriding concern to save money on fuel, as in periods of colder weather the boiler will be working even harder to maintain a thermostatic set point.

In very cold weather other householders would simply extend the operating period, often through use of the system override:

“It’s on a timer, and I try to cut down [the times] when it was on. You can try and override it or whatever, you know if you want it hotter but I try not to do that because of the cost”. (C11 Single, female, retired)

The practise of restricting heating to certain spaces for certain periods was often conducted in conjunction with use of supplementary heating systems, commonly oil filled radiators, fan heaters and, where installed, the radiant gas fire in the lounge. The supplementary heating was often used to provide a “boost”, for example to a bedroom, shortly before going to bed. This was considered a cheaper practice than heating the space using the central heating system. Where heating system control is poor this may indeed be the case.

Supplementary heating was usually used during exceptionally cold periods, but in some cases, the practise had become habitual. In one instance a particular area of a bedroom was heated with supplementary heating in order to tackle a problem with damp.

5.2 Coping strategies in a cold home

As noted above, most participants in this study were, to at least some extent, limiting their use of heating systems because of concerns about the cost. Furthermore, all properties were (by nature of the scheme) poorly insulated. The study found a rich variety of non-heating system control-related behaviours employed by householders to maintain thermal comfort in the absence of heating and/or an inherently cold home. Many of these involved heating the body rather than the space.

For example a number of householders reported wrapping up in blankets in the evenings to create an “instant heat” (C1, single, female, retired; C10, single, male, retired). In one extreme instance the householder used sleeping bags to stay warm in the living room (C24, young family). Others went to bed somewhat earlier than they would have liked (C1, single, female, retired; C24, young family; C53, single parent). One householder reported moving around the home through the day to track the radiant heat from sunlight:

“If the sun wasn’t out you would notice it [the cold], but it will gradually go around and often in the afternoons I’ll go in that room to, say, knit or read when the sun was there and you’d come back in here [the lounge] and you’d think, “ooh” such a marked difference when the sun’s gone round.”
(C20 Single, female, retired)

Three households reported the importance of the flame effect on an electric radiant fire and the visual aspect of a gas radiant fire in creating a sense of comfort: *“Although I do try not to put it [the gas fire] on all the time in the evening, if I’m a bit low I do because it lights up you know.”* (C11, single, female, retired)

This aspect of comfort, i.e. the sense of cosiness created by the visual appearance of the flame, did not seem to be impacted by the effects of the SWI system. Even after measures had been installed and householders reported improved comfort and no need for supplementary heating, the visual effect was still desirable.

The findings from the depth interviews provide significant insight into the strategies adopted by low income households living in poorly insulated properties to maintain comfort within the home. Whilst all were living on a constrained income, the extent to which they limited their use of heating in line with their budgetary constraints varied. Thus some were maintaining a level of warmth satisfactory to their needs, but paying the price with unsustainably high fuel bills. Others were heating to their financial capacity which generally meant not being as warm and comfortable as they would like. In the most extreme case, the household was heating to almost beyond their means (borrowing money from family to pay for fuel; sacrificing spending in other areas) yet were still “freezing”.

F2⇒ Where use of control systems to create comfort is either ineffective or proscribed because of concerns over the cost of heating, householders will adopt a range of comfort seeking strategies usually involving heating the body rather than the space. In extreme cases this can compromise lifestyle and restrict activity within the home.

5.3 The effect of a poorly insulated home

5.3.1 Fuel poverty status

As noted in section 3, as part of the FFFP scheme eligibility assessment procedure all households were subject to detailed surveys of the energy performance and fabric condition of the home to give a SAP (‘Standard Assessment Procedure’) rating (see Box 1). The SAP rating gives a **modelled** value for household energy bills and carbon emissions, both before and after the installation of measures. This is based on the assumed need for heat and power in the home (i.e. for space and water heating, cooking, lighting and appliances) and is used to assess fuel poverty status. The definition of fuel poverty is based on a theoretical requirement for a household to spend more than 10% of its income

on fuel to heat the home to an adequate standard of warmth¹⁰. This is generally defined as 21°C in the living room and 18°C in other occupied rooms. Hence, fuel poverty status of households participating in this research (shown below) is based on the modelled household energy bill derived from the SAP assessment.

Box 1. Modelling energy demand using SAP

Standard Assessment Procedure (SAP) Ratings

The Standard Assessment Procedure (SAP) is the Government's official standard used to calculate the energy performance and efficiency of a dwelling. The calculation takes into account the size, shape and physical characteristics of the house, including insulation levels, to estimate the rate of heat loss through walls, roofs, windows, doors and floors. It also uses information about a property's heating system, in particular its efficiency in converting a particular fuel into heat.

The SAP calculation makes a set of standard assumptions on the heating regime, hot water, lighting and appliances, and occupancy patterns of every dwelling. A standard heating regime is assumed, whereby the living space (usually defined as the living room) is heated to 21°C and the rest of the house to 18°C for 9 hours during weekdays and for 16 hours at the weekend. (This is defined by the Government as the amount of heating needed to maintain an adequate level of warmth in a home.)

Combining these assumptions with the physical characteristics of a property allows for a calculation of the amount of fuel required to heat and power a dwelling to this standard. Fuel costs and carbon emission factors can then be applied to these estimates of energy needed for heat and power in the home, to ascertain the total cost and associated carbon emissions. Finally, a SAP rating is calculated, on a scale of 1 to 100, which provides an overall indicator of the energy performance of a dwelling. The rating is a calculation of a building's performance based on energy costs per m², and is therefore intrinsically linked to the theoretical running costs of the dwelling. The higher the SAP rating, the better the energy performance and the lower the energy costs.

Figure 2 shows the total annual household energy bill based on the SAP assessment of energy needed for heat and power in the home before and after the installation of the measures. The percentage figure shown represents the reduction in the energy bill expected to result from the installation of recommended measures. There is significant divergence in the modelled energy bill of participating households, which range from around £1,100 to over £2,000 (before measures). This reflects the diversity of property types (and sizes) included in this study. Savings expected on energy bills as a result of the installation of measures also range from 9% (Cornish property, receiving external wall insulation to the lower storey only) to 29% (a bungalow receiving full external wall insulation and PV panels).

Figure 3 shows the modelled household energy bill (before and after) as a proportion of household income – i.e. fuel poverty status. (Note Customer 32 is omitted from this second graph as their circumstances were quite unique: having only recently been made redundant and with no regular source of income at the time of application to the scheme, modelled (and indeed actual) household

¹⁰ This is the original (and at the time of writing, current) definition of fuel poverty. At the Spending Review in October 2010 the Government announced it would commission an independent review of the fuel poverty target and definition. This review was undertaken by Professor John Hills (hence its frequent reference as the 'Hill's Review'). The final report, published in March 2012, concluded with a proposed new 'low income, high cost' (LIHC) definition of fuel poverty, such that "a person is to be regarded as living 'in fuel poverty' if he is a member of a household living on a lower income in a home which cannot be kept warm at reasonable cost."

energy bills represented more than 100% of household income). For the majority of households in this study, modelled energy bills represented between 7 and 19% of household income before measures. Overall, seven of the eleven properties in the scheme were fuel poor according to the official definition. It is interesting to note that even after the application of measures, six remain fuel poor. This suggests therefore that for these households, the installation of solid wall insulation alone is not sufficient, and supplementary measures and/or raised income will be needed to lift these households fully out of fuel poverty.

F3⇒ One measure alone may not be sufficient to lift the most severe cases out of fuel poverty. For these households a package of measures and/or raising household income will be required.

Figure 2. Modelled household energy bill before and after measures (based on SAP)

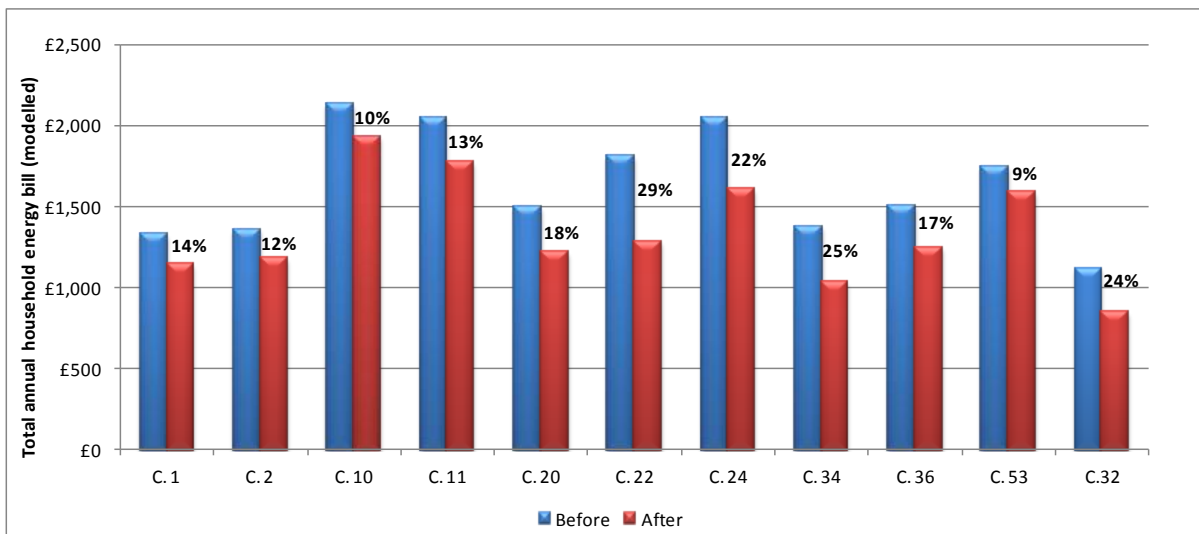


Figure 3. Fuel poverty status: before and after measures

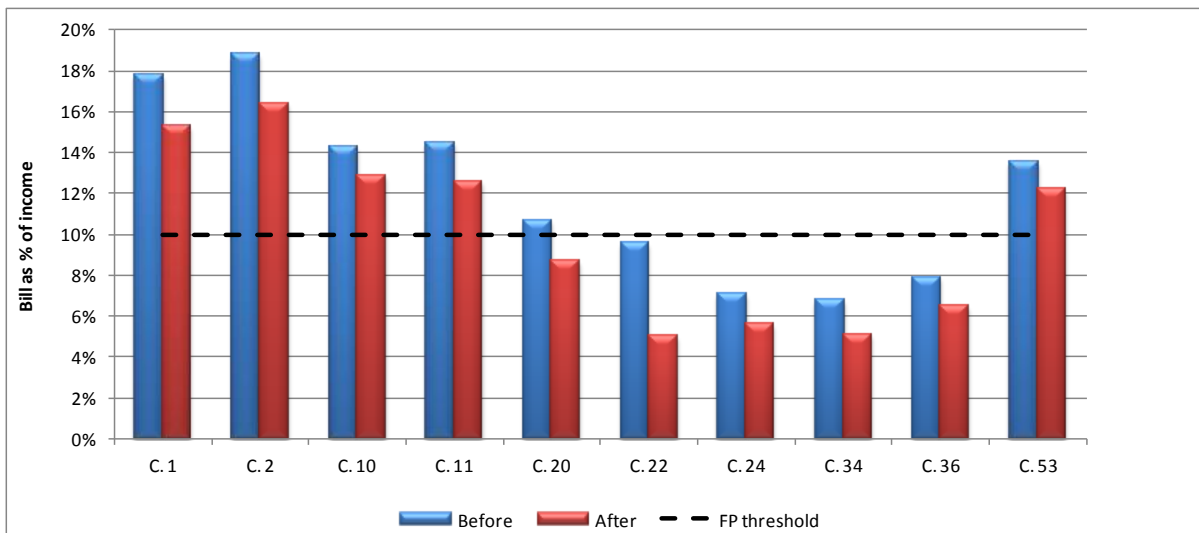
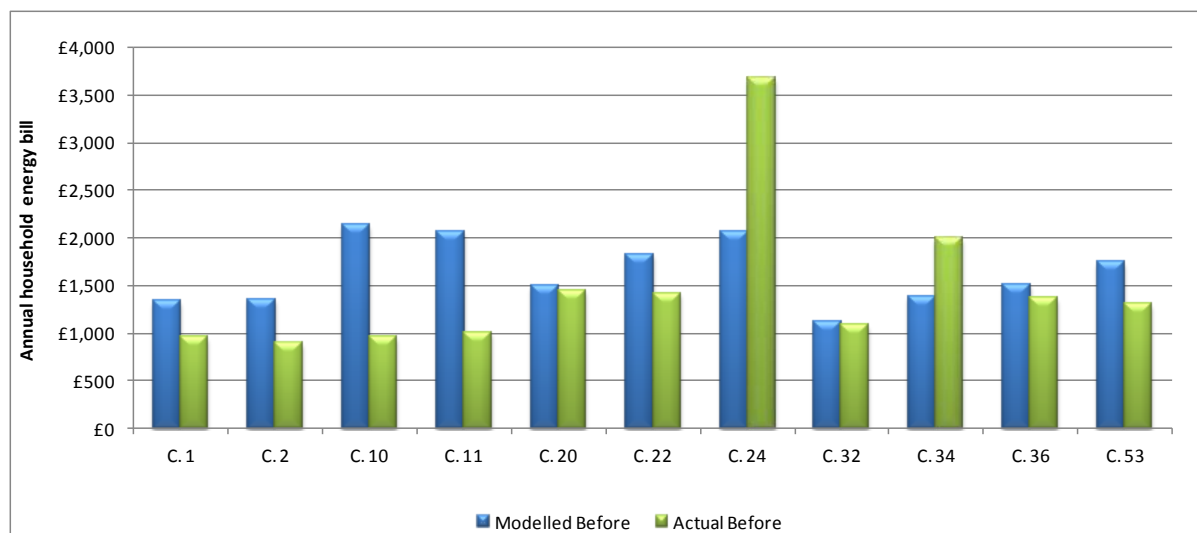


Figure 4 shows how modelled energy bills compare with actual household expenditure (derived from energy bills/ customers direct debit payments) on fuel before the installation of recommended measures (i.e. on application to the scheme). For all but two households, expenditure appears lower than the modelled required spend on fuel, suggesting actual energy consumption before measures in these households is much lower than the modelled estimated level of energy consumption

needed to adequately heat their home – i.e. they are under-heating and going cold. This may be due to a combination of factors, including the poor thermal efficiency of the property; household budget constraints; ineffective use of heating systems; and personal preferences and norms. This finding is consistent with participants' reported experience of struggling to maintain satisfactory levels of warmth over the winter period prior to applying to the scheme. Where households are under-heating, there is increased likelihood that benefits of insulation measures will be taken as comfort.

Figure 4. Comparison of modelled and actual expenditure on fuel before measures



5.3.2 Interior temperatures

Whilst high spending on fuel (relative to income) despite efforts to the contrary was consistent amongst scheme participants, householders' experience of internal temperatures was very different: some maintained a level of warmth just about satisfactory to their needs, whilst others suffered cold homes. This is based on customers' own perception of level of warmth. Data from the internal temperature data loggers provides some interesting context to these perceptions.

Due to scheme and project timescales, in most cases it was unfortunately not possible to obtain detailed 'before' data on the internal temperature of the homes. However, temperature data loggers were installed in all households in December 2010 and remained in place until the final evaluation (May 2012), giving a complete annual temperature profile.

The full spread of data obtained from these devices has been analysed to produce a daily minimum and maximum temperature profile in customers' homes from the beginning of January 2011 to end-April 2012 (see Annex III – Daily internal temperature). The temperature profile is shown relative to the standard target 21°C in living areas.

The graphs show very clear differences in the interior temperature of households in the study, which corresponds with customers' own perception of the level of warmth. Whilst some maintain a heating profile in line with the recommended standard, others appear to be heating to temperatures well short of this, and some exceed it (quite surprising given the income status and physical property characteristics of households in the study). The depth interviews with householders suggest these differences are as much a reflection of the different physical household characteristics (structure,

size, heating systems, etc) as they are of occupancy characteristics (budgetary constraints, heating practices and personal preferences).

For example, analysis of customer 32’s heating profile shows an average daily temperature lower than the standard 21°C (Figure 5). This corresponds with his stated preference for a cooler internal temperature, describing in the interviews how he does not tend to feel the cold. The daily minimum and maximum profile also shows a very erratic heating profile, which reflects the lifestyle he described - he is often required to go away at short notice, thus he prefers to control the heating manually (by thermostat), leaving it off completely when he is out/away.

Figure 5. Customer 32 daily average lounge temperature

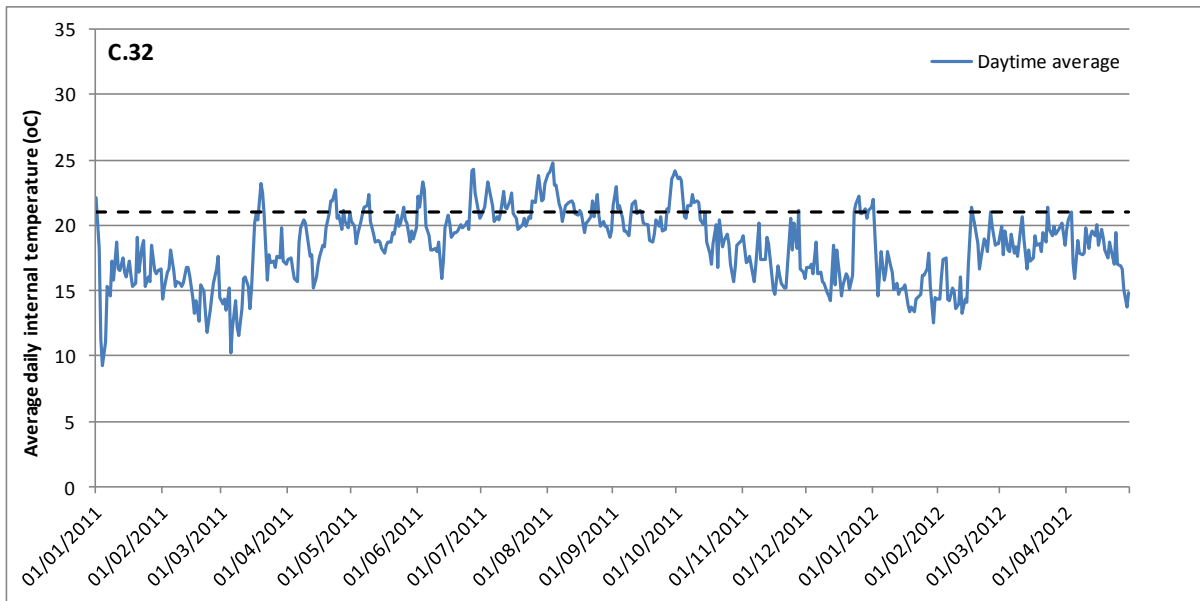
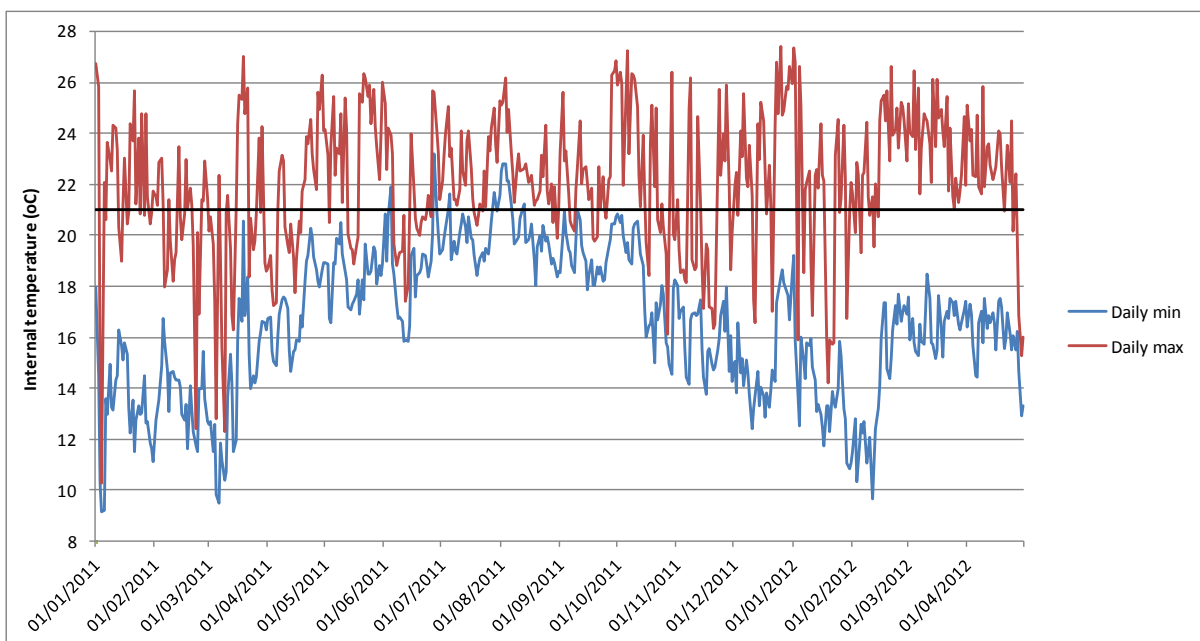
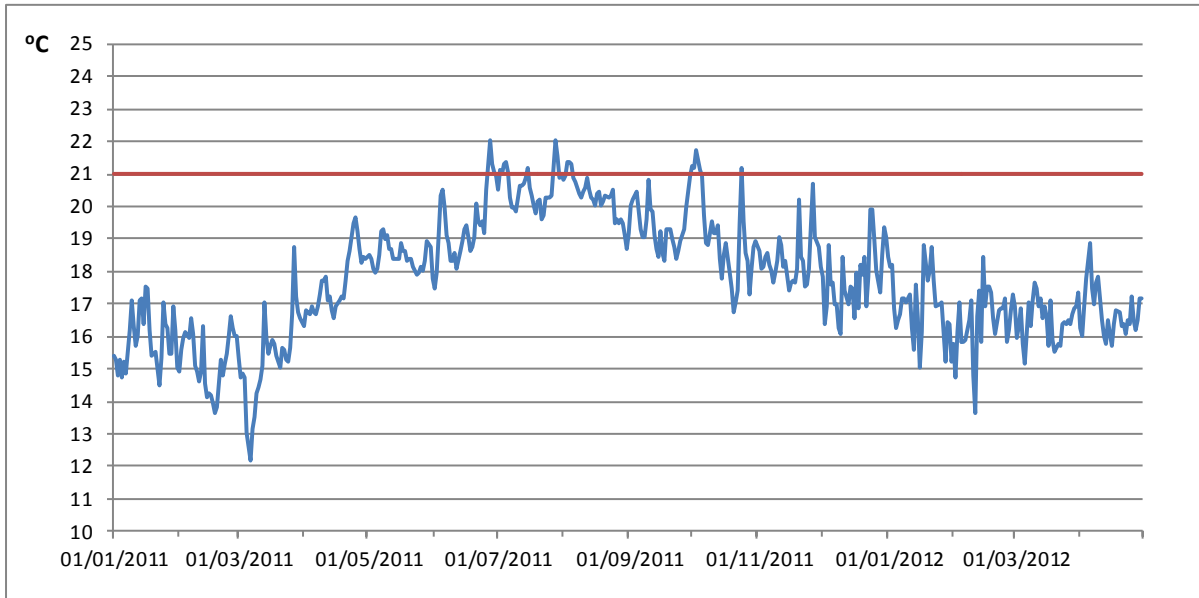


Figure 6. Customer 32 Daily minimum and maximum internal temperature



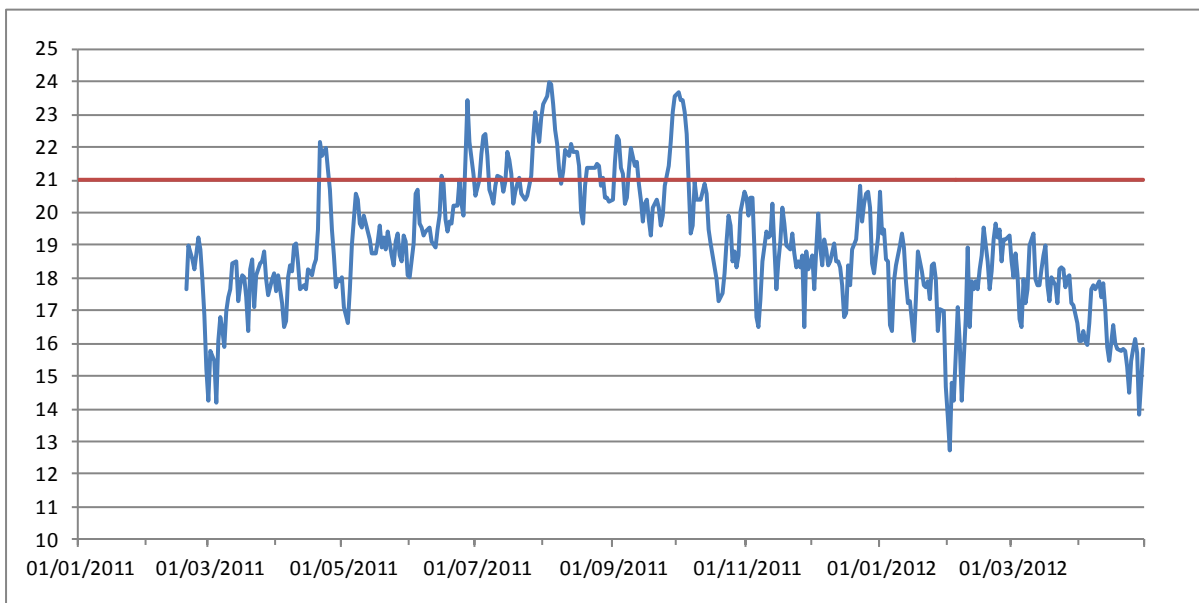
Customer 24 also shows a low internal temperature. This customer described their home as “freezing” during the winter prior to applying to the scheme. Whilst they also note considerable improvements post-installation (discussed later), the temperature profile suggests comfort may still be compromised due to budget constraints: they heat their home to their financial capacity, but, even with the property fully insulated, this is not sufficient to achieve the standard level of warmth.

Figure 7. C24 daily minimum and maximum internal temperature



Similarly, customer 53 described a very frugal approach to using the heating, partly due to cost concerns but also a perception that it is ‘unhealthy’ to heat the home too much. This is evident in the internal temperature profile of her home (Figure 8).

Figure 8. C53 average daily temperature in living area (°C)



Thus whilst all homes participating in the scheme were ‘hard-to-treat’ and all occupants relatively low income and fuel poor, the way they heat their home and their experience of internal

temperature is very different. This finding maps to that of their experience of the insulation work, which also appears very different: some notice a marked difference in internal temperature (i.e. take the benefits as comfort); whilst others found they could reduce their use of heating systems and experience lower fuel bills as a result. This is discussed in more detail in the next section.

F4. ⇨ The diversity of practices adopted by householders in heating their home and their experience of internal temperature is likely to translate into a diverse range of responses to, and impacts of, the insulation.

6 Customers' experience of the measures

This section describes customers' complete experience of having solid wall insulation installed, including: their understanding, motivations and expectations of the measures (before installation); their experience of the actual installation process; and how they feel about the work once complete.

6.1 Motivations and expectations

Householders' motivations to take up the insulation offer were on the whole centred on achieving lower energy bills and a more comfortable living environment. However, the emphasis placed on each factor depended on individual circumstances. The scheme's 'fuel poverty' criteria meant that all participants had high energy bills relative to income, of which they were fully aware (Figure 9). Furthermore, and as discussed in section 5.1, customers' energy bills remained a significant financial burden despite their consistent efforts to limit fuel consumption: seven out of the eleven participants had made some attempt to limit their use of heating in the previous winter because of concerns about the cost (Table 3, page 21). This was often in parallel with attempts to reduce expenditure in other areas and/or seek additional sources of income (Table 4).

Figure 9. Householders' perceived financial burden of energy bills (before measures)

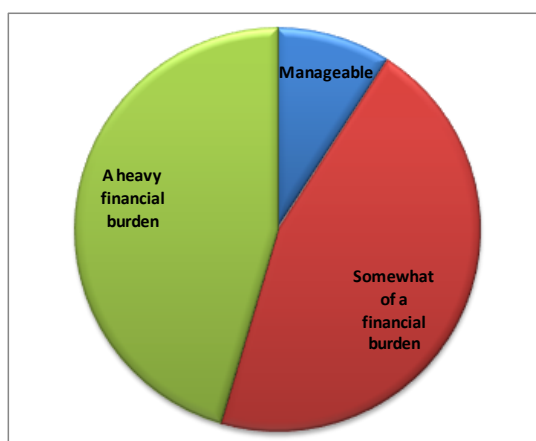


Table 4. Measures taken to help make ends meet in the last 12 months

	N
Cut back on spending on heating	6
Cut back on spending on non-essentials	4
Cut back on spending on other essentials	3
Used savings put aside for other things	3
Sold things I/we owned to raise extra cash	2
Borrowed from friends, family, or other individuals	2
Cut back on spending on food	1
Earned extra income by taking on more work or hours	1

Householders' motivations for insulating their property appear both reactive – i.e. they were responding to their immediate circumstances (a cold home/unmanageable energy bills) – and more considered, being driven by a longer-term perspective. With respect to the latter, the majority of

participants acknowledged the increasing cost of energy. Thus to these households, insulating their home provided some level of (anticipated) protection against future price rises. This perception pertained once the measure was in place: customers still saw themselves as better off as a result of the insulation, even if they had not actually experienced a reduction in energy costs; they apportioned this to the rising unit cost of energy and maintained that in the absence of the insulation their bills would have risen even further.

A common theme amongst households participating in this scheme related in particular to an individual now living alone in what had been the family home. This tended to mean a single adult occupying a fairly large property, with correspondingly high heating costs (i.e. a typical under-occupied, 'fuel poor' household). Despite energy bills being a financial burden and cause for concern, their desire to remain in the family home dominated and was a key motivation for taking up the insulation offer:

"I'm trying to get the house so I don't have to worry too much about it you know, because I really want to stay here, if I can, make it much more affordable" (C.11, retired widow).

In a similar vein, a retired couple talked of concerns for the future, specifically one of them being able to remain in the home, live comfortably and manage the bills on a single pension (should the other pass away). For these households, longer term concerns took precedence over short term comfort gains.

F5.⇒ Insulation's capacity to "future-proof" the home against fuel price rises and/or a reduced income coupled with an understandable desire to remain in the existing home may make an unsustainable existence more sustainable.

6.2 Understanding of the measures

All participants appeared very aware that their property was poorly insulated, and had made some attempt to make their homes warmer in the past, including: upgrading heating systems; insulating lofts, hot water tanks and pipes; fitting draught excluders; installing double-glazed windows and doors; lining curtains; fitting boards on internal walls; and sealing up vents. However, customers' understanding and prior experience of SWI varied significantly. Some had never heard of a wall insulation system appropriate for their property, whilst others had actively pursued this measure for some time. Of the latter, two had enquired about grant funding in the past (and been refused) and were considering a 'pay-as-you-save' approach (with a low-interest loan) to self-fund the work, despite the repayments representing a "*significant chunk of my income*" (C1). One customer had been trying to get the walls insulated for some nine years and at one time had been fully prepared to self-fund the work (which never came to fruition due to the installer pulling out):

"I would have been prepared to pay £16,000 at that time 'cause my wife was living and working and I was working. We'd have had to get sort of like half of it on a bank loan but I was prepared to do that just to save me money...Nine years of frustration and the coldness, I just had to get it done" (C.32, widower, retired).

Those that were aware of solid wall insulation had all seen other properties in their area have the work done. This firsthand experience appears an important motivating and reassuring factor:

“We had seen some people having their cladding done because the Housing Association had done their houses here on the green and down further. And I said to my husband, ‘Well maybe that’s the way to go?’ So we had started making enquiries about having some cladding done.” (C36, single, female, retired).

This is a strong argument for a geographic approach in rolling out SWI schemes: having an ‘exemplar’ property, being able to discuss the work with neighbours and experience it firsthand could significantly help in promoting awareness and uptake of the measure.

F6. ⇒ The high visibility of SWI suggests an important role for exemplar properties as a motivating and reassuring factor in promoting uptake of solid wall insulation as part of an area-based approach to targeting and marketing.

6.3 Selling the scheme

Despite varying motivations, levels of understanding and past experience of solid wall insulation, customers consistently – and perhaps surprisingly - expressed very few concerns or reservations about having the work done. On the whole, they felt well-informed about what was involved and were unperturbed by the (expected) level of disruption. This was to some extent linked to both ‘desperation’ to make their home warmer and/or lower their fuel bills, and the fact the scheme was 100% grant funded: it is possible that participants in this study were prepared to put up with a greater level of (perceived) disruption than others in less desperate situations and/or having to self-fund the work. This is an important finding however. Disruption – or rather the perceived level of disruption – associated with SWI is considered a key barrier to its take-up¹¹. All participants in this study were prepared for some level of disruption. Their actual experience varied significantly, but overtime the end result – a warmer, more comfortable and better looking home – on the whole diminished any negative aspects of the process. This is discussed further in section 6.5.

All seemed well aware and incredibly grateful that such extensive and costly measures were being offered for free. However, this also provoked some scepticism and concern around it being ‘too good to be true’. This was a key finding noted in the scheme managers’ report:

“One of the challenges of the scheme was reaching those people in fuel poverty so that they were aware of what was offered through the scheme. Once these customers were found the next challenge was to convince them that the offer was genuine and that the scheme really was fully funded. Due to the unusually high grants involved this was a significant challenge but was in some way overcome by the fact the scheme was funded and endorsed by the council - this was particularly reassuring to the older customers on the scheme.”¹²

F7 ⇒ The “too good to be true” aspect of the scheme highlighted the importance of council endorsement when such extensive and costly measures are being offered for free or at heavily subsidised rates, particularly to vulnerable households.

¹¹ E.g. see ACE, 2011. *Scaling the solid wall*. Report to Consumer Focus.

¹² p.100, Freedom from Fuel Poverty Final Report. December 2010.

http://www.cse.org.uk/downloads/file/freedom_from_fuel_povert_final_report.pdf

6.4 Costs of SWI measures

Whilst most customers in this study were fully reassured by the scheme managers and contented that the offer of the free measure was genuine, two householders still expressed cost-related reservations about the work. This related to a genuine concern that they would end up bearing the brunt of some unexpected costs. Being on a low income and constrained budget understandably made householders very risk averse where costs were concerned: *“being retired, small savings, there’s no way we can afford to have this done” (C.34, retired couple)*

One case was fairly unique here in that the customer was aware of a damp problem in the house. On the one hand he was really hoping (albeit not overly optimistically) that the insulation would solve, or at least reduce, the problem. On the other hand, however, he was very apprehensive that something would go wrong with the work or it would uncover further, more complex problems that he would then be burdened with. For this customer, much hinged on the outcome of the insulation work and the whole process was a real source of anxiety:

“If I was a wealthy person I wouldn’t worry about it because if anything went wrong then I’d have it put right but if something goes wrong that’s through no fault of my own, I haven’t got the resources to pay for it to be done” (C.22, retired couple).

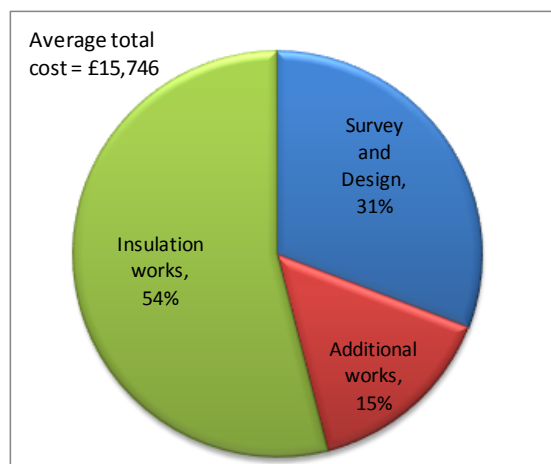
This customer’s concern actually became reality for another householder. The installation works resulted in unforeseen problems with a roof extension. These were significant and required remedial action. There was some uncertainty over whether the problems were the result of the installation or related to previous work on the property. In this case, the contractor agreed to address the problems, and bore the associated financial implications.

Analysis of the complete cost of installation works at each site (as reported in the scheme manager’s report and included in Annex IV of this report) shows the significance of such additional costs that should not be underestimated. The average total cost of the external wall insulation was around £15,750. However, only just over half of this was attributed to actual insulation costs: the site survey and design (including planning and building regulation fees) accounted for some 30% and ‘additional works’¹³ at the site for around 15%. These additional costs have significant implications for future SWI schemes, as was highlighted in the scheme manager’s report:

“While the high survey costs (31%) can be avoided in part by using an approved system based approach, the costs of the additional works cannot be avoided (15%). For the purpose of this scheme, working with vulnerable people, it was important to cover these costs as additional costs could otherwise discourage a customer from going ahead with the works” (p.22).

Figure 10. Breakdown of costs of external wall insulation

¹³ Additional works included: extending boiler flues; guttering removed and replaced including down pipes; satellite/BT removed and replaced; structural reinforcement to allow for additional weight of insulation (park homes); extending window sills/surrounds; removed/refitted canopy, burglar alarm, outside lights, outside tap; extended drainage pipes/remove and refit stack; scaffolding.



In shaping and designing future SWI schemes, roles, expectations and the extent of work covered need to be carefully assessed and clearly defined at the outset. In targeting measures at low income households, it is likely that costs of all aspects of work will need to be covered by the scheme to ensure measures reach those who most need them.

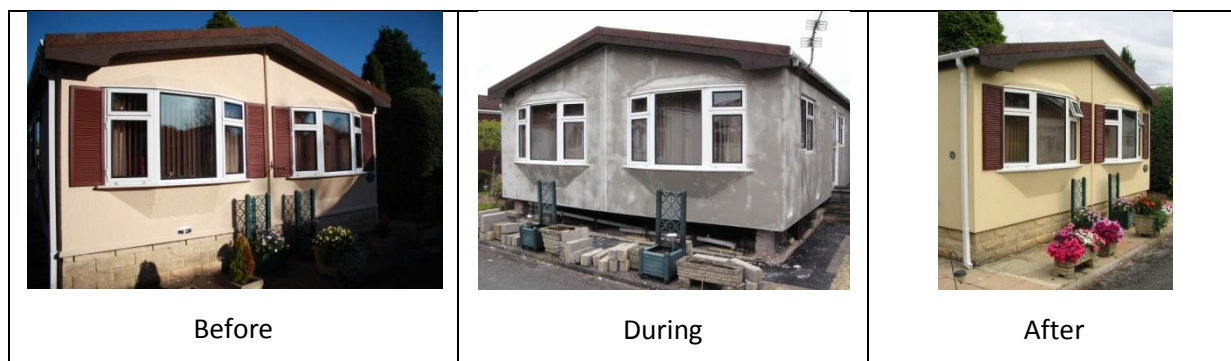
F8 ⇒ Customer and contractor expectations of the works included in installing solid wall insulation need to be carefully managed and defined.

F9 ⇒ In any scheme targeting low income households, it is likely that the full cost of any works required for the insulation to be installed will need to be covered to ensure uptake.

6.5 Disruption and the customer journey

Customer expectations of disruption during the installation process seemed well-managed. All participants expected and were prepared for some level of disruption and this was of little concern. However, householders' experience of the actual installation process was very diverse. The length of time from application to the scheme to completion of works ranged from as little as five months (customer 10) to fifteen (customer 53). Similarly, actual installation time ranged from less than one month to over six. There were a number of reasons for this, both personal to the customer (two households (C20 and C36) experienced a family bereavement during the application phase and as such temporarily put installation on hold) and related to the installation process itself. There are some important implications and lessons that can be drawn from the latter in the context of considering a wider rollout of a SWI scheme, as discussed below.

Figure 11. Before, during and after SWI installation at the park home of C1



6.5.1 Building regulations and planning complexities

Several of the properties in this pilot scheme were within a 'World Heritage City' boundary and/or were of non-traditional construction. This introduced an additional level of complexity, with detailed building surveys required before work could be agreed. For one household in particular, this revealed structural problems inherent in the concrete construction of the property¹⁴ which had to be resolved prior to any insulation works. Such complexities can introduce significant delay and cost to the process. Customer expectations need to be carefully managed in this respect, and in the context of a wider rollout of a SWI scheme, the cost of surveying and additional work need to be considered, as discussed above.

6.5.2 The weather

Two of the installations (customer 20 and 32) coincided with a particularly severe period of winter weather. The wet render system being applied to these properties requires temperatures above 5°C for at least five consecutive days. This introduced significant delays: work at these two properties could not be completed for some four months (whilst the customer had expected it to be done within about 3 weeks). This meant scaffolding had to remain in place on site, at the inconvenience of both the customer and contractor (the latter of which would also have incurred significant cost implications). This also coincided with the Christmas period when the customers had family visiting. Despite the significant delays and obvious inconvenience, customers were understanding and patient with the process: they recognised that the delays were beyond the builders' control; felt they had been treated considerately; and were satisfied by the overall level of service. But again, such potential interruptions to work need to be considered by both installers/scheme managers and the customer.

6.5.3 Snagging

Whilst the bulk of the insulation work was often completed within a matter of weeks, snagging issues prolonged the period before work could be signed off (to both the customers' and building inspectors' satisfaction). The installation of SWI requires a number of different artisans to be on site - plasterers, electricians, plumbers, carpenters etc. Several participants reported less than satisfactory finishes in some areas (e.g. poor carpentry, shoddy fittings) which resulted in tradesmen having to be recalled to the site and prolonging the overall installation process. Such issues all add to the cost of the work, as discussed in section 6.4.

6.5.4 Impacts of disruption

The points above, the latter two in particular, were significant in shaping customers' overall views of the insulation works. Whilst there was a real sense amongst participants of not wanting to complain (mainly because they had a firm grasp of the extent and cost of work they were being offered for free and were very grateful for this), there are some key lessons to be learned from their experience. Householders generally expected some level of disruption and mess – acknowledging this was inevitable with any building work. However, three households had a particularly negative experience

¹⁴ The building is non-traditional construction known as 'Cornish house', constructed of precast reinforced concrete (PRC) after the war for social housing. The structural survey concluded that if the insulation and cladding system was fixed to the existing concrete panels, there would be significant risk to the structural integrity of the building. The solution was to use auxiliary timber frame supports, with insulation in between and a hybrid cladding over, with an outer board coated with a render to match the Bath stone of existing and proposed properties on the estate.

with builders not clearing up after themselves satisfactorily, whilst others reported a number of snagging issues which could have been avoided with greater care and attention to detail.

“I knew it was going to be an upheaval, I expected that and that’s fine, that didn’t bother me. I thought, it’s going to be disruptive, I could have put up with, well I did put up with it, but I mean, all these little bits I had to pull them up on, I didn’t like that really.” (C.11, retired female)

Thus, whilst all householders described varying levels of ‘mess’ during the installation process, this could be positively or negatively framed, depending on: their expectations; personal preferences, tolerances and previous experiences of building works; and whether they perceived the disruption to be inevitable and acceptable, or unnecessary and avoidable. The latter point is particularly pertinent in designing and managing a solid wall insulation scheme. Disruption is tolerated and need not be a barrier to SWI. On-site management and communications have a key role to play here. With the range of works required in installing SWI, ensuring that there is one individual to oversee all processes at the site, to ensure all possible actions to minimise disruption are taken (as with any building work, for example builders tidying up at the end of the day) and to act as a single point of contact is fundamental to the customer journey.

F10 ⇒ These issues highlight the importance of on-site management to oversee all elements of work involved in installing solid wall insulation and the importance of a single point of contact for the customer in the event of any concerns and questions about the installation process.

The relatively long time frame over which this evaluation was conducted has provided opportunity to explore customers perceptions of the insulation works both immediately after completion - when the experience would be very fresh in their mind and they had perhaps not yet experienced the benefits to any great extent - and at least one year after work was done.

As noted earlier in this report, an unexpected problem with a leaky roof developed at one site following the installation of the external wall insulation. Whilst the contractor agreed, and made attempts, to remedy this at the time, on visiting the householder in spring 2012 for the final interview, it transpired that the problem had not been sufficiently resolved and the problem with the leak pertained. It had become a real source of anxiety for the customer and required an ongoing effort in seeking resolution. The implications of this unexpected and indirect consequence of having the insulation installed were significant: it left the customer feeling disappointed with the work, to the extent that ‘in hindsight’ they would not have had it done and would not be inclined to recommend it, in spite of feeling some benefits in improved thermal comfort in the home. The experience of this customer (albeit the only case in this study) highlights the importance of ensuring processes and protocols are in place to ensure any unexpected works and remedial/snagging issues stemming from the installation of SWI are resolved in a timely and customer-satisfaction assured manner.

However, this is a unique case in this evaluation; the experiences described at the final interview for all other customers suggest that any inconvenience incurred at the time of the installation work was outweighed by the benefits they were now enjoying, with a warmer, more comfortable and better looking home:

“We did know it would be a disruption, but now it’s done we’re glad we’ve had it done. Considering we’ve got small children it wasn’t half as bad as it could’ve been really” (C.24, young family)

Even for those who had experienced significant delays, this did not detract from them recognising the overall benefits of having the work done and would still recommend it to others:

“I’d say, ‘Yes, definitely have it done’, but be prepared!” (C1, single, female, retired)

6.6 Leveraging opportunities for further efficiency measures

The results from SAP assessments showed that one measure alone – albeit an expensive and extensive one - was not always sufficient to lift the most severe cases out of fuel poverty. For these households a package of measures and/or raising household income will be required¹⁵. Having gained access to the property, and with customer consent for extensive work to be carried out, there is an argument for ensuring all possible measures are installed where practicably possible and energy efficiency advice delivered in tandem – i.e. to ‘future-proof’ the property.

F11⇒.Future schemes should be designed such that the most cost effective measures are applied in sequence, and the householder is lifted out of fuel poverty at minimum cost. However, the order of measures would also need to make sense from a practical point of view– i.e. windows at the same time as external wall insulation, radiators at the same time as internal wall insulation, etc. This would require multiple trades on site as well as significant project management of the works on a house by house basis.

In fact, the experiences of customers in this study suggest that undertaking and engaging with one (albeit fairly substantial, complex and significant) insulation measure can act as motivation to take-up other measures. Since applying to the FFFP scheme, customers had, off their own back: had PV installed; insulated their loft; replaced doors and windows; undertaken draught-proofing measures; replaced old gas wall fires with energy efficient electric models:

“[My husband] has gone and put some more insulation in – he’s got inside and put some more insulation this side so that made a bit of a difference. And obviously we’ve got that [new double glazed] door for in here and he’s thinking about pulling down this ceiling and then putting some more insulation in there as well, and we did the loft. I don’t think we can do anymore in respect of insulation” (C.24, young family).

¹⁵ A key finding in the ‘How Much? The cost of alleviating fuel poverty’ report: <http://www.cse.org.uk/pdf/pub1110.pdf>

7 Impacts of measures

Householders reported a wide variety of impacts, mainly related to thermal comfort, but also on noise levels, damp and condensation issues, health and on the “general atmosphere” of the home. These impacts are explored in more detail below.

7.1 Household energy consumption

It is very difficult to accurately measure the impact of the insulation on actual household energy consumption. This would require detailed ‘before’ and ‘after’ energy data (meter readings) and adjustment to allow for climatic differences from one year to the next. This is principally a qualitative study, hence this level of quantification goes beyond the scope of the project. However, we have attempted to collate and analyse information from energy bills (where available) and meter readings (taken on every visit to the property) to ascertain any impact on actual energy consumption in very broad terms.

The results of this analysis are presented in the table below. To summarise, there is evidence to suggest that energy consumption has reduced quite substantially in five of the eleven participating households.

For customer 24 – a young family living in a rural cottage with oil central heating - the change has been significant in terms of energy consumption, spending and comfort. (It should be noted that in addition to the internal wall insulation and PV installed through the FFFP scheme, this customer has also had double glazing installed and insulated their loft). They remain very careful and economical with their use of the central heating, and have changed some practices in the home to make the most of the free electricity from the PV panels (e.g. putting the washing machine on when it’s sunny). The key difference for this household is that when they do put the heating on (consuming precious financial resource) they feel the benefits; and the evidence from bills suggests this has translated into needing to use the central heating even less (reduced oil consumption (kWh) and spending (£)):

“When it’s really cold we put it on. We’re still careful, we don’t have it on unless it’s really, really cold, we try and get by with the log burner but when we do put it on it heats up really quickly and the heat stays a bit longer which is a change, yeah, it’s brilliant...When we do put the oil on as well it does make it warmer whereas before it didn’t even make it any warmer. And we’re a little bit better off because we’ve got the solar panels now and using less oil so, yeah, it’s a lot better.” (C24, young family).

Evidence from energy bills for Customer 2 – a single retired gentlemen living in a Park Home – shows a decrease in electricity consumption. This aligns with his reported decrease in need to use the electric fire (supplementary heating) over the last winter. This could be attributable to the insulation and/or it being a milder winter. It is more difficult to monitor oil consumption (in terms of kWh) over time, but he is convinced he must be using less oil (data does support this), even if this does not translate into financial savings due to rising oil prices. In this sense insulating the property is perceived to offer protection against fuel price rises so the customer considers himself ‘net’ better off. This sentiment was echoed by Customer 1, who very much views the insulation as a way of avoiding/reducing the impacts of fuel price rises (discussed below).

Customer 32 shows a mixed response in terms of impact on actual energy consumption. He has lowered the thermostat since having the insulation installed. He explains this is because he previously felt it needed to be set higher in order to get the house up to a decent temperature:

“A lot of heat wasn’t coming in; it was going out. If I turned it [the thermostat] up as high as it is now you couldn’t live in the house...it would be like a sauna, that’s the difference. Like I say it’s using a lower temperature to get to the heat I would normally have with the old system up high. I was burning money just to keep warm. Now it’s right the way down.” (C32, single male, not working).

However, whilst he still economises with the heating, if anything the improvements in the energy efficiency of his property make him feel less inclined to do so because he now knows heat isn’t being wasted.

Evidence from bills and meter reads suggest customer 34 – a retired couple - have reduced their gas consumption fairly substantially. Whilst climatic differences between the years may be an important factor here, actions reported by the customer do align with the reduction evidenced in the meter readings and bills data:

“We reduced it [heating timer] by an hour a day...and cut the temperature that the water runs at on the back boiler...we didn’t need the heating on. It was very hot sometimes and I said, “This is silly.” That’s the reason why we put it down. What’s the use of having something done if you’re leaving it the same temperature? It’d be ridiculous...My thoughts were, “I’ll cut it down, but I can always put it back up again if it was required”...And as it wasn’t noticed, it stayed...it goes off at about half past eight in the morning, usually before I used to put the heating back on because it was cold...but now I don’t do that” (C34, retired couple).

Customer 36 presents an interesting case study. In the process of applying to the FFFP scheme, this customer also had a new boiler (replacing an old back boiler) and double glazing (doors and windows) fitted. Since the insulation was installed she has replaced the old gas fire in the lounge (where there are no radiators) with a new (energy efficient) electric flame effect fire. The decrease in gas consumption evident through energy bills and meter readings therefore aligns with these physical changes to the property. It does however make it difficult to attribute savings to the (external) SWI alone. Interestingly, the customer does not report any behavioural changes in her use of heating in the home. However, the significant difference in the systems available to her (e.g. the new combi-boiler has a new control panel) essentially means behaviour change has been enforced.

Customer 53 (single mum, young family) had not been in the property long before applying to the FFFP scheme, hence the lack of ‘before’ consumption data. This customer had – and has maintained – a very economical approach to use of heating in the home (for financial and personal preference reasons). But if anything – and as with Customer 32 - having the walls insulated means she is more inclined to use it:

“I’ve always been very careful with having the heating on, but I’ve not been so careful this year. In fact, I’ve even had it on when it was cold a couple of weeks ago. But what I’ve noticed is the house heats up very quickly...it heats up quicker, it’s not all going to just disappear.” (C53, single mum, 3 young children).

This customer had also had the boiler replaced, a new fire fitted, and changed some key habits (using the electric shower to fill the bath) within the timeframe of having the insulation installed, which has implications for energy consumption levels.

Table 5. Summary of impacts on actual energy consumption in context of household circumstances¹⁶

ID	Occupancy	Property type	Main heating fuel	Insulation	Work complete	Summary of impact on consumption	Context from interviews
C1	Single, female, retired	Park Home	Electric	External	Jul-10	No discernible change (perhaps up to ~4% reduction on baseline (=up to 1kWh/day))	Customer has not changed how she heats the home, though acknowledges winter 2010/11 was particularly cold so had to heat more, whilst 2011/12 was mild in comparison, yet went on longer and had to heat into May, (usually turns it off in April). She thinks it is warmer without having to heat as much but mainly sees insulation as offering some protection against fuel price rises: <i>"I mean the first winter, obviously it was exceptionally cold, but because I'd had the insulation done my bills didn't go sky high which they would have done had I not had it done...I think that I am able to keep myself warmer in the winter without increasing the cost too much". (C1, final interview).</i>
C2	Single, male, retired	Park Home	Oil	External	Jun-10	Reduction in overall energy consumption mainly from electricity; oil difficult to measure- data suggests decrease.	Customer has not needed the electric fire over the last winter (though still puts on for flame flicker effect). Turned thermostat down after having work done "just to see" – heats to about 21°C which suits him perfectly. Convinced he must be using less oil so hopes this will have counteracted impacts of oil price rises (i.e. insulation protecting from costs going up, so even though he may not experience a decrease in costs, he considers he is still 'net' better off).
C10	Single, male, retired	1950's Semi	Mains gas	Sempatap	May-10	No discernible change	Customer has not noticed a dramatic difference in level of warmth though feels house is a bit warmer, particularly in the hall (where there is large external wall area). No change in heating practices - continues to control heating manually using boiler controls as no room thermostat. This, combined with the type of insulation (Sempatap), corresponds with no change in actual consumption – customer just feels a little more comfortable.
C11	Single, female, retired	Mendip stone, mid-terrace	Mains gas	External, back only	Nov-10	No discernible change.	Did notice a difference in warmth at the back of the house (NB only had back of property insulated), but this effect was not enough to prompt her to adjust her heating system. However, she has been using the fire more over the last winter due to having visitors: <i>"I think, to be quite honest, I've had visitors and I've been using it more because I'm frightened it isn't warm enough for them, that's the only thing... So I was putting the fire on because she's been coming weekly – just to brighten it up really, when you're sat here in the winter. So I have been using the fire more".</i>

¹⁶ Note that C24 and C53 had not been in their home for a whole year prior to joining the scheme so 'before' consumption data is limited.

ID	Occupancy	Property type	Main heating fuel	Insulation	Work complete	Summary of impact on consumption	Context from interviews
C20	Single, female, retired	1930's Semi	Calor gas	External	Feb-11	Overall decrease: electricity ~ 25%. Difficult to monitor LPG consumption but data suggests possibly up to 30-40% reduction.	Overall consumption appears to have reduced quite substantially (30-40% on baseline). This does correspond (to some extent) with the customer's comments that she has felt less need to use the fire in the lounge in the evenings (after the heating went off) over the winter like she used to; has noticed the temperature in the house does not drop so quickly. However, she was unwell and in hospital for a period in the spring so the house was unoccupied. Also her husband passed away just before the work was done, which may impact on energy consumption (e.g. thinks she cooks less now).
C22	Couple, retired	1930's, Detached bungalow	Mains gas	External & PV	Dec-10	No discernible change.	General view is that it is 'better' though not noticed a significant or substantial change in internal temperature. They continue to control the heating manually by the thermostat in the hall, turning it down to 10 at night so heating goes off, and up to around 18 during the day. Would expect this to translate into a reduction in consumption if house is warming up more quickly and holding the heat. They have not changed their living patterns to align with PV generation. Also have had their daughter and son-in-law living with them for the last 9 months (over the winter), which will impact on electricity (due to additional washing loads, showering etc).
C24	Young family	Mendip stone, end-terrace	Oil	Mainly internal & PV	Aug-10	Decrease in oil consumption. Financial savings on electricity as well.	Impact on comfort has been significant. Whilst still very careful with use of (oil) central heating, now when they do put it on, they really notice the benefits. This has translated into significant reductions in expenditure on oil (NB customer has also replaced doors and windows (double glazing) and insulated the loft).
C32	Single, male, not working	1940's steel frame, Semi	Mains gas	External	Feb-11	Evidence of some reduction in overall energy use, mainly due to electricity; no discernible change in gas (or possible slight increase).	Customer has lowered the thermostat – noticed the house warms up much more quickly and holds the heat better. He still economises with the heating but if anything now feels less inclined to do so because now knows heat isn't being wasted. Customer has also now had PV installed.
C34	Couple, retired	1940's steel frame, Semi	Mains gas	External	Dec-10	Overall suggests decrease in consumption due to gas.	Decrease seen here needs to be considered in context of comparing cold winter with mild one. However, a decrease in consumption also corresponds with reported actions: Customer has reduced time and temperature of heating.

ID	Occupancy	Property type	Main heating fuel	Insulation	Work complete	Summary of impact on consumption	Context from interviews
C36	Single, female, retired	1940's steel frame, Semi	Mains gas	External	Dec-10	Decrease in Gas consumption. Possible slight increase in electricity.	The change in consumption seen here corresponds with activity in the home. This customer has had a significant amount of work done, over and above the external wall insulation, including a new boiler, new windows and doors and a new fire place. This work encompassed an old wall mounted gas fire and back boiler being replaced with gas combi boiler and electric fire – hence decrease in gas consumption, but possible increase in electricity consumption. The customer has noticed a difference in level of warmth, particularly how quickly the house warms up and holds the heat for longer. She has made no conscious change to how she heats the home, but the new systems in place mean a change to the heating regime has been enforced.
C53	Single-mum, young family	'Cornish house', Semi	Mains gas	External	Jul-11	Lack of before data to compare but possible decrease in gas consumption & slight increase in electricity.	Customer has noticed significant difference in how quickly the house heats up and holds its heat for longer (and cooler on very hot days). She maintains a very economical approach to use of heating, but is now more comfortable despite limited use. She actually feels happier about putting the heating on – and will use it a bit more than previously – as now feels the benefits more noticeably and aware it is not going straight out the walls. Customer has also had the boiler replaced and has a room thermostat but still manually controls heating. She was using the electric shower to fill the bath and wasn't aware this would be more expensive than using the gas system (a habit she has now changed). She has replaced the gas fire in the lounge (which she never used as it gave her a headache) with an electric one, which she does use occasionally – favours using this over having the heating on when kids have gone to bed as has limited control over heating rooms (lack of TRVs).

7.2 Household energy bills

As discussed above, customers had varying expectations of the impact of the insulation on their energy bills. The impact of measures on modelled bills (based on the SAP survey) – and therefore fuel poverty status - is presented in section 5.3.1 of this report.

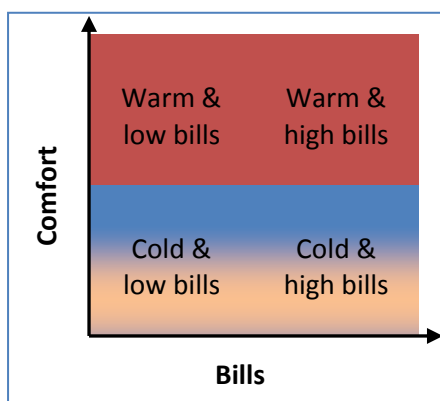
It is difficult to assess the impact of measures on actual energy bills due to the fluctuations in the unit price of fuel. Thus, the analysis of actual energy consumption (kWh) presented in the previous section provides a more useful context. That said, we did explore the financial impacts of the scheme, by reviewing household energy bills and through discussion with customers in the interviews.

The actual impact on energy bills of the insulation will depend on both individual customer response and the energy market. On the whole customers in this scheme had high energy bills (relative to income) but were still not as warm as they would have liked – i.e. they sat somewhere to the right and lower half of the bills/comfort spectrum (“cold and high bills”, Figure 12). As a result of insulating their property, these customers may therefore:

1. Maintain their existing heating regime and take all the benefits as comfort (i.e. same fuel expenditure but they’re warmer – i.e. shift **up** the spectrum);
2. Feel able to reduce their heating use whilst maintaining a satisfactory level of comfort as a result of the insulation and see the benefit in lower fuel bills (i.e. shift to the **left** on the spectrum).

The potential for the latter, however, also depends on the market: fluctuations in the unit price of energy could swallow up any potential savings from reduced consumption. Customers may therefore: take benefits as comfort but still see their bills go up (thus remaining in fuel poverty); or reduce their fuel consumption whilst maintaining satisfactory levels of comfort, but detect no difference in the fuel bills due to price rises.

Figure 12. Bills and comfort spectrum



The evidence from householder interviews and energy bills suggests customers in this scheme have experienced the full range of scenarios described above. For example, one customer describes maintaining an economical approach to the use of heating in the home, but the benefits in comfort have been such that this has translated into financial savings:

“To be honest with the insulation we’ve had put round the walls and everything, that’s better than we thought because the difference of how quickly the house heats up compared with before...[when

we put the heating on] it did help slightly but it took such a long time it felt it was hardly touching it, where now we can sort of put the log burner on or the heating and it heats up so quickly and it's just such a difference. You can't really explain it, it's just brilliant." [C.24, young family].

Another customer was sure he had used less oil, but this had not translated into cost savings due to unit price fluctuations: *"Since I've had this done, yes it's fine because I haven't used as much oil, but although I haven't used it, it's cost as much because the price has gone up."* (C.2, single retired male)

Whilst customer 2 had not seen his bills go down, he still viewed the insulation as offering protection against fuel price rises. This sentiment was echoed by customer 1:

"I mean the first winter, obviously it was exceptionally cold, but because I'd had the insulation done my bills didn't go sky high which they would have done had I not had it done...I think that I am able to keep myself warmer in the winter without increasing the cost too much". (C1, single retired female).

This customer also made reference to the complexity of the energy market and trying to get the best deal:

"You see the thing is that having had this job done, I mean that doesn't mean to say that at the end of the day I'm not going to be in fuel poverty because the price is always going up. I'm not using any more but the price of it is going up all the time. And I'm afraid it looks like it's always going to, and I try to fix my bills when I get the opportunity, I fix the price...I mean they give you these opportunities to fix the price for say 18 months... But then they charge you more above the standard rates to do that, and you've got to take a chance that the difference between the standard rate and what you're going to be paying is going to be less than the increase in fuel prices during that 18 month period. And it really is very difficult to know what to do." (C1, single retired female)

Two customers (C24 and C34) appeared to be experiencing the 'best of both worlds', describing in the final interview how they had been much warmer and more comfortable in their home over the winter and financially better off:

"I got all the bills together and I looked, we've bought a lot less oil. And we filled it – I can't remember the date but we filled it up something like February or fairly recently because we thought 'well we'd probably need some', but we didn't even need it, we still had quite a lot of oil left in the tank from the time we filled it up before which was the last year that you came. So yeah, that's been really good... Obviously when we do put the oil on as well it does make it warmer whereas before it didn't even make it any warmer." (C24, young family)

Another customer, though not experiencing any decrease in household energy bills, has noticed such a dramatic impact on comfort in the home, that financial implications have become almost immaterial:

"It surpasses it, absolutely surpasses it [expectations]. I didn't really think it was going to make a lot of difference; I thought it might make some difference, but it's way beyond my expectations." (C32, final interview).

The trade-offs between fuel expenditure/savings and thermal comfort are explored further below.

7.3 Thermal comfort

All households reported improvements to their thermal comfort as a result of the insulation, although the extent of the impact was more subtle for some than for others. Reported impacts ranged from very little discernible difference in internal heat levels (C10) to “massive” differences (C24). Furthermore, this additional comfort was experienced in a number of ways. For example, customers noticed their home warming up more quickly; heat was considered to be dispersed more “evenly” throughout the home; and the property “held the heat” for longer:

“If I’d been out say and it’s [the heating] been off practically all day and I come back in and it doesn’t strike you like it used to, you think ‘oh there’s nothing on but it feels really snugly and warm” (C.20, single retired female).

The differences in customer response and experience of the impact of the insulation on their thermal comfort can be better understood in the context of customer heating regimes and approaches to controlling internal temperature *before* the insulation was installed. As discussed in section 5 these factors will be highly influential in determining whether householders experience a marked increase in thermal comfort or whether only marginal impacts are detected. The most common possible responses and the distribution of householders in this study exhibiting these responses are summarised in the matrix below.

Table 6. Matrix of thermal comfort: customer heating practices and impacts of insulation on comfort

		Post-installation thermal comfort	
		Same	Improved
Pre-installation heating practice	Home under-heated	No change in comfort. Savings from the measure taken entirely as lower energy input to the home (therefore expect lower bills). ⇒ No customers fell into this quadrant	Same heating regime maintained but comfort improved. Energy input to the home similar to prior to insulation measure therefore some or all potential savings taken as comfort. ⇒ C1, C11, C20
	Home heated to desired temperature	No or marginal change in comfort. Savings from the measure taken as lower energy input to the home (therefore expect lower bills) ⇒ C10, C22	New increased level of service exceeds comfort requirements potentially resulting in discomfort. Controls and settings adjusted accordingly. Savings taken as lower energy input to the home whilst maintaining pre-measure comfort levels. ⇒ C2, C32, C36

Benefits taken as improved comfort & lower bills: C24, C34, C53

Findings from this study suggest that over half of the households were under-heating due to budget constraints, poor thermal fabric, inefficient heating systems, or ineffective use of heating systems (or a combination of these factors). Of these, all noted some improvement post-installation, with the majority (seven) experiencing significant change.

Interview responses suggest three of these householders are maintaining the same heating regimes (timings and thermostat settings) as prior to the measure, but the property’s new thermal

characteristics meant that these settings now delivered a more comfortable environment. As a result (plus with the impact of energy price fluctuations), they have not experienced any financial savings on energy bills, as C1 describes in her experience: *"I don't think I've saved anything. I don't think I've saved any money, but I've been, I've been warmer for the money that I've spent."* (C1, single, female, retired).

For some under-heated households, the improvements in comfort were such that they had notably less need for supplementary strategies for keeping warm: *"I'm less likely to find other ways of trying to keep warm other than actual heating. Whereas before I might have a couple of fleeces that I would put round and a hot water bottle, two hot water bottles when it was really cold sometimes"* (C.1, female, single, retired).

Whilst others reported changing patterns of supplementary heating usage after the measure: oil filled radiators, fan heaters and fires were thought to be used less often in a number of instances. As discussed in section 7.1, these changes have translated into reduced energy consumption in some instances (as far as the data allows for this conclusion to be drawn), but again, changes in energy prices have limited the financial savings.

A second "under-heated" group (C24, C34, C53), shown in the middle of the matrix, had the sense they had captured both savings and improved comfort. These customers described experiences of living in a cold home prior to the measure, although their extent of heating was very different: C34 was fairly liberal in their use of heating but extremely poor thermal efficiency and a draughty property meant they still felt the cold; C24 on the other hand heated to their financial capacity but felt little benefit in warmth, due to highly inefficient building fabric. However, post-installation these customers noted a marked improvement in comfort, to the extent that they felt warmer and were able to reduce their heating use:

Husband: "Actually the temperature, I've cut the boiler down by one notch." Wife: "And I'll get out of bed in the morning when the heating has started and think gosh this is hot in here and I'll turn it off and we don't have it in the morning then." (C34, couple, retired)

"We're still careful with it because we've got the log burner as well but yeah, it's a lot better... When it's really cold we put it on. We're still careful, we don't have it on unless it's really, really cold, we try and get by with the log burner but when we do put it on it heats up really quickly and the heat stays a bit longer which is a change, yeah, it's brilliant." (C24, young family; final interview)

C53 presents a mixed message in terms of comfort and energy use in the home. Initially, post-installation, she reported reduced need for heating the home, feeling the home was warmer "straight away" and as such had "not had to have the heating on for two weeks now. So even when it has felt cold I haven't put the heating on at all which has been brilliant so hopefully I'm going to save an absolute packet on my heating bills." However, in the final interview in spring 2012, this same customer described quite a different approach: having the house insulated made her feel more inclined to use the heating when needed, as she now felt the benefits and knew it wasn't money wasted: *"I've always been very careful with having the heating on, but I've not been so careful this year. In fact, I've even had it on when it was cold a couple of weeks ago. But what I've noticed is the house heats up very quickly....It's going to heat up quicker but without having to have it on so long, it's not all going to just disappear."*

F12. ⇒ Our findings suggest that comfort taking from energy efficiency interventions is a continuum: all potential savings from the measure will be taken as comfort in only a minority of cases. The majority will fall somewhere between the two extremes of 100% comfort taking and 100% bill savings. As such, the actual impact of SWI at any one property is very difficult to predict.

Householders who were already heating their home to desired levels responded somewhat differently to the improvements in thermal efficiency compared to the under-heating groups. Following the installation of SWI, households had lowered thermostat settings, turned off radiators, reduced heating periods or done a combination of these things:

“As I say, it’s using a lower temperature to get to the heat I would normally have - in the old system I would have to have it up high. If I turned it up that high now you couldn’t live in the house. It would be just too much, it would be like a sauna, that’s the difference in the two, they are miles apart.”
(C32, single, male, not working)

Households that had reduced thermostat settings - “turning down the heating a notch” - following the measure, had previously heated their homes to desired levels under thermostatic control. It may therefore seem slightly puzzling that the same internal temperature was considered to be uncomfortably hot following the measure. One explanation may lie in the multiple determinants of a sense of comfort: air movement, radiant heat temperatures and air temperature all play a role. SWI systems will reduce draughts, create a more even temperature distribution in the house thereby reducing convection currents, and will increase the temperature of the inner surface of the wall thereby increasing the radiant heat experienced by the householder. It is likely that the combination of these impacts is sometimes sufficient to cause air temperatures, previously experienced as comfortable, to become uncomfortably warm. By reducing heating periods and thermostat settings, this group is taking efficiency gains as financial savings rather than comfort.

The final group (C10, C22), who also heated their home to the desired level prior to the measure but experienced little improvement to their comfort post-installation, principally differ from the ‘uncomfortably warm’ group because of how they control their heating. In both instances heating was not under automatic thermostatic control. C22 used their thermostat as an on-off switch because the system had no timer, whilst C10 had no thermostat at all, controlling room temperature by constantly adjusting the flow temperature of the boiler. Consequently, in both instances, desired comfort was delivered reactively by manual adjustment of settings, both before and after the installation of SWI. This will make the impacts of the measure very difficult to detect, particularly in terms of improved comfort, which is what we found with these customers. Benefits from the measure are more likely to be taken as financial savings rather than improved comfort (although circumstantial changes in household occupancy for one, and the nature of the (fixed) energy tariff for the other, seem to have precluded this).

F13. ⇒ In cases where a household both under-heats the home because of cost concerns and inhabits a poor building fabric, most or all savings from SWI will be taken in improved comfort. However some under-heated households will capture both savings and comfort improvements. Where homes are already heated to desired comfort levels prior to the measure, more complex responses result from SWI. Depending on control strategies (use of thermostats etc), some households may notice only marginal improvements to comfort. Others may even experience discomfort and adjust settings accordingly. In both cases, financial savings should result.

7.4 Summer comfort

A number of respondents felt their homes were difficult to keep comfortably cool in the summer months and resorted to a variety of practises to stay comfortable including using fans (C1, single female, retired), (C10, single male, retired) and sometimes more drastic measures, *“a wet flannel, feet in a bowl in the summer, it was so hot, it was like an oven”*. (C34, couple, retired) “. However interviewees reported a noticeably cooler internal temperature in summer following the installation of the SWI. This resulted in a much more comfortable environment:

“my bedroom, at night, because the sun comes round that way at night, it used to be like really hot but I did notice it was so much different and I suppose that is partly because it [the SWI] keeps the heat out as well as holding it in one way or another” (C2, single male, retired).

“Also I think in the summer, it stays a shade cooler. Which I’m glad of because I don’t like it hot.” (C20, single female retired).

In some instances the cooler temperatures, removed the need for cooling devices such as fans, *“I did notice that in other years when I’ve had to get out my free standing fan, I didn’t need to get it out at all last year. So I think it does keep it a little bit cooler although I wouldn’t say drastically so.”* (C1, single female, retired).

F14 ⇒ SWI has a noticeable impact on occupants’ sense of comfort in summer months. Homes that are thought to be to be uncomfortably hot are thought to be cooler and more comfortable. This may reduce or eliminate the need for supplementary cooling using fans and other devices. Modest energy savings may result.

7.5 Damp and condensation

Damp and excessive condensation was an important issue for some households in the study. C22, in particular, experienced heavy condensation on the glazing and seemed more concerned about tackling an ongoing damp problem in a bedroom via the measure than with improving comfort. The damp problem required a particular heating regime with radiators left on in the bedroom and the occasional use of supplementary heating. However, as a result of the SWI the damp problem appeared to be “cured”:

“As my wife says, last year we were actually wiping our hand over the wall behind the bed and it has come away wet...Now that seems to be cured.” (C22, couple, retired).

Although the damp problem had improved, the problem with condensation appeared to be “worse than I’ve ever known it” and was considered by the respondents to be a possible unforeseen outcome of the insulation work, which is possible: the insulation may have the effect of raising the internal air temperature, which would then be capable of holding more moisture, thus condensing in greater quantities on cold bridges such as glazing¹⁷.

F15. ⇒ SWI insulation systems should come with guidance on tackling condensation issues as they are likely to be exacerbated by the warmer internal temperatures and the reduction in uncontrolled ventilation following installation of the measure.

¹⁷ This issue is well understood as a potential consequence of solid wall insulation and a range of guidance exists to mitigate such impacts, See, for example, English Heritage guidance on the subject: http://www.climatechangeandyourhome.org.uk/live/content_pdfs/779.pdf

7.6 Draughts

As suggested by the comfort analysis, the measure had a significant and noticeable impact on the draughtiness of the home. Prior to the measure the majority of the respondents reported that their home was draughty and had taken a number of remedial measures to try and cut down draughts often with little success: *“we did everything - all the joints in the wood are taped, and round the skirting board you’d have a draught you know”* (C20, single female, retired). This respondent also reported taping up the ventilation grill in the kitchen each winter. Blocking off ventilation points in a bid to counteract “draughts” was reported by other respondents also. For example, *“In the front room, we’ve got a vent on the window which I’ve actually put plastic over it and taped it down because a lot of cold was coming through there”* (C53, single female, retired).

This practise of taping up ventilation points, particularly in areas where the air will be more humid such as kitchens and bathrooms, will inevitably result in greater damp and condensation problems where there are cold bridges. This is clearly not a desirable practise but entirely understandable in the context of a draughty uncomfortable home. It might be expected that a less draughty fabric resulting from a SWI system would result in a reduced incentive to block off ventilation points where ventilation is actually required, however it may be difficult to break habitual practises in some cases. This could lead to increased problems with condensation and potential damp on cold bridges in homes having SWI because of its effects on the thermal properties of the building envelope.

A number of respondents did report noticeable reductions in the draughtiness of the home following the measure. For example, *“I put two doors on the passage outside to cut the draughts down, but we still hung a blanket over the back door, cause that’s where most of it was coming from, but that’s gone now, we’ve got rid of that [following the measure]”*. (C34, couple, retired)

F16.⇒ In some poorly insulated properties with leaky fabrics, a number of undesirable practices may have developed to counteract draughts, specifically taping up or blocking off controlled ventilation points. SWI insulation systems will tend to reduce draughtiness and increase the moisture content of the air, therefore it is particularly important in this instance that controlled ventilation points are allowed to operate as intended in order to avoid a marked increase in condensation problems on cold bridges.

7.7 Health

A number of households spoke about the relationships between living in a cold home and health impacts. C10, for example (single, male, retired) voiced a concern, *“well certainly the older you get, the more the winter affects you as regards temperature”* and speculated (albeit fairly blithely!) that he may “live even longer” as a result of the measure.

C24 (young family) identified linkages between the “freezing” internal temperatures they had endured prior to the measure and the propensity for illness in the family, including coughs and colds, and even as a cause of her husband’s tonsillitis:

“It was too cold. Yeah. Freezing...Yeah we all had bugs as well. We all kept constantly getting bugs, the children and everything.” (C24, young family)

Following the measure the customer felt that the warmer environment had resulted in less illness amongst the children:

“We’re just feeling a lot more comfortable in here... the children haven’t been so ill.” (C24, young family).

Several other households speculated that they had suffered fewer colds and flu events since the insulation went in (e.g. C2, male, single, retired; C34, couple, retired).

In addition to improvements to physical health, some respondents reported improvements to their wellbeing as a result of the measure. One household reported that concern over unsustainably high heating costs and the coldness of the home had made them feel depressed:

“We were depressed. I mean it’s a lovely spot but it was so depressing because you didn’t want to come home. We were trying to stay out.” (C24, young family)

Following the measure the household felt much more comfortable:

“Well we’re just feeling a lot more comfortable in here. It was a bit depressing before because you think well, we’re freezing when we’re spending money on heating and nothing’s happening but now at least when you do put your heating on you know it’s making a difference.” (C24, young family).

In summary, whilst acknowledging the limitations of this small qualitative study, these findings do suggest that the measure may have improved the physical health of the occupants. Wellbeing has also been demonstrably improved by the measure.

F17.⇒ It is likely that some SWI recipients will report improvements to their health as a result of the measure

7.8 Lifestyle impacts

The scheme had a number of impacts on the lifestyle and social life of the occupants. By providing a comfortable environment, the measure eliminated or reduced the frequency of a whole range of householder behaviours that had arisen in response to the overwhelming need to remain comfortable in a home that was difficult or expensive to heat.

Lifestyle impacts of the measure were principally derived from making the home more “liveable”. For example, householders frequently mentioned the need to use less blankets or to wear less clothing indoors:

“Before, even when we had the heating on, we needed the blanket as well, because it was still too cold. But now if we have the heating on we’re finding it actually got very, very warm in here.” (C24, young family).

For one householder, the change in the internal environment was so marked it impacted on his ability to enjoy leisure activities at home:

“It’s more comfortable to sit on the settee or lie on the settee and read, because I don’t like taking things to bed to read. I’ve got a television there, but I don’t ever use it because I think the bed’s for lying down on and going to sleep, so I like to do all my reading here, where it’s nice and quiet with my little lamp on, and before I wouldn’t have done that. Because it was too cold. If I wanted to read I’d have to put the heating up. It was ridiculous. So my leisure activities here, as I say my writing and I’m in a computer club now so I’m doing lots of projects and I like to sit here. If it’s really cold and the heating’s on then I get nice heat and whereas I wouldn’t be able to do that before - I’d be sitting there with a blanket over me - because I don’t possess a jumper, not one jumper have I got [laughter]

- I'd have one of the blankets over me doing it in there or on the coffee table and you're hunched over, so at the end of the day my back's killing me, my eyes are not working properly and my arms are aching, shoulders, the lot. Now I sit here and I'm perfectly happy, I can do nearly 3 hours work here. It's much more comfortable." (C32, single male retired; final interview)

Two households (C1, C53) also mentioned that they would often go to bed earlier than they would have ideally liked to because remaining in the living area was uncomfortable: *"So I find I often think well I'll go to bed about half past nine or something like that and read or watch the television in bed. And rather than stay in the cold in here" (C1, single female, retired).*

Households frequently reported that certain rooms or areas of the house were especially cold or deliberately unheated to save on fuel bills. In one extreme instance, prior to the measure, the home was so cold and uncomfortable, the family had spent as little time in it as possible over the previous winter months: *"It was so depressing because you didn't want to come home. We were trying to stay out. Go and stay anywhere like friends houses or taking her to toddlers [groups], 'cause it's warmer in the village hall and that kind of thing. Went out to get in the warm, went to my parents place." (C24, young family).*

By contrast, this same customer now reports a much more comfortable home environment – one to which they feel happier to invite friends and family to:

"We have had people come round actually because our friends always used to joke, 'come round with like 12 jumpers and like a blanket' and now they come in and they've gone 'my god, it's actually warm in your house!'. And people have actually laughed about it." (C24, young family, final interview).

Evidently by making the home comfortable, householders in these circumstances will spend more time at home, thereby transforming lifestyle from one based around spending time away from home in the winter months to one where activities could take place in the home.

A number of households also remarked that the home seemed cooler during the summer months as a result of the measure. This had also improved the liveability of the space. For one particular household summer overheating in the kitchen area significantly impacted comfort resulting in a number of practises affecting lifestyle, *"he used to sit out there [the kitchen] because he watched telly out there with a flannel on his head", "a wet flannel, feet in a bowl in the summer, it was so hot, it was like an oven". (C34, couple, retired).* Following the installation the temperature of the kitchen was noticeably cooler in the summer months and consequently this practise was no longer thought necessary.

F18.⇒ In all instances SWI was found to improve the "liveability" of the home, removing the need for comfort seeking practises which impacted lifestyle and in opening up areas of the home for use and enjoyment.

Installing an energy efficiency measure that results in financial savings could also indirectly impact lifestyle by creating additional disposable income. We explored this with interviewees but did not find any evidence to support this assertion. This may be due to the sample of households in this study – all being relatively low income and in fuel poverty. Any financial savings (or income from the FIT where relevant) seemed to go into the general 'pot' towards household bills.

7.9 Social impacts

Several householders received comments from visitors, neighbours, and in some cases passers-by, about the insulation work, both whilst work was in progress and on the end result. This included general (wholly positive) comments about the appearance of the property post-installation and enquiries as to the nature of the works:

“A lot of people have commented on it and said how nice it looks. Even people coming to the door.” (C36, single female retired; final interview)

The level of interest generated by these few (and geographically spread) installations implicates the importance of an ‘exemplar’ property in promoting uptake, as discussed in section 0.

External SWI is by nature highly visible, but less well understood as a home improvement measure. For one customer, the level of interest and enquiries from neighbours became a source of embarrassment. This was mainly because the work was being done for free and he felt uncomfortable having to explain to others how and why this was:

“You know, we’ve had people stop me and say I hear you’re having a lot of work done, that’s going to cost you a bit...I would turn around and say it’s not going to cost me anything...It’s a bit embarrassing because we don’t like discussing our finances outside.” (C.22, retired couple).

Such situations could be alleviated, and indeed the highly visible nature of external solid wall insulation be exploited, by having some form of information board or leaflet at a site where work is in progress. This could be a useful mechanism to help combat some of the misconceptions/key concerns surrounding solid wall insulation and promote awareness of any local schemes. In areas where there are a high number of similar properties that could benefit from the measure, this could be a particularly effective and low-cost approach to encouraging uptake.

F19.⇒ The highly visible nature of external solid wall insulation could be exploited as a marketing mechanism through the use of information boards/leaflets at sites where work is in progress.

Scheme participants noted comments (again all positive) from visitors about the impact on internal temperature. The effect here could be two-fold. Firstly, any visitors experiencing the impact for themselves may be encouraged to pursue the measure in their own home. This is most relevant in the case of neighbours who live in similar properties:

“A friend of mine that sometimes pops in from up the road, she’s got a house like this and she said one day, ‘Oh, have you still got your heating on?’ And I said, ‘No.’ And she said, ‘It’s really warm in here’. And I said, ‘Yeah.’ And it was about, it might have been lunchtime, just after lunch, when she came and like I say, it [the heating] goes off, at nine or half past.” (C.36)

A further potential effect linked to visitors’ perceptions of the internal temperature of participants’ homes relates to householders tendency for ‘thermal hosting’ – that is, turning the heating up for the benefit of visitors when they would otherwise have made do without. Several households participating in this scheme noted this behaviour. With the insulation in place and the home maintaining a more comfortable temperature, householders may feel less inclined to do this, thus reducing their consumption.

Before: *“Well I suppose if you’ve got somebody coming you’ve got to crank up the heat so they don’t come into a fridge. That’s about it really but it’s costing you money at the end of the day and it’s*

money going out, as I say, because it's not, there's no insulation there... but when my mother comes to stay, I've got no choice [about putting the heating on]"

After: *"Well everybody's happier when they come in the house now, especially me mother. 'Cause the heating's got to go up to about 16 when she comes and I have to go and get me shorts on and me T-shirt. [Laughter] But I'm much happier now. Much happier. No more earache from me mother and me daughter when she comes in saying, 'Oh, it's cold in here'. It's always been a very, very cold house, because to heat the house you've got to heat the walls first and that's where you're losing all your money. Obviously I'm going to be better off money wise 'cause it's not going to cost me as much." (C32, single, male, retired)*

F20.⇒ In some instances SWI may have quite dramatic impacts on occupant lifestyle and social life. By providing a comfortable environment occupants are more disposed to spend time at home and to bring others to their home.

7.10 Appearance and maintenance

Two key factors emerged as unanticipated benefits of having SWI, namely: the impact on the appearance and maintenance requirements of the property; and the impact on noise.

Scheme participants were able to have some input into the finish on their property following the installation of measures. In most cases preferences could be satisfied, although at two properties there had to be some compromise due to cost. All participants were wholly satisfied once work was complete, although for some this did follow snagging issues (some significant) which first had to be rectified.

The fact that works were being fully funded was again a key factor here: customers were, in some cases, reluctant to complain, being so appreciative that the work was being done for free. However, this could not detract from the fact it was their home and the appearance and level of finish was important to them. Whether paying for the measures themselves or not, if work is not completed to the customer's satisfaction, this needs to be rectified. As discussed in section 6.5, schemes involving such extensive measures could benefit from an on-site project manager to oversee all aspects of the work.

Having said that, in the majority of cases, the finished product met with, if not exceeded, customer expectations. In particular, an 'added bonus' for many, which had not been anticipated, was the reduced maintenance requirements:

"The thing I like most about it is the fact obviously, it's going to be that much warmer and hopefully, my bills will be down. But also, there's no maintenance for me, I mean, everything's cladded...the contrast with the white, it really does look nice...So yeah, I'm really pleased with it. So many people have stopped and said, 'Oh, I see you've had work done. What's it like, how's it been and it looks really nice.'" (C.36, single retired female)

"The finish on it, it's guaranteed for so long, I forget, it'll see my lifetime, 25 years I think it was. There's no upkeep, now it's there, it's there. I haven't got to bother with it at all. Whereas previously, the place had to be done over every so many years with stone cement stuff...Thank goodness I don't have to put up with that anymore." (C2, single, male, retired)

Figure 13. SWI improves the appearance of the home as demonstrated by C20's completed installation in comparison with the other half of the semi-detached dwelling.



The one household that had full internal wall insulation offered similarly positive feedback:

“We thought that maybe it would make the rooms look a lot smaller but it doesn’t actually make them look any smaller...we haven’t noticed the loss of space at all. In a way it, in a strange way, it kind of makes them look a bit bigger. I don’t know whether it’s because they’re painted white or whether the windows look deeper set, so it just makes the room look a bit bigger.” (C24, young family)

Customer responses to the impact of the insulation on the appearance and maintenance requirements of the property emphasise the applicability of marketing SWI as a home improvement measure. These ‘added benefits’ appeared on a par with the improvements in thermal efficiency and/or reduced fuel bills to some customers in this study. Furthermore, expectations for level of disruption may be better aligned with the concept of ‘home improvements’ than ‘insulation’.

F21.⇒ Marketing of solid wall insulation should capture the full range of benefits beyond improved thermal efficiency. Marketing the measure as a ‘home improvement’ may be more appealing to the customer and more appropriate to the nature of work involved than focusing on the insulation angle per se.

7.11 Noise

Six out of the eleven participating households noted the “sound proofing effect” of the insulation. For those who live on a fairly busy road this was a particularly welcomed (but unexpected) benefit:

“I’ll tell you something else; it’s not so noisy either. We can’t hear the things outside so much. It’s insulated the - we don’t hear so much traffic. And we get the buses down here.” (C.34)

Even for those who did not live in a particularly noisy area, this was still considered an additional benefit and could therefore be framed as such in the marketing of future SWI schemes.

F22.⇒ The sound proofing effect of solid wall insulation could be included as an additional potential benefit in future marketing of schemes.

8 Key findings and recommendations

This evaluation and the scheme manager's report have produced a number of key findings related to (1) managing comfort; (2) impacts of the measure; and (3) the process of installing solid wall insulation in hard-to-treat homes. These are summarised below.

8.1 Managing comfort in hard-to-treat homes

Where use of heating system controls to create comfort is either ineffective or proscribed because of concerns over the cost of heating, householders will adopt a range of comfort seeking strategies, usually involving heating the body rather than the space. Whilst for some this was a standard practice to which they had become accustomed – i.e. they were habitually conservative with their heating – for others this represented a real compromise of lifestyle and activity within the home, and could be a real source of misery¹⁸. For example, in one extreme instance the household was forced to leave the home altogether to spend parts of the day in warmer spaces.

Recommendation 1. Householders develop integrated clusters of habits, behaviours and beliefs in their efforts to maintain comfort. In homes with very poor fabric and control systems some of these may be actively wasteful of energy. These modes of practise are supported by wider normative beliefs around what is expected, modern, desirable etc. Consequently, policy makers should anticipate that SWI, an intervention having significant multiple impacts on the home's thermal performance, will not only make households warmer - it will have potentially transformative effects on many aspects of lifestyle and even the beliefs underpinning certain lifestyle and energy consuming habits. This is likely to be particularly evident in households adopting extreme comfort seeking behaviours as a result of living in under-heated homes.

A poorly insulated and leaky fabric will engender a variety of control strategies in the struggle to maintain comfort. In terms of the impact of SWI, some of these practices may sabotage the design intent of the home, for example blocking ventilation points or using thermostats as on-off switches. This may result in energy wastage or undesirable and unintended consequences of insulating the home, such as increased condensation. There is therefore an important educational element to the installation of complex measures, to ensure the full potential benefits are realised (discussed further below).

8.2 Impacts of Solid Wall Insulation

8.2.1 Impacts on Comfort

All households noticed changes to their comfort, lifestyle and even health as a result of the measure. Households often described their homes as “warming up more quickly”, whilst heat was considered to be dispersed more “evenly” throughout the home and the property thought to “hold the heat” for longer.

The diversity of practices adopted by householders in this study in heating their home translate into a diverse range of responses to the installation of the insulation. Some householders continued to

¹⁸ This was a key finding as reported in the study: “You just have to get by’ Coping with low incomes and cold homes.” http://www.cse.org.uk/downloads/file/you_just_have_to_get_by.pdf

heat their homes exactly as before but now feel the benefit of warmth, whilst others have adjusted their heating practices.

In cases where a household both under-heats the home because of cost concerns and inhabits a poor building fabric, most or all savings from SWI will be taken in improved comfort. However some under-heated households will capture both savings and comfort improvements.

Where homes were heated to desired comfort levels prior to the measure, responses to the SWI were found to be dependent on the household's control strategy – principally their use of thermostats. Those households who did not keep their home under thermostatic control, for example by regulating internal temperature through constant adjustment of the boiler flow temperature, seemed to notice only marginal improvements to comfort. In contrast, those who kept their home under thermostatic control reported that the increased level of service resulting from SWI often made them “too warm” and accordingly adjusted settings downwards.

One explanation for this may lie in the multiple determinants of a sense of comfort: air movement, radiant heat temperatures, and air temperature all play a role. SWI systems will reduce draughts, create a more even temperature distribution in the house thereby reducing convection currents, and will increase the temperature of the inner surface of the wall thereby increasing the radiant heat experienced by the householder. It is likely that the combination of these impacts is sometimes sufficient to cause air temperatures, previously experienced as comfortable, to become uncomfortably warm. For this reason, we believe some households heating their homes to comfortable levels under thermostatic control prior to SWI subsequently experienced internal temperatures as too warm.

This finding indicates that with or without thermostatic control where homes have been heated to comfortable levels prior to the measure, we should expect financial savings to result from the SWI installation, thereby directly addressing fuel poverty. Whilst such financial savings were not realised for all such cases in this study, participants acknowledged that fluctuations in energy prices are a key factor here. In doing so, they adopt the view that the insulation offers some protection against the increasing costs, considering themselves to still be ‘net’ better off than without the SWI.

Recommendation 2. Unlike some efficiency and micro-generation measures, impacts of SWI on “liveability” and comfort on the home are noticed and can be profound, especially where homes are under-heated prior to the measure. Scheme designers and policy makers should maximise awareness of these benefits as part of social marketing strategies supporting mass rollout of SWI systems.

Differences in household response to the measure are fundamental in the context of the Green Deal and the formulation of the ECO. Consider two identical homes, one under-heated because of the occupants' concern about fuel bills, the other heated to desired temperatures but with an unsustainable impact on household finances. Each has SWI installed. The under-heated home takes the savings as comfort and sees no change in their bill, whereas the home that was heated to desired levels takes the efficiency improvements as financial savings.

Under current thinking, both households would have the same opportunity to access a loan for the measure through the Green Deal, as eligibility is assessed using the Golden Rule. This applies the standard occupancy approach to assessing household energy costs and savings. The occupancy assessment, which aims to take a view on actual household energy consumption and potential

savings on energy bills, is therefore essential here to ensure that pre-measure under-heated householders are aware that the savings assumed under the Golden Rule may not be realised in practice, thus limiting their ability to repay any loan through real savings on their bills. It is therefore essential that Green Deal providers show a duty of care in who they offer Green Deal finance to, and/or additional mechanisms are in place to ensure under-heated households do not get into fuel debt through taking out Green Deal finance incompatible with their personal circumstances.

This situation suggests that energy savings and comfort taking rates from particular measures in fuel poor groups should be deemed. The alternative, an attempt to account for different comfort taking rates driven by different priorities and preferences, would seem to open the possibility of unequal access to Green Deal finance and to be extremely onerous in terms of administration.

As this study has indicated, most households will fall somewhere between 100% financial savings and 100% comfort taking – i.e. for the majority of fuel poor households there should be some, perhaps very small, financial savings from the SWI measure. The ECO subsidy for SWI should therefore be set high enough that the majority of fuel poor households, making some savings from the SWI even if very small, can access the Green Deal loan by meeting the Golden Rule. For the minority, with chronically under-heated homes taking all savings as comfort, additional arrangements will have to be made.

Recommendation 3: In formulating Green Deal policy these findings highlight the importance of considering what constitutes a “saving” against the counterfactual case, i.e. a situation where the household is either comfortable or is under-heated prior to the SWI measure. Given dramatically different rates of comfort taking amongst fuel poor groups, this finding presents a case for deeming SWI savings and setting ECO subsidy rates accordingly. The occupancy assessment and duty of care is fundamental in ensuring under-heated households do not suffer fuel debt as a result of taking up Green Deal finance where savings are not going to be realised.

8.2.2 Draughtiness

The study found that the SWI systems markedly reduced the sense of draughtiness. This is of course a positive outcome. However, because of very poor fabric standards in some properties, we found a number of undesirable practices had developed to counteract draughts, specifically taping up or blocking off controlled ventilation points. In all likelihood these practises will continue post SWI installation. It is known that SWI will increase the moisture content of the air as it will tend to be warmer as a result of the measure, therefore it is particularly important in this instance that controlled ventilation points are allowed to operate as intended in order to avoid a marked increase in condensation problems on cold bridges.

Recommendation 4: Because of unanticipated potential effects of SWI and various maintenance aspects which differ from conventional external wall treatments, e.g. painting and susceptibility to damage from point loads, we feel that SWI systems should come with a user guide, “living with your new insulation” and/or a requirement to give verbal advice to the householder once the system is installed. This should mitigate potential issues and allow householders to get the best from the systems.

8.2.3 Further benefits

This evaluation, albeit small in scale, has revealed a number of ‘additional’ benefits of solid wall insulation that householders had not been expecting, but which added much to their overall perception and level of satisfaction with the work. In particular the impact of SWI on the appearance of the property (both on the outside with external and on the inside with internal solid wall insulation) and the reduced maintenance requirements (with external wall insulation) were heavily praised by scheme participants.

Recommendation 5: Because of its impact on the appearance of a property, solid wall insulation lends itself to marketing as a ‘home improvement’ measure to a much greater extent than other energy efficiency measures. Branding it as such may also enhance its appeal to householders and better portray the nature and cost of work involved which can be extensive compared to other insulation measures.

Customers also noted improvements in comfort in the summer months with the insulation providing a cooling effect. This may reduce or eliminate the need for supplementary cooling using fans and other devices, resulting in additional, albeit modest, energy savings.

Customers also noted health, lifestyle and social benefits, including removing the need for comfort seeking practises which impacted lifestyle and opening up areas of the home for use and enjoyment, the importance of which should not be underestimated.

8.3 Installing Solid Wall Insulation in hard-to-treat homes

8.3.1 Targeting and promoting uptake of measures

One of the key challenges of the scheme was to identify and reach the target audience (i.e. the fuel poor), and even then take up of measures was very slow. This was linked to the unusually high grants being offered – the ‘too good to be true’ notion – and the low income status of the target audience meant they were particularly risk-averse. Having council endorsement of the scheme was important here, particularly in reassuring the older customers on the scheme.

Recommendation 6: Amongst low income and consequently risk-averse groups some sort of official endorsement of the scheme, for instance by a local authority, should be in place, as this could be critical to uptake.

Several different approaches were used in marketing the scheme including advertising in local papers and taking referrals through the Energy Saving Trust advice centre. The most successful marketing technique, however, proved to be a doorstep flyer drop (by a B&NES Council Officer) in an area where SWI was being installed in some social housing. The directness of this approach, combined with the ‘first hand’ experience of householders in seeing the work carried out on neighbouring properties, appeared fundamental to uptake of the grant offer in this area. This finding is consistent with other evaluation studies of SWI schemes¹⁹.

Recommendation 7: Our findings suggest that an area-based approach to future solid wall insulation could be effective. The high visibility of SWI could be exploited as a motivating and

¹⁹ E.g. see ACE, 2011. *Scaling the solid wall*. Report by the Association for the Conservation of Energy for Consumer Focus.

reassuring factor in promoting uptake (see recommendation above). This could be maximised by the use of information boards/leaflets at sites where work is in progress.

8.3.2 Maximising opportunities for additional energy efficiency improvements

The FFFP scheme specifically set out to test the effectiveness of SWI and solar installations in helping hard-to-treat households in fuel poverty. However, it was fully acknowledged by scheme managers that these did not always represent the most cost effective energy efficiency measures.

Recommendation 8: Future schemes should be designed such that the most cost effective measures are applied in sequence, and the householder is lifted out of fuel poverty at minimum cost. However, the order of measures would also need to make sense from a practical point of view— i.e. windows at the same time as external wall insulation, radiators at the same time as internal wall insulation, etc. This would require multiple trades on site as well as significant project management of the works on a house by house basis.

The experience of customers in this study suggest that undertaking and engaging with one (albeit fairly substantial, complex and significant) insulation measure can be motivation to take-up other measures. Since applying to the FFFP scheme, customers had, off their own back and at their own expense had: PV installed; insulated their loft; replaced doors and windows; undertaken draught-proofing measures; replaced old gas wall fires with energy efficient electric models. These (re-) actions further emphasise the potential for and importance of maximising the opportunity once the home-owner is engaged with an energy efficiency scheme.

8.3.3 Costs of measures

The (high) total costs of installation in this scheme may be somewhat unique given the property types involved (i.e. four out of the eleven being non-traditional). However, all sites entailed some level of costs additional to the actual insulation element. In a scheme such as this, targeted at low income, vulnerable households, it was important that the full cost of measures was covered. However, this is something that needs to be considered in future schemes, particularly in the context of the Green Deal and Golden Rule, which is based on the premise that the insulation will deliver financial savings on energy bills sufficient to cover loan repayments. This is particularly important for low income households who may not be able to afford the loan repayments if the savings aren't realised. How the cost of additional works (structural or survey related) will play out here is unclear.

Recommendation 9: Green Deal providers should consider the value of installing packages of measures in combination and to deliver additional savings/revenue (i.e. from FIT and RHI) to subsidise the costs of the most expensive measures that won't deliver the Golden Rule on their own.

8.3.4 The customer journey

An issue raised by several customers in this evaluation related to on-site and overall scheme management. SWI necessitates a number of different trades being on-site to complete different elements of the work. On-site management is a key factor in ensuring each element is delivered in a timely and orderly manner, and the finish is to both the customer and contractor's satisfaction. Indeed, the only customer in this study who felt the benefits of the SWI did not outweigh the

disruption involved in the work had experienced an unexpected and indirect negative impact, which was still unresolved over a year after work was completed.

Recommendation 10: Ensuring contractors have a formal process for onsite project management with a single point of contact for the SWI recipient will make a significant difference to the customer journey in many cases. While smaller companies might argue this sort of structure can be restrictive, being contractually bound to a process should help fulfil all the necessary project requirements.

This is particularly relevant with SWI which, much like cavity-wall insulation in its early days, seems to create an uncertainty with customers who feel that the potential risks do not outweigh the benefits. Where the element of customer choice is restricted by having an appointed contractor, there is a responsibility on the scheme to ensure the customer journey is as smooth as possible.

Participants in this study all had very different experiences of the actual installation process. This was due to: the diverse mix of property types; the different SWI systems applied; and timing of the works (two were unfortunate in coinciding with a spell of very cold weather which caused significant delays). Householders described varying levels of 'mess' during the installation process. Their perception and experience of the level of disruption was not just a factor of what they had actually endured, but also their expectations; understanding of the nature of work involved; tolerance to and prior experience of living with building works; and whether they perceived the disruption to be inevitable and acceptable, or unnecessary and avoidable. The latter was the key reason behind any negative experiences reported and related mainly to mess that could (in the householders' eyes at least) have been avoided by simple measures and a little more care and attention (e.g. builders simply tidying up at the end of the day). These kinds of issues are not unique to the installation of SWI, but apply to any substantial building or home improvement works. Indeed, it could be argued that external SWI poses significantly less risk of disruption than other home improvement measures, such as replacing a bathroom or kitchen, as all works are constrained to the outside of the property and do not entail any disruption to basic household services (water supply, cooking facilities etc). Having visited the householders over a year after they experienced the SWI installation, any inconvenience incurred at the time was, on the whole, far outweighed by the benefits they were now enjoying, with a warmer, more comfortable and better looking home.

Recommendation 11: The perceived level of disruption associated with SWI is considered a key barrier to its uptake²⁰. The findings from this study suggest this need not be the case. The experience of participants here suggest all were expecting and prepared for some level of disruption, and their actual experience was well within these expectations.

²⁰ E.g. see, ACE, 2011. Scaling the solid wall. Report to Consumer Focus.

Annex I – Householder questionnaire

Face-to-face survey conducted at beginning and end of project – i.e. in first and third interviews.

1. How would you describe the overall level of warmth in your home last winter? Was it...
 1. Much colder than you would have liked
 2. A bit colder than you would have liked
 3. About right
 4. A bit warmer than you would have liked
 5. A lot warmer than you would have liked
 6. Both too warm and too cold

2. And still thinking about last winter, what kind of heating system/s did you have in your home?
 1. Gas central heating
 2. Oil central heating
 3. Night storage heaters
 4. Fixed room fires or heaters
 5. Open fires or stoves (solid fuel)
 6. Portable heaters: Electric
 7. Portable heaters: Bottled gas/paraffin
 8. Portable heaters: Oil-filled
 9. Other

3. And did you use all of these systems last winter, at any time? If no – Which did you not use?

4. Thinking about any time of day or night, did you (and your partner) cut back on fuel use at home in any of these ways last winter, because you were concerned about the costs?
 1. Turned heating off, even though I would have preferred to have it on
 2. Turned the heating down, even though I would have preferred it to be warmer
 3. Turned the heating down or off in some rooms but not others, even though I would have preferred not to
 4. Only heated and used one room in my house for periods of the day
 5. Used less hot water than I would have preferred
 6. Turned out lights in my home, even though I would have preferred to have them on
 7. Had fewer hot meals or hot drinks that I would have liked
 8. None of these

5. In the last 12 months, have [*you / you or your partner*] done any of the following things in order to make ends meet?
 1. Cut back on spending on food
 2. Cut back on spending on heating
 3. Cut back on spending on other essentials
 4. Cut back on spending on non-essentials

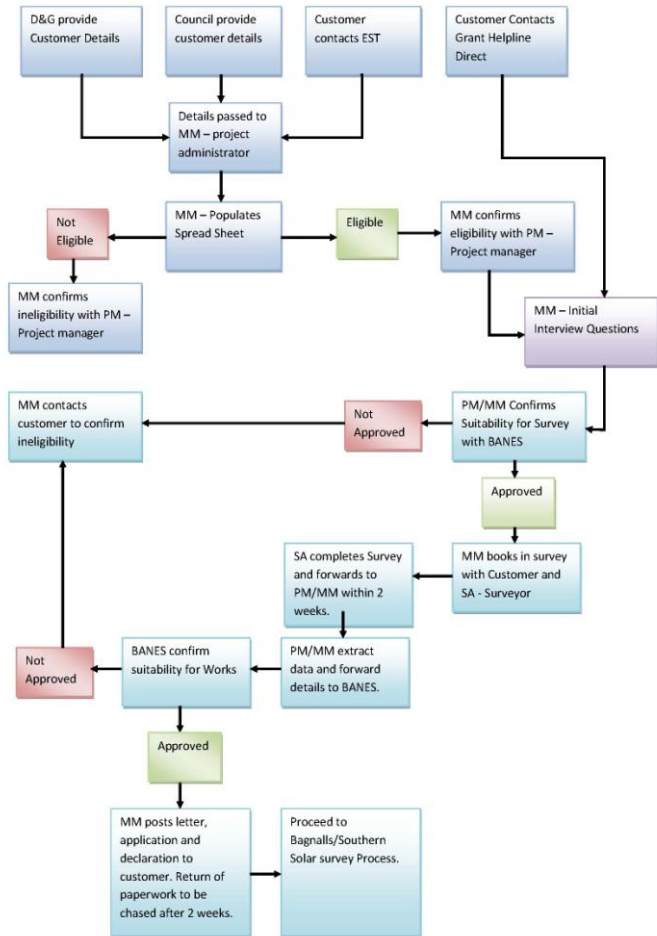
5. Used savings put aside for other things
6. Earned extra income by taking on more work or hours
7. Sold things I/we owned to raise extra cash
8. Borrowed from friends, family, or other individuals
9. Taken out new loans from commercial lenders
10. Increased the amount owed on a credit card or overdraft
11. Delayed making payments on money owed
12. None of these

6. Still thinking back to last winter, would you say your fuel bills were...

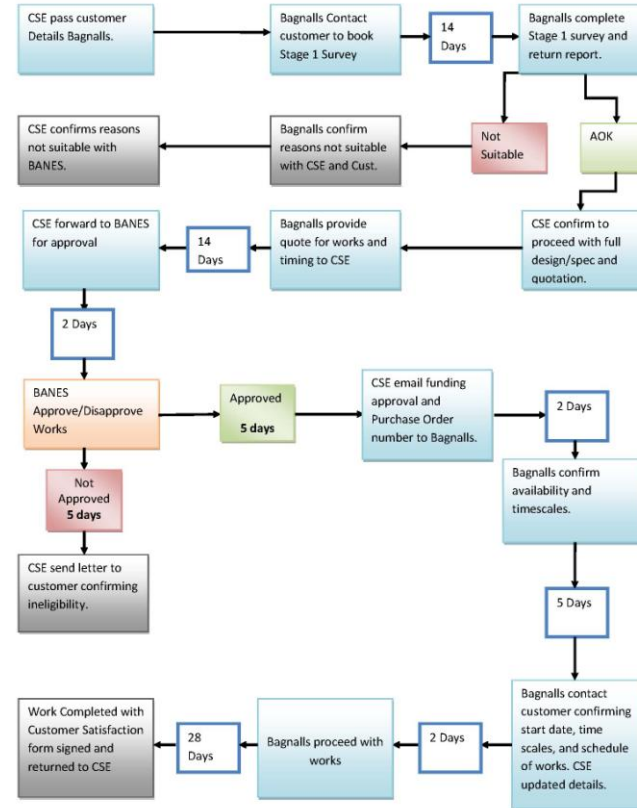
1. A heavy financial burden
2. Somewhat of a financial burden
3. Or not a problem at all?

Annex II – Scheme Process

The application process



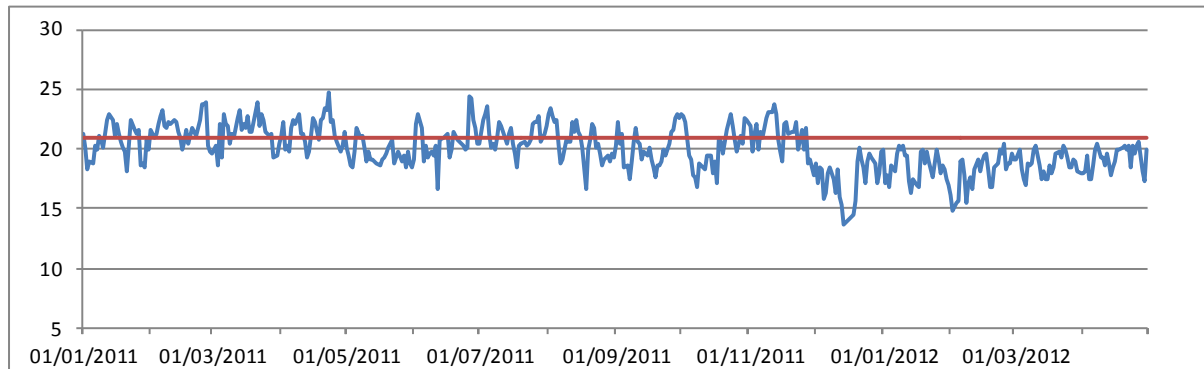
The installation process



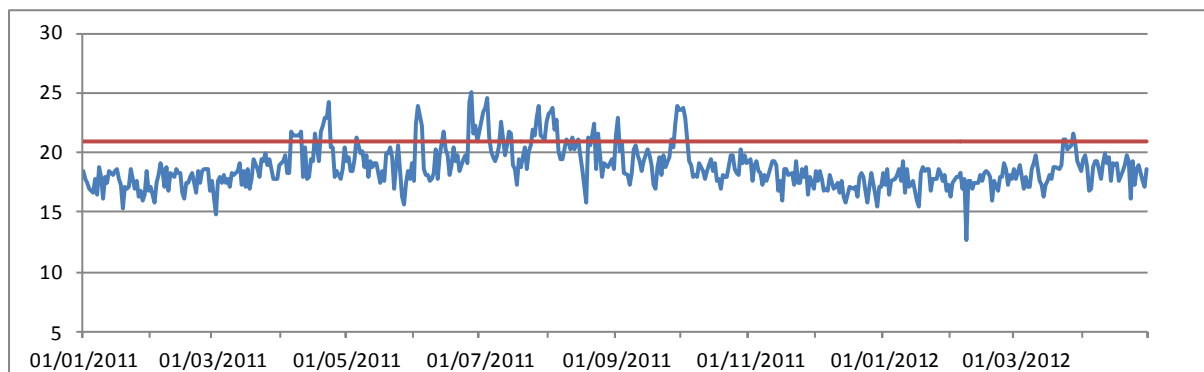
Annex III – Daily internal temperature profiles

The graphs below show the daily average (8am to 10pm) temperature in customers' homes from the beginning of January 2011 to the end of April 2012. All axes are to the same scale for ease of comparison (5°C to 30°C for the y-axis). The standard 21°C in living areas is marked on all graphs by the solid red line.

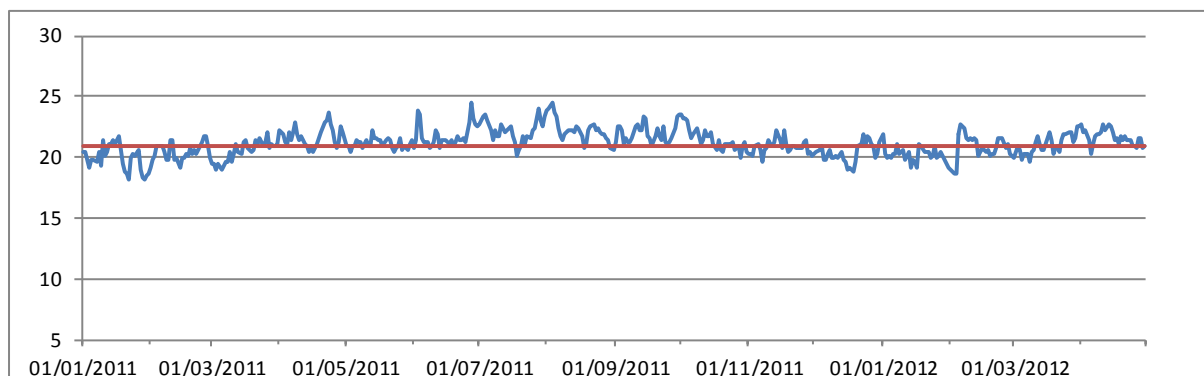
Customer 1



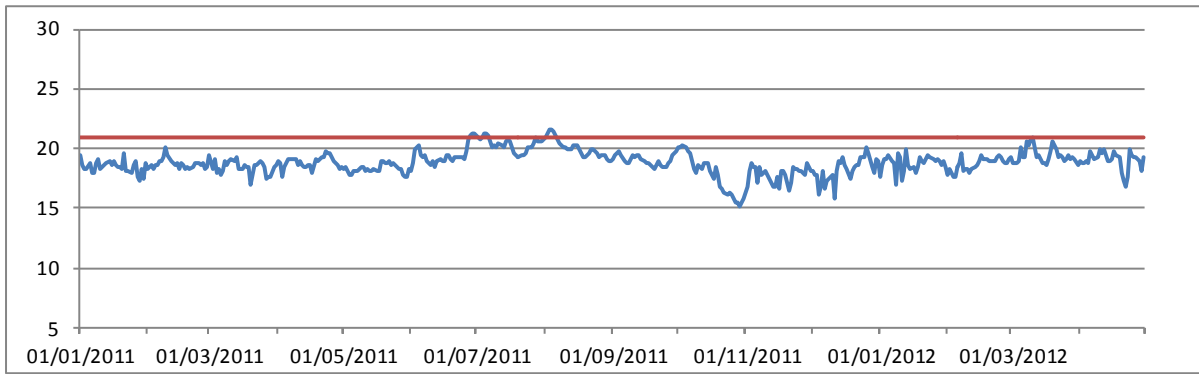
Customer 2



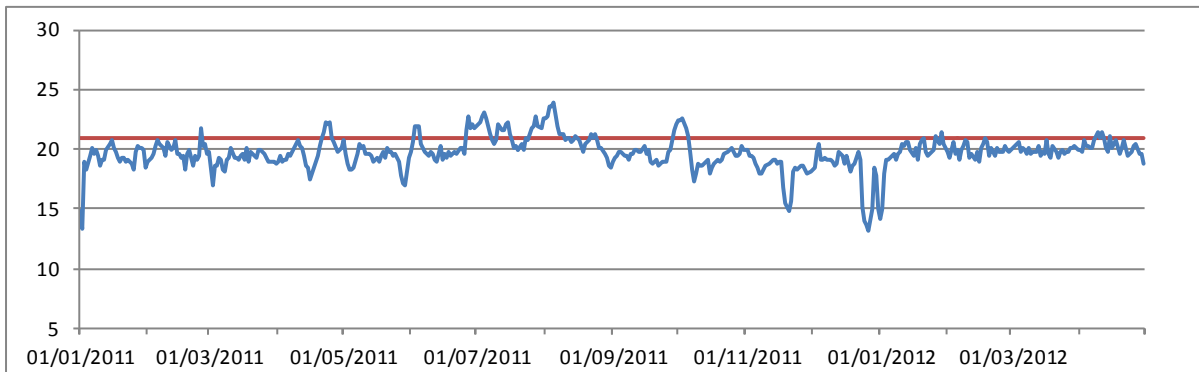
Customer 10



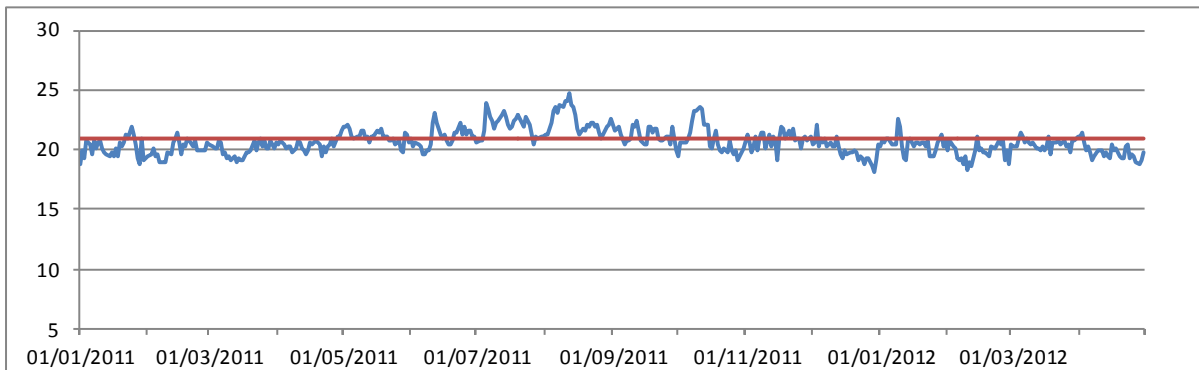
Customer 11



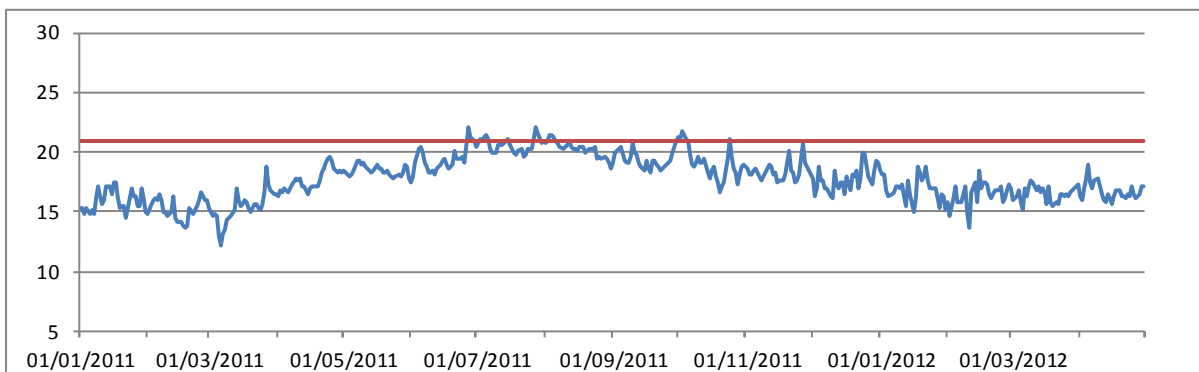
Customer 20



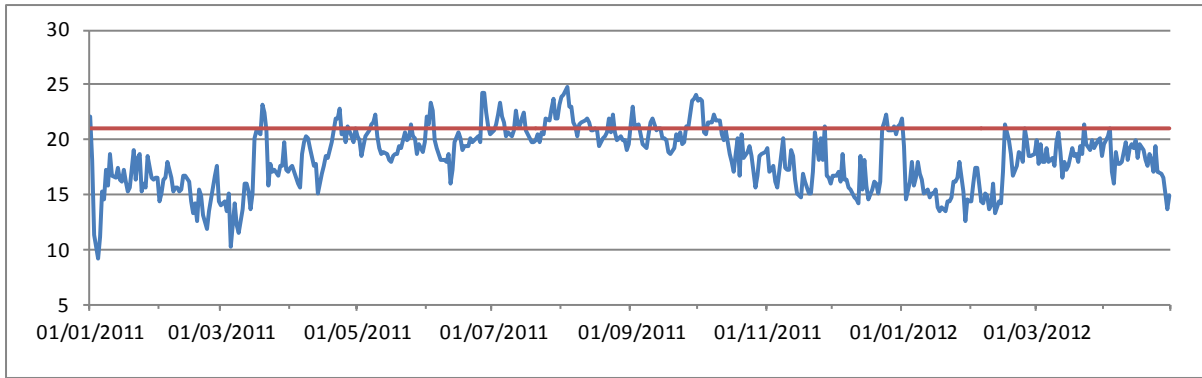
Customer 22



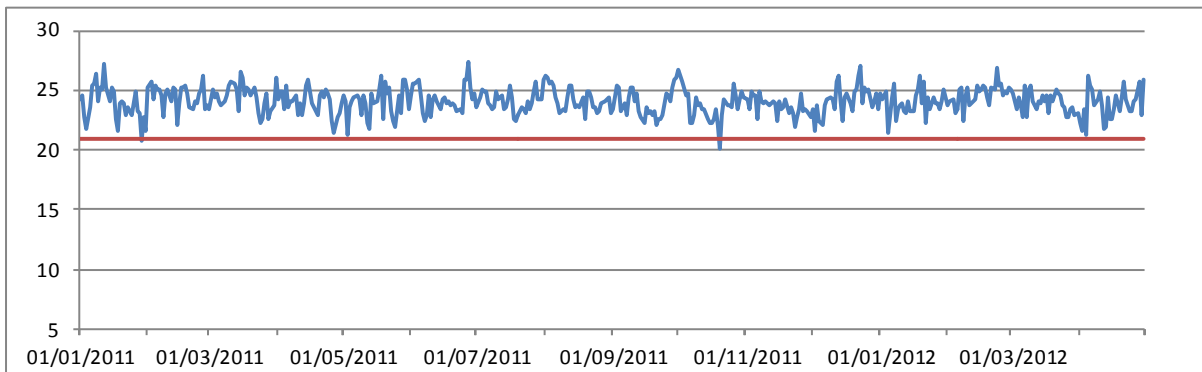
Customer 24



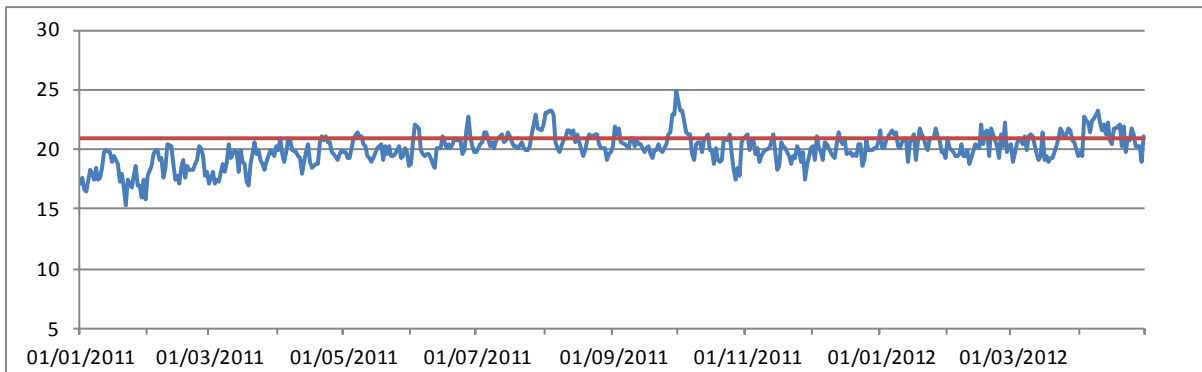
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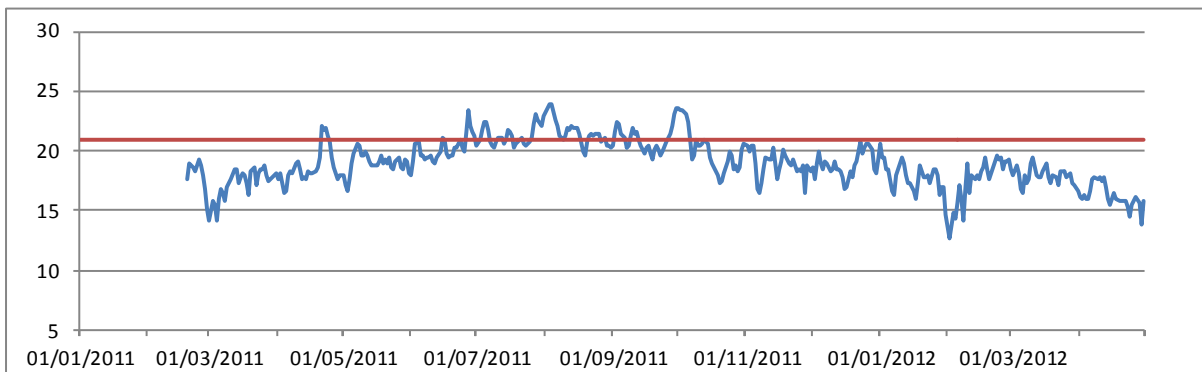
Customer 34



Customer 36



Customer 53



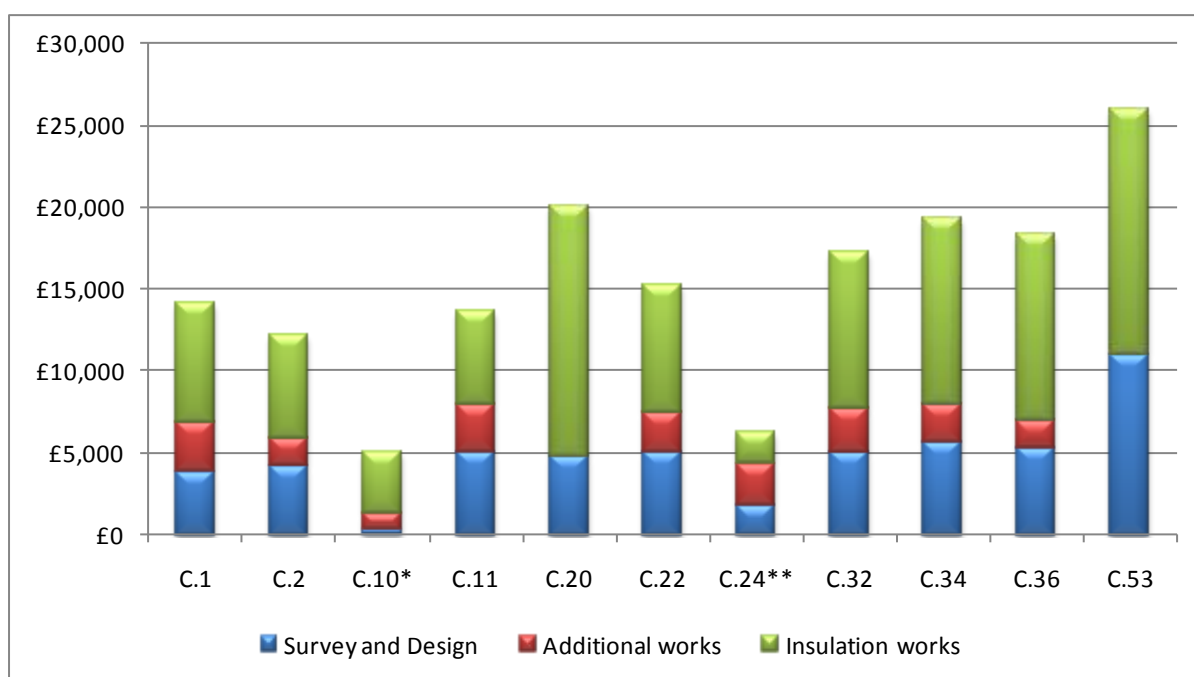
Annex IV – Costs of measures

The scheme manager's final report on the Freedom from Fuel Poverty Scheme includes a detailed breakdown and discussion of the costs of the all measures and associated works. These are summarised below, where:

- Survey and Design costs include planning and building regulation fees;
- Insulation works costs include site supervision by structural engineer.

Note the full breakdown of costs for Customer 20 and 53 were not available at the time of reporting, hence the insulation works costs shown include all on-site work.

Annex Figure 1. Breakdown of costs of insulation works



* Sempatap; ** Mainly internal insulation, with small area of external.

Annex Table 1. Average cost of External solid wall insulation

	Average cost	% of Total
Survey and design	£4,862	31%
Additional works	£2,384	15%
Insulation works	£8,501	54%
Total cost	£15,746	100%

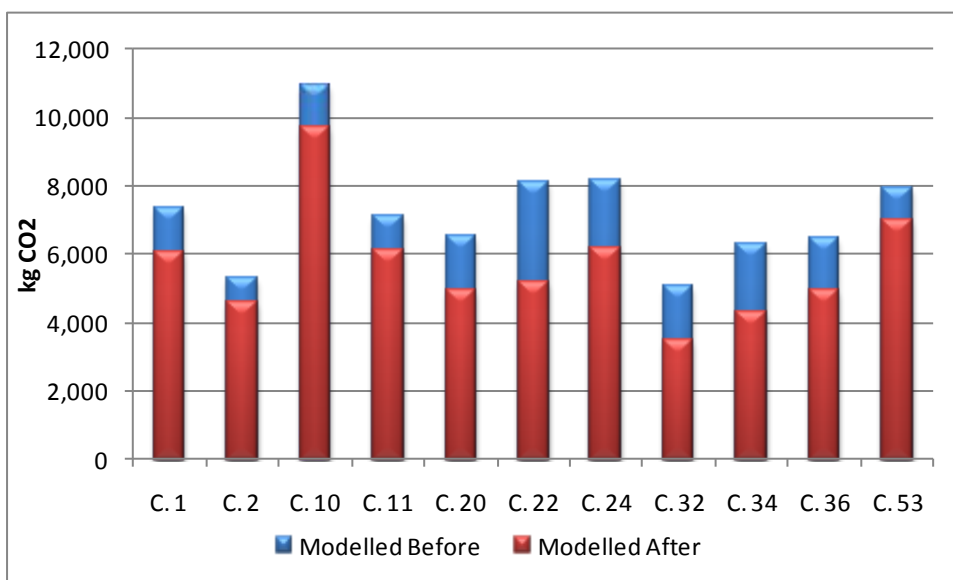
(Costs shown exclude: internal insulation at C.10 and C.24; and C.20 and C.53 where full breakdown not available).

Annex V – Impact on carbon emissions

This evaluation has sought to assess the impact of measures in both the theoretical (SAP-based) and real world scenario. The latter is based on a review of historic bills, direct debit payments and meter readings. In all but two cases²¹ sufficient data has been collated to estimate actual household fuel spend, consumption and carbon emissions (by applying carbon emissions factors to consumption values) prior to the installation of measures. However, due to the delays in the installation of measures, at the time of writing there is insufficient data to assess the actual impact of measures. This will be assessed and results presented in the final project evaluation report in June 2012. The results presented here therefore focus on modelled impacts based on the SAP survey data.

Annex Figure 2 shows the modelled annual carbon emissions before and after the installation of measures for each household (note for customer 22 and 24 this includes a saving in electricity consumption from PV generation, but excludes any additional revenue from FITs). Projected savings represent a reduction of between 11 and 36%.

Annex Figure 2. Modelled household CO₂ emissions before and after the installation of measures



²¹ Two of the households – customers 24 and 53 - had been in their property for less than a year before applying to the scheme, hence there is insufficient historical records. In these cases estimations of actual spend and consumption are presented but should be treated with caution.