Hard To Treat Homes in Northern Ireland

Evaluation Report

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Image on front cover: *Nepal Charm*.

Contents

Executive Summary

In the spring of 2008, NIE Energy, supported by the Department For Social Development Northern Ireland (DSDNI) initiated a project to explore non standard energy saving and renewable energy options for harder to treat properties in Northern Ireland. The overall objective of the HarderTo Treat (HTT) intervention was to apply a "whole house" approach to energy efficiency and renewable energy, and to monitor technical performance and customer satisfaction through a variety of different evaluations. The University of Ulster monitored the *customer satisfaction* aspect of the pilot, and the present report gives details of the results.

After setting the scene in Chapter 1, the report provides a comprehensive review of research into HTT homes in Chapter 2, including consideration of the factors which offer a rationale for treatment, as well as factors which mitigate against treatment. Chapter 3 gives information on the recruitment of the households into the pilot, and the measures that were installed – these included high-efficiency oil- or wood pellet boilers, radiators, internal wall insulation, loft insulation top-ups, and solar panels (solar water heating and photovoltaics). Chapter 4 outlines the research procedures and methods, which are covered in more detail in the Appendices Booklet.

In Chapters 5 and 6, the report evaluates the effects of the intervention through a series of quantitative surveys and qualitative analyses. These are based on baseline data collected before the refurbishment and follow-up data a year later.

The targeting of households for inclusion in the study showed evidence of best practice. In this, the challenge was not simply to locate vulnerable households, but to identify vulnerable households who were *also* able to manage a major refurbishment of their home and new control systems. In this, the recruitment process excelled. Their status as fuel poor was not in question: all were classifiable as being in fuel poverty, with the average being spent on heat and light before refurbishment being 17% of income. They mastered new systems well, reporting little difficulty immediately after refurbishment, and even less difficulty a year later.

Households were very satisfied with the retrofit experience and the quality of the installations; they were also broadly satisfied with the contractors who carried out the work. Overall, the interventions greatly exceeded participant expectations, most particularly thermal comfort and

energy affordability. In addition, participants estimated that their heating bills were 23% lower, and their electricity bills were 6% lower, resulting in an estimated saving of £297 per annum on heat and light. For households who were both vulnerable and on low income, these savings were significant. Balancing the costs of installation (roughly £10,000 per household) against estimated annual savings suggested a cost-neutral outcome provided the installations remained efficient over 20-25 years. The mental wellbeing of participants was significantly improved post-retrofit. Although the study found no effects on physical health it is concluded that this may be the result of the sample being too small for trends in this domain to reach statistical significance. Attitudes to home did not change.

The primary motive for people participating in the scheme was found to be alleviating damp in their home. This was a surprising discovery, since HTT programmes seldom if ever promote the treatment of damp as a primary goal, and this was not part of the current project's objectives. For future programmes, the pilot highlighted the importance of ensuring that householders are apprised of the primary purposes of treatment (i.e. energy savings and thermal comfort).

Four case studies make up Chapter 7, and these highlight the extent to which lack of heat and hot water impinge on the everyday lives of already vulnerable households. One case study captures a lone pensioner who spent his days in the greenhouse because it was warmer than his home. Another describes a busy mother who dreads the morning visit of carers because she cannot heat enough hot water in time for their arrival. Another gives details of the everyday life of a grandmother who heats her bathroom with a small electric fire for 2 hours before being able to take a bath, and worries that her grandchildren might fall into the coal fire downstairs. The challenges of a HTT home emerge from the case studies as both enduring and diverse.

Conclusions are contained in Chapter 8. Overall, homes were made measurably more comfortable for families on low income, and daily routines became more manageable. Whilst prior to retrofit, households had been spending 17% of their income on heating and electricity, this reduced to 14% post-retrofit, and was augmented by significant improvements in the ability to access decent heating and hot water. Participants reported highly significant changes in thermal comfort, both summer and winter. The intervention alleviated the severity of fuel poverty for the households, and significantly changed their perceptions of energy affordability and efficiency.

The report concludes with ten recommendations for future work.

1. Introduction

1.1. Setting the scene

In the spring of 2008, NIE Energy, supported by the Department For Social Development Northern Ireland (DSDNI) initiated a project to explore non standard energy saving and renewable energy options for harder to treat properties in Northern Ireland. A pilot programme was launched to trial commercially available technologies, and assess their potential for reducing the impact of fuel poverty on homes that were difficult to heat. The project targeted *vulnerable* householders who fell outside of the statutory grant provision for other fuel poverty schemes, such as the Warm Homes scheme. Vulnerable households in the context of fuel poverty are those containing people over 60 years old, young children, and/or people living with a long-term illness or disability. To aid recruitment of participants, the partners sought the assistance of many local fuel poverty support agencies (e.g. Northern Investing For Health Fuel Poverty Partnership) who had experience in making referrals to similar schemes.

The overall objective of the Harder To Treat intervention was to apply a "whole house" approach to energy efficiency and renewable energy, and to monitor technical performance and customer satisfaction through a variety of different evaluations. The University of Ulster was asked to monitor the *customer satisfaction* aspect of the pilot, and the present report comprises the results of that exercise.

Primary questions addressed in this report

1. What are the experiences of agencies and householders involved in the delivery of a Harder To Treat refurbishment programme?
2. What are the impacts of a Harder To Treat refurbishment programme on energy efficiency, energy affordability and energy management in the households?
3. What impacts, if any, are to be found on the wellbeing and broader daily living patterns of householders involved in a Harder To Treat refurbishment programme?

The scheme delivered interventions in harder to treat homes which were inhabited by owner-occupiers, all of whom were on low income and vulnerable to the effects of cold and damp. The homes which became part of the trial were mainly detached, older houses, many in open countryside and coastal locations. Some had either no heating, or solid fuel, or electric heating before refurbishment. Most of the homes that were recruited into the trial were inhabited by senior citizens.

1.1.1. The context

To date, studies which have examined the impact and cost-effectiveness of refurbishing harder to treat homes have been limited. Figure 1.1 provides information on studies which evaluated the installation of more expensive technologies in the UK, most of which were installed in Harder To Treat (HTT) homes. The authors of the Figure also note that, amongst "*the 70 projects identified in this study, Northern Ireland and Wales are not well represented*" (EEPH, 2010).

This is not to say that studies based in Northern Ireland do not exist. In a study carried out by Northern Ireland Housing Executive (NIHE, 2008), five HTT homes were identified which were suited to the installation of various micro-generation and renewable technologies. Case studies were based on each of the five homes, which each received a combination of different measures. All householders experienced improved comfort levels and householder feedback about the scheme was 100% positive. Reductions in energy bills were reported in all cases as well as some reported improvements in condensation levels. The project helped raise awareness of renewable technologies and led to the development of the 'CLEVER homes' project which installed 150 solar ventilation systems in Northern Ireland; it also gave support to plans for mainstreaming renewable technologies into Northern Ireland Housing Executive houses. Nevertheless, the NIHE study is now 2 years old, and was based on only 5 homes. The present study has several advantages in that:

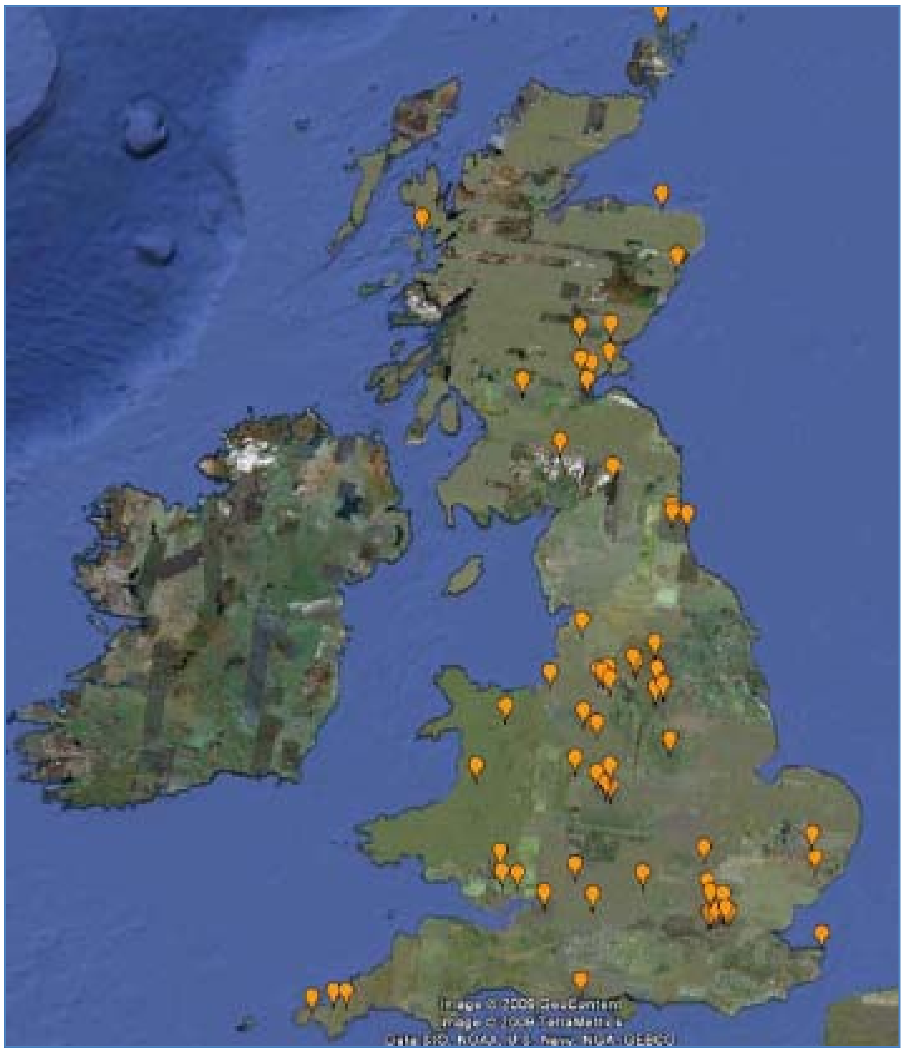
- It is based on a larger sample (n = 34[1])
- It allowed more time between retrofit and evaluation so that measures could bed in
- It provided a more comprehensive evaluation - part of which was independently carried out

[1] 46 households were included in the project to receive practical assistance with 34 taking part in the UU research

- It triangulated perspectives from a range of stakeholders, including NIE Energy as project managers, the householders, and 2 independent researchers.

Given the dearth of in-depth studies of HTT homes worldwide, let alone in the UK, the evaluation seems timely in every respect.

Figure 1.1 Locations in which studies of HTT homes have been carried out



Source: EEPH, 2010

1.2. Defining Harder To Treat Homes

Two key points must be borne in mind when considering how Harder To Treat Homes are defined:

- the concept has never been defined in a way which permits direct measurement

- as a consequence, the term is "measured" through a variety of proxy measures, often in different combinations.

This makes the concept itself nebulous, difficult to quantify, and impossible to compare accurately across time or regions. Notwithstanding this, a consensus has recently emerged. The box below provides details.

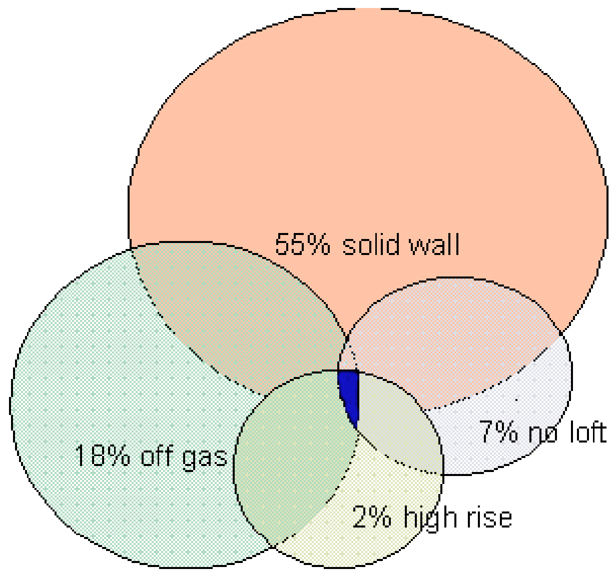
Defining Harder To Treat Homes

The broad definition of a harder to treat home is:
"*A solid walled property which will never be on the gas network*" (NIHE, 2008).

A more detailed definition is provided by the Energy Saving Trust (EST):
"'*Homes that for a variety of reasons cannot accommodate 'staple' energy efficiency measures .....They may include: homes that are off the gas network; homes with solid walls; homes with no loft space; homes in a state of disrepair; high-rise blocks; and any other homes where for technical and practical reasons these staple energy efficiency measures cannot be fitted*" (EST, 2008).

Figure 1.2 illustrates some of the key elements which contribute to a home being hard to treat. It makes clear the extent to which these elements co-exist in all manner of combinations, with only a tiny proportion of homes fulfilling all 4 of the main criteria.

Figure 1.2 Hard To Treat Homes in England and their characteristics



Source: Defra, 2008

Initially the term ***Hard** To Treat* was used, but this is being gradually replaced by the term ***Harder** to Treat*, reflecting sensitivity to the negative implications of the original term. The concept is relatively new, and as yet, there are no data collected at regional or national level on the prevalence of Harder To Treat homes (HTT homes) in the UK.

1.2.1. Proxies for Harder To Treat status

As is evident in the definition above, a harder to treat (HTT) home is defined principally in terms of its energy inefficiency. In the UK as a whole, energy inefficiency is measured using SAP ratings (SAP means Standard Assessment Procedure). The SAP rating of any particular dwelling is derived from a complex algorithm that encompasses measures of a home's heating type, insulation quality, ventilation, and many other measures (Ward, 2008). The SAP is the UK Government's currently recommended methodology for assigning home energy ratings, and assumes standard use by typical occupants (Roberts, 2008). Scores are represented on a logarithmic scale, which ranges from 1 (poor) to 120 (excellent) (BRE, 2005). SAP ratings were introduced in the 1995 Building Regulations and a value of between 80 and 85 was recommended as being acceptable (BRE, 2005). The higher the SAP rating, therefore, the more energy efficient the home . A home which is Harder To Treat is likely to have a low SAP rating as a consequence of the home being unable to accommodate staple energy efficiency measures. The energy efficiency measure which is most often absent in a HTT home is wall insulation (Everett, 2007). This is usually lacking because the walls of a HTT home are solid in construction and cannot be cavity-filled with insulation material. By virtue of its solid wall construction, a HTT home is likely to have been built many generations ago.

Table 1.1 gives details of SAP ratings for dwellings of different ages, taken from the last Northern Ireland House Condition Survey. From this it can be seen that pre-1919 homes are almost three times more likely than average to have low SAP ratings i.e. less than 20. Encouragingly for the present project, Table 1.1 also makes clear that it *is* feasible to attain a relatively high SAP in pre-1919 dwellings, since 7% of them had a SAP higher than 60 at the last House Condition Survey.

Table 1.1 SAP ratings by dwelling age for Northern Ireland homes in 2006

Dwelling age	**SAP < 20**	**SAP 20-39**	**SAP 40-59**	**SAP 60+**
Pre-1919	18%	34%	41%	7%
1919-1944	7%	21%	54%	18%
1945-1964	6%	14%	47%	33%
1965-1980	4%	10%	45%	41%
Post-1980	3%	4%	21%	72%
All	***7%***	***14%***	***39%***	***41%***

Source: NIHE 2008

1.2.2. Trends in Harder To Treat Homes in Northern Ireland

> "*The devolved nation House Condition Surveys need analysis along the lines of that performed by BRE (2008) for the English HTT stock to establish a better baseline understanding of the stock and occupants*". (EEPH, 2010).

As has already been described, HTT homes have low energy efficiency, low SAP ratings, and are most commonly homes which are older than average. However, it is difficult to stipulate exactly how many of them there are in Northern Ireland (or anywhere else in the world for that matter) because "*harder to treat*" is such a poorly defined concept, and data on HTT status has never been collected. The closest proxy available for likelihood of a home being HTT is its age, but this remains nothing more than a proxy: as is evident from Table 1.1 above, 3% of all homes built post 1980 also have SAP ratings under 20, and may therefore be HTT. Nevertheless, age remains a significant predictor of HTT status.

Table 1.2 provides a profile of older houses in Northern Ireland, and how this has changed over time. What is evident from the Table is that significant inroads were made into demolishing old housing stock in the 15 years between 1974 and 1991. In this interval, the percentage of housing stock which was pre-1919 decreased from more than one-third of all houses to 21% of all houses – a reduction of 13%. At that time, demolition may have seemed a cost-effective approach to solving the shortcomings of an ageing housing stock.

Table 1.2. Profile of Northern Ireland's HHTH housing stock 1974 to 2006

Year	**1974**	**1991**	**1996**	**2001**	**2006**
% of homes which were built before 1919	34.5%	21.2%	20.0%	18.0%	16.1%
% of homes which were built between 1919-1944	16.5%	11.3%	11.5%	10.7%	10.1%
% of all homes which were built before 1945	***51.0%***	***32.5%***	***31.5%***	***28.7%***	***26.2%***

Source : NIHE, 2008

However, in the next 15-year period (from 1991 to 2006) fewer older houses were demolished, with the baseline (i.e. 21% of housing stock in 1991) reducing by only 5% in the 15 years to 2006. Hence, at the time of the last House Condition Survey (2006), 16% of homes had been built before 1919.

Combining these oldest (pre-1919) homes with homes built before 1945, Table 1.2 indicates that more than a quarter (26%) of Northern Ireland's housing stock was 60 years old or more at the last House Condition Survey. Whilst this comprises a high proportion of homes, it should be noted that 39% of England's housing stock was 60 years old or more at that time (Ravetz, 2008), so while the problem is a serious one for Northern Ireland, it is even more acute in England.

Unfortunately, the fall-off in demolition rates post 1991 in Northern Ireland, was not matched by an increase in repairs, retrofits, or restoration works to older properties. They were not refurbished instead of being demolished. In fact, the number of older houses which were unfit for habitation rose significantly between 1996 and 2006: from 57% to 63%. Furthermore, Table 1.3 illustrates the changes in average SAP ratings 2001 to 2006 for Northern Ireland, from which it can also be seen that there was no change in the average SAP rating of a pre-1919 dwelling during that time.

Table 1.3. Average SAP rating by dwelling age in 2006 with comparable 2001 data.

	Average SAP 2001	**Average SAP 2006**	**Change**
Pre-1919 homes	37	37	0%
1919-1944	43	46	+3%
1945-1964	50	51	+1%
1965-1980	54	54	0%
1981-1990	61	62	+1%
Post-1990	67	62	-5%

Source : NIHE, 2008

The stasis in tackling older and harder to treat properties since 1991, as evidenced in this section on trends in Northern Ireland, provides convincing support for a need to re-focus efforts on addressing the condition of Northern Ireland's oldest housing stock. Older homes have been neither demolished nor adequately repaired in the last 15 to 20 years.

1.2.3. HTT Homes in Northern Ireland – where and who?

Urban and rural distribution

The 2006 House Condition Survey indicated that the probability of a home being very old (i.e. pre-1919) was more than double in rural areas as compared with urban areas. Council areas such as Armagh, Cookstown, and Fermanagh had especially high prevalence, all of which are predominantly rural areas. However, the highest proportion of pre-1919 housing stock can be found in South Belfast, so a simple rural targeting exercise would miss some important urban areas of high prevalence.

By contrast, three times as many homes in England which are pre-1919 are in urban areas, with the majority being located in London and suburban areas of the South East of England (EHCS, 2006). This comparative data indicates a particular need for regional targeting approaches to the treatment of HTT homes. In Northern Ireland, a rural targeting program seems strongly indicated, but less so in England. Despite this, the Centre for Sustainable Energy (CSE) in Bristol evaluated the challenges raised by hard-to-treat homes in England, and concluded that the problem is sufficiently extensive in rural areas of England for new approaches to targeting the rural fuel poor in England to be urgently required (CSE, 2006). CSE's view is that, although the problem is more common in urban areas, it is harder to locate in rural areas. The same almost certainly applies in Northern Ireland. The Centre recommends mapping available data by Census Output Area (COA) to identify pockets of rural need; they recommend that these COA maps are then combined with a community-based local initiative to encourage newly identified beneficiaries to participate (COA's typically contain about 125 households and are the smallest unit commonly deployed for census-based demographic analysis).

There is some evidence that the rural predominance of HTT homes may create unique challenges for a refurbishment programme in the UK. Among these challenges include the value rural HTT householders place on their traditional home and its heritage, their relative inexperience of having their home altered, and the high costs associated with carrying out work in a home of such vintage.

<u>The inhabitants of Harder To Treat Homes.</u>

The 2006 House Condition Survey suggests that income is a poor predictor of the likelihood that a household will be living in a HTT home. In 2006, roughly a third of HTT homes were occupied by people of high income (annual incomes of £30,000 or more), a third were lived in by households with a modest income (between £10,000 and £19,999), and a third were occupied by households with low income (less than £10,000 per annum). This highlights the importance of using fine-grained and multi-factor recruitment techniques for targeting those most in need of subsidy and assistance.

There is, however, some evidence of pattern in terms of household composition. Among the population as a whole, 13% live in HTT homes. However, elderly people are over-represented (18%) and lone parents are under-represented (11%). There are no unusual trends for families with children (13%) or lone adults under 60 years old (14%). There is also little to distinguish

HTT homes from other homes in terms of religious affiliation (14.2% of Catholic families live in pre-1919 dwellings, and 14.2% of Protestant families).

1.3 Tackling Harder To Treat Homes – the rationale

The rationale for refurbishing harder to treat homes is multi-dimensional, and includes:

- impacts of treatment on regional carbon emissions
- reductions in regional fuel poverty rates
- improvements in people's attitudes to their home and its upkeep
- improvements in the health of people living in HTT homes.

Each of these is considered here.

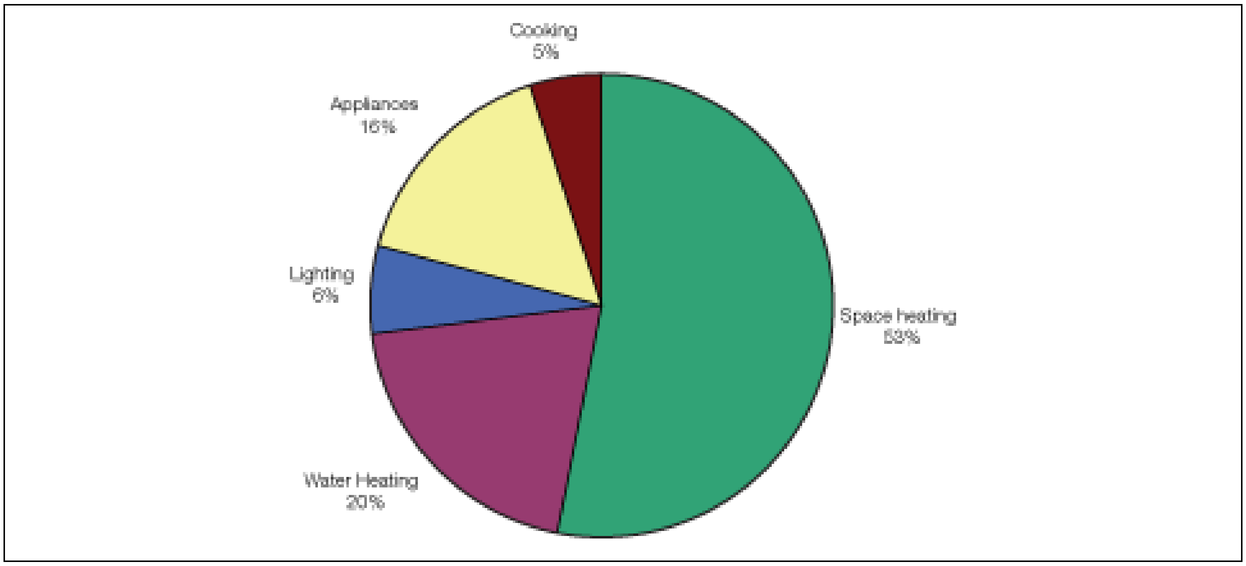
1.3.1. The rationale: Carbon reduction

The scientific consensus at government level is that the UK must cut carbon emissions by 80% by the year 2050 in order to avoid dangerous climate change (Green Futures, 2008). By 2020, domestic carbon emissions have to be reduced by nearly 9MtC (from a baseline of 40MtC) to meet the objectives of the Climate Change Bill and by 31.6MtC by 2050 (Boardman, 2007).

The Sustainable Development Commission estimates that 70% of UK's 2050 housing stock has already been built (SDC, 2007). Therefore, the adaptation of existing housing stock is crucial (Roberts, 2008) and the need to retrofit these existing homes on a massive scale is clear (Jenkins, 2010). As will be illustrated in Chapter 2, retrofit is considered the more appropriate option since building new homes is carbon intensive and carries further environmental impacts (SDC, 2007).

Figure 1.3 illustrates the sources of household carbon emissions, and shows that the provision of space and water heating is accountable for 73% of domestic emissions (DCLG, 2006). Given that this Figure represents all of the UK, and that Northern Ireland relies much less on cleaner sources of energy such as gas, the proportion of household carbon emissions from space and water heating in Northern Ireland is likely to be greater still. In addition, there is a significantly greater need for space heating in Northern Ireland given it is one of the coldest and most northerly regions of the UK. A recent analysis of average temperatures in Northern Ireland in the last 25 years indicated that there were fewer than 10 days per annum when temperatures were high enough for heating not to be required in the average home i.e. days with a daily average temperature of 15.5 ^{0}C or higher (Liddell, Morris & McKenzie, 2010). Adaptations to existing housing such as retrofitted insulation, upgrading boilers, and harnessing renewable technologies could, therefore, play a significant role in reducing domestic emissions UK-wide, but even more so in Northern Ireland.

Figure 1.3 Domestic carbon emissions – 2005



Source: DEFRA (taken from DCLG, 2006)

In terms of carbon savings which might accrue from the application of these refurbishments, Table 1.4 indicates that a total of 12.7 MtC per year could be saved by adopting a package of wall insulation, loft insulation, solar photovoltaics, and solar water heating for all suitable UK homes. This saving in carbon would supercede the 2020 domestic carbon target of 9MtC to meet the objectives of the Climate Change Bill.

Table 1.4. Domestic Efficiency Measures and carbon-saving potential

Measures	**Carbon saved (kgC/yr)**	**Potential homes ('000) †**	**Potential carbon saving (MtC/yr)**
Cavity wall insulation	242	8,500	**2.1**
Loft insulation (full and top-up)	190	6,186	**1.2**
Solid wall insulation	694	7,479	**5.2**
Solar photovoltaics	249	9,892	**2.5**
Solar water heating	88	19,330	**1.7**

Source: BRE, 2005

It should be noted that the potential savings on Table 1.4 are based on a typical 3-bed semi-detached property. The figures for micro-generation in particular are subject to a high degree of variability and uncertainty and should therefore be treated as indicative only. The savings shown are gross and take no account for rebound or comfort taking (estimated to be up to 30% of potential savings).

It must also be noted that these calculations by government and statisticians assume historically stable levels of carbon consumption over the next 10 years. Given warming temperatures in the South of the UK, Tarbase (2010) estimates that many homes in that region are on the threshold of investing in air conditioning, which is predicted to become a common household commodity in the next 20 years. If so, carbon emissions will increase notably over current baselines as a result of the added energy burden of air conditioners.

1.3.2. The Rationale: Reducing levels of Fuel Poverty

Northern Ireland's policy on climate change is committed to addressing fuel poverty in its implementation (Arkell et al., 2007). This reflects the fact that – as well as carbon emissions – a major problem arising from harder to treat homes is the likelihood that families living in them will experience fuel poverty.

A number of different definitions of fuel poverty are in use, but the definition that is commonly used in the UK policy context is:

"Fuel poverty occurs when a household ***needs to spend*** *more than 10% of their income on energy in order to maintain an acceptable level of heat throughout their home"* (DSDNI, 2004).

An acceptable level of heat is defined by the World Health Organization as 21°C in the living room and 18°C in other occupied rooms (WHO, 2007). As Boardman (2009) recently pointed out, an important aspect of this definition which is often overlooked, is that few families can afford to spend more than 10% of their income on energy. The corollary of this is that households who *need to spend* more than 10% of their income on energy find this unaffordable and so are compelled to live in damp and cold conditions. The risks to human health which cold and damp houses generate, especially for the elderly and the young, comprise the primary justification for Fuel Poverty Strategies throughout the United Kingdom (Liddell & Morris, 2010).

The cost of maintaining healthy temperature levels in 'Harder to Treat' buildings is significantly higher than in other homes (NIHE, 2008), and residents who would otherwise manage energy bills in a more efficient home often experience fuel poverty through no fault of their own (EST, 2008). In such homes, the most popular method for reducing energy costs, as reported by the Northern Ireland Housing Executive, is either turning off heating altogether or turning off heating in unused rooms of the house (NIHE, 2008). In addition, EST reports that low-income householders sometimes believe that extractor ventilation fans are allowing expensive warmth to escape from their homes, and so may switch off or disable them. All of these actions result in not only a cold dwelling , but one with high moisture content and a high probability of surface condensation (EST, 2007). This condensation leads to the saturation of wall and ceiling finishes, which can subsequently result in mould growth (EST, 2007). Left unchecked, mould created by condensation will contribute to disrepair within the property and increase its HTT status (NIHE, 2008). More importantly, according to the WHO the *combination* of cold and damp is particularly risky for human respiratory health (WHO, 2007).

EST (2007) outlines the most effective response to dealing with surface condensation which involves a combination of four measures:

- Insulation to raise the temperature of the internal air and internal surface temperatures of walls and ceilings
- Improved heating efficiency to enable householders to heat their homes properly at a lower cost
- Controlled ventilation to remove moisture from the internal air
- Advice to help the occupants understand how to use their heating and ventilation systems.

1.3.3. The Rationale: Improving wellbeing and attitudes to home

In 2008, the Building Research Establishment (BRE) published a study of HTT homes based on the English House Condition Survey. They compared attitudes of residents living in HTT homes with residents of other homes (non-HTT). It was the first attitudinal study of its kind. A synopsis of results is contained in Table 1.5. These data indicate that residents of HTT homes are much less likely to be satisfied with their home heating and insulation, and are also less likely to feel satisfied with their home. They were also less likely to express satisfaction with their home overall. However, they consider the affordability of their heating in the same ways as do residents of non-HTT homes. This may be as a result of having become inured to the extreme costs of heating their home, or because they make determined attempts to cut costs.

Table 1.5. Comparison of attitudes amongst residents of HTT and non-HTT homes

% Very satisfied	Heating efficacy	Insulation efficacy	Affordability of heating	Satisfaction with home
HTT Homes	59%	35%	32%	51%
Non-HTT Homes	71%	49%	34%	56%

Source: BRE, 2008

In addition, the BRE report indicated that the proportion of HTT residents who reported being unable to keep comfortably warm in their living room in winter was almost double (9%) that of residents in non-HTT homes (5%). Two points are notable from this finding. First, the implications of this for the health and wellbeing of people living in HTT homes is another important part of the rationale for tackling HTT homes. Second, whilst almost double for HTT residents, 9% of residents being unable to heat their living rooms adequately in winter is a relatively low figure. Research from Northern Ireland indicates that the figure is at least 30% (Yohannis & Mondol, 2010); the importance of implementing HTT improvement packages is much greater in regions like Northern Ireland than it is in many other parts of the UK.

1.3.4. The Rationale: Protecting human health

In the UK winter of 2007/8, it is estimated that over 28,000 more people died during the winter than during the summer months (Boardman, 2009). Cold indoor temperatures are a major contributor to this excess winter death rate (Wilkinson et al., 2007). The UK is not alone in manifesting such a significant health risk associated with cold. Surprisingly, though, the highest number of excess winter deaths do not occur in the coldest countries of the world. Instead, countries such as Italy and Greece have significantly higher excess winter mortality rates than do countries with much colder winters, such as Finland and Sweden. This is thought to be, at least in part, a consequence of Mediterranean homes being less well protected from cold and damp conditions in winter (Barnett, et al., 2005). In such regions, tiled floors, high ceilings and French windows help people to stay cool in hot summers, but offer little protection from cold in the few winter months of each year.

It is because of these risks to health, and to life itself, that the UK developed a Fuel Poverty Strategy leading up to the new millennium. The Strategy declared its first priority as being: "*...to ensure that …no older householder, no family with children, and no householder who is disabled or has a long-term illness need risk ill health due to a cold home.*" (BERR, 2001, p.10).

As indicated in this quote, the health impacts of living in a cold and damp home are to be found across the life-span, amongst the very young as well as amongst the more mature members of society.

Five major research evaluations of housing and human health have recently been published in scientific journals (Barnes et al., 2008; Frank et al., 2006; Green & Gilbertson, 2008; Howden-

Chapman et al., 2007; Walker et al., 2009). These have looked at the impacts of cold and damp homes on health and wellbeing. There are patterns of consistent agreement as to what these impacts seem to be.

Firstly, the studies indicate that tackling fuel poverty is not a major way of curing physical illnesses among older people. This should not surprise us. The adverse effects of living in a harder to treat home for 20 or 30 years will accumulate over time, and become progressively more difficult to treat as people age. It is unlikely that improving conditions in their last years of life will generate clinically proven impacts on their health. However, people in general consistently report feeling better in themselves after their homes are refurbished, and this emerges from almost every study in which mental health and home energy efficiency improvements have been investigated. This suggests that *wellbeing and mental health* may be notably improved by living in warmer and drier conditions.

Evaluators of England's Warm Front scheme speculated about why mental health seemed the prime beneficiary of fuel poverty interventions. If heating becomes more affordable, they argued, householders might obtain significant relief from the stress associated with debt or the threat of it. This, in turn, could significantly reduce vulnerability to borderline anxiety and depression. Based on these findings, the Warm Front evaluators concluded that a reduction in perceived financial strain was likely to be the "*…main route from Warm Front to health gain*" (Green & Gilbertson, 2008, p. 19). Evidence such as this underlines the broader social and emotional significance which fuel poverty has for people who experience it, over and above the impacts it may or may not have on their physical wellbeing.

> In the Chief Medical Officer's most recent Annual Report for England, these findings are echoed in the quote:
> "*Persistent cold, together with the financial worry of being able (or unable) to afford adequate heating, can cause depression. People in fuel poverty are 2.5 times more likely to report high or moderate stress than those able to afford their heating*."
> (CMO, 2009, p.35).

Effects on physical health are more notable among young people, especially children with a pre-existing respiratory health condition. Rates of school absenteeism are significantly lower for these children after their homes are made warmer and drier (Free et al., 2009). This may be as a consequence of improvements in respiratory health, since another of the evaluative studies found that 15% of children in cold and damp homes had respiratory problems, compared with 6% of children that had never lived in homes that were cold and damp (Barnes, et al., 2008).

Health impacts among babies have also been noted. In a North American study, infants from low-income families who received a winter fuel subsidy gained weight more normally and were less likely to attend hospital than were infants whose homes had not received a fuel subsidy (Frank et al., 2006).

Only one of the studies explored the health impacts of living in a cold and damp home on teenagers, but its results are worth noting. When the contribution of many other factors had been accounted for, cold and damp conditions were significantly associated with “multiple mental health risk” among teens (Barnes, et al., 2008). For example, 13% had truanted (compared with 3% in homes with affordable warmth), 10% had been expelled/excluded from schools (compared to 3% in homes with affordable warmth), and 7% had been in trouble with the police (2% in homes with affordable warmth).

Liddell & Morris (2010) conjectured on how these surprising results might be explained. More than most other age groups, teenagers seek time away from family members, either for solitude or to spend private time with their peers. One of the more common consequences of fuel poverty is that families confine heating to rooms which are used by most of the household most of the time, e.g. kitchens and living rooms. Where heating is limited to public spaces, and family members cluster together in them, there may be fewer opportunities for privacy and personal space. Since family relationships often come under strain during adolescence, crowding could be especially challenging at this age. Evidence in support of this speculation can be found in some of the study’s other findings. Children in homes that lacked affordable warmth were less likely to have a quiet place to do homework, and 10% felt unhappy in their family compared with 2% in the group that had affordable warmth. They were also more than twice as likely to have run away from home. Factors such as these may lead to adolescents from harder to heat homes choosing to seek privacy and respite in public spaces such as parks, shopping precincts, or sports halls. These are venues where they may be more vulnerable to anti-social behaviours and other mental health risks. The finding that 27% of teenagers from homes without affordable warmth were worried about bullying and mugging, compared with 15% of teenagers who lived in warmer homes lends some support to this possibility.

With regard to the impacts of treating HTT homes and the potential benefits this might have for human health, it seems safe to conclude that there is potential for measurable gains in adult *perceptions* of physical wellbeing. Actual c*linical* impacts on adult physical health are less likely. However, significant effects on the physical health of the young are much more in evidence. Additionally, mental health impacts emerged as surprisingly strong amongst adolescents.

Taken as a whole, the health impacts of tackling fuel poverty appear noteworthy, especially since these impacts derive – not from a new drug or new therapy – but from improvements in wall and loft insulation, and the introduction of a more efficient heating system.

2. Factors which mitigate against the impact of treatment

In interventions like the present one, it is important to balance the potential advantages of intervention against factors which may negate positive impacts. Four mitigating factors are relevant here:

- Demolition versus repair as a cost-effective strategy
- Length of payback period
- Rebound effects
- Continued use of old technology

2.1. Demolish or repair?

Northern Ireland's historical trend in leaving HTT homes standing but not refurbished raises the question of whether it may have become more cost-effective to demolish and rebuild pre-1919 homes, or whether they are still capable of cost-effective refurbishment. Table 2.1 presents data on the average cost of repairing a pre-1919 home in Northern Ireland, at 2006 prices. The formidable cost of completing even the most urgent repairs in older dwellings becomes apparent from this table. Given that more than three-quarters (76.8%) of pre-1919 homes are in need of repair to bring them to an acceptable standard for habitation, and each will cost 14 times as much to repair as a post-1980 home, the pressures towards demolition appear strong within an economic model.

Table 2.1 Cost of urgent repairs to homes of different ages in Northern Ireland

Dwelling age	Average cost of urgent repair	Number of homes in need	Percentage of stock in need
Pre 1919	£5,058	87,440	76.8%
1919-1944	£1,173	48,670	68.5%
1945-1964	£429	78,740	55.7%
1965-1980	£322	84,230	49.8%
Post 1980	£363	66,770	31.9%

Source : NIHE, 2008

Table 2.1 considers only the cost of "urgent" repair, which comprises repairs to elements of a building which are seriously hazardous to inhabitants. In fact, the cost of retrofitting HTT homes involves much more than repairing the most hazardous elements. Jenkins (2010) quotes Tarbase data which estimate costs averaging £31,900 per retrofit for HTT homes in England. If limited to only fuel poor homes throughout England, and further limited to those most needy of all (i.e. in social housing), Tarbase estimate a cost of £17.5 billion. If these costs were devolved entirely to home-owners, Tarbase equate the costs to 3 weddings, or 10 foreign holidays, or 4 new cars – these costs far exceed what customer surveys suggest that householders would be prepared to pay (Tarbase, 2010).

However, if carbon emissions are factored into a cost-benefit analysis, evidence suggested that a HTT home's carbon emissions would be cut by an average of 57% after refurbishment (Jenkins, 2010). This could make refurbishment of HTT homes both cost- and carbon-effective in the longer term.

Recent evidence from an evaluation funded by the Building and Social Housing Federation compared the cost of "*demolition and rebuild*" with the cost of retrofitting HTT homes. The evaluation distinguished between:

- "*embodied carbon*" (i.e. what would be used in the demolition and rebuilding process)
- "*operational carbon*" (i.e. what the building itself would emit after intervention).

The report concluded that, over a 50 year period, the embodied carbon load of newly built homes (which have to be constructed from scratch) was more than three times that of the old home remaining in place with a retrofit. Although the new replacement home would be more energy efficient, it would not be sufficiently more energy efficient to recoup the embodied carbon burden over a 50 year period (EHA, 2008). In some cases, the study points out, pre-1919 retrofitted homes in England had been made more energy efficient than many homes built since the 1990's.

> The 2008 EHA report concluded that it would cost more in new embodied carbon emissions to demolish the old and build a new home than could be recouped in 50 years from the energy efficiency savings offered by the new home.

In addition, there is more to the decision-making process than economics. Many residents of HTT homes cherish a multi-generational heritage embodied in their family home, whilst many more dream of achieving such a heritage for their own children. This means that a large proportion of householders could be expected to resist demolition as a solution to their energy efficiency needs, regardless of carbon. In this context, it is fortunate that the EHA report suggests that refurbishment can be more cost-effective than demolition, given the many human rights issues which might be raised by enforced demolition of older properties.

2.2. Length of payback period

Households that participated in the present intervention received refurbishments free of charge, since this suited the purposes of the pilot. However, any decision to upgrade an intervention of this sort to regional scale would require length of payback period to be factored into a cost-benefit analysis. The 'payback period' of an energy efficiency measure is defined as the length of time necessary to recover the installation costs of the measure from savings on energy bills

(NIHE, 2008). The easiest way of measuring cost-effectiveness of energy saving measures is by "simple payback" where the initial expenditure on the measure is ***x*** and the annual cost saving is ***y***, the payback will be ***x/y*** years (Dixon & Gupta, 2008).

Many retrofit measures seem less advantageous when viewed in terms of simple payback times (Lloyd et al., 2008). Canadian studies indicated that payback periods are often 20 years or longer in HTT homes, because refurbishment needs to be wide-ranging and is likely to include expensive technologies. This makes payback issues significantly off-putting for those householders who are required to invest their own income or investments in a retrofit (Guler et al., 2001). The issue gives credibility to local area-based plans for treating HTT homes, rather than scattered treatments in randomly distributed households, since area-based strategies invoke economies of scale. There is considerable potential for an areas-based strategy, since the Energy Efficiency Partnership For Homes recently estimated that there are more than 10 million HTT homes in the UK, many of them in clusters such as terraced developments and high-rise apartments, (EEPH, 2010).

EEPH estimate that the most efficient payback option involves "whole house" solutions for HTT homes, where all possible refurbishments are installed at the same time. The calculations on which they base this assessment can be seen in Figure 2.1. Whilst installation of some single measures (even expensive ones such as an efficient boiler) offers good returns on NPV (net present value), the installation of other measures requires a much longer payback time. However, by installing all of these measures at the same time, as a package, EEPH argues that the payback time – relative to total NPV – can be optimized.

The phrase "whole house" solution should not be taken to imply that there is a single "whole house" solution i.e. a one-size-fits-all set of measures for HTT homes. On the contrary, EEPH recommends a bespoke approach in which each HTT home is treated individually, with a tailored package of measures that suit its unique circumstances. Scottish assessors concur that the only workable solution for many HTT homes will be a tailored package for each home or small cluster, and the Scottish government is currently running a 2-year pilot to test this option (Restrick, 2009). This bespoke approach was also followed in the work undertaken for the present Northern Ireland Pilot.

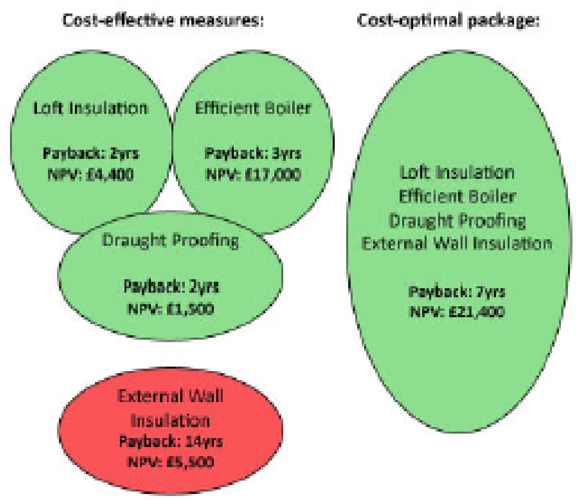
Figure 2.1 Payback periods for cost-effective measures – individual or packaged approaches.

Box 1: Whole-house, cost-optimal packages.

Current mechanisms that provide energy efficiency advice, such as the Energy Performance Certificates, typically recommend individual measures that are 'cost-effective' – typically measures that pay for themselves through energy savings within seven years. This approach rules out many measures which pay for themselves within their lifetimes, including many measures suitable for HTT homes.

The HESS consultation (DECC, 2009) suggested that future refurbishment interventions should "*include all the measures available, at the time of assessment, that are suitable for a property and which pay back through energy bill savings over their lifetime when installed as part of a coordinated package.*" This is in keeping with the European Commission's proposals for the recast of the Energy Performance of Buildings Directive which call for the implementation of 'cost-optimal' improvements to existing buildings. ECEEE (2009) provide a detailed account of the 'cost-optimal' definition.

Whilst 'cost effective' looks at simple payback, 'cost optimal' looks at the lifecycle costs or net present value of an improvement package. The cost-optimal solution is the one which gives the greatest return when subtracting the installation costs from lifetime energy savings. As the example above shows, the cost optimal package definition allows the inclusion of a wider range of expensive measures alongside cheaper measures – external wall insulation would not pass the traditional 'cost-effective' test, but if installing all of these measures as a package, the addition of EWI increases the NPV.



Source: EEPH, 2010

In summary, the current evidence base suggest that the most effective way to tackle the problem of payback periods is to implement a bespoke whole house solution tailored to each HTT home.

2.3. Rebound effects

Energy improvements in buildings often underperform, in that they fail to deliver the levels of improvement in domestic energy consumption that policymakers aspire to. This is primarily attributable to the so called "comfort factor" of householders, where improvements in energy efficiency are converted by householders into maintaining higher temperatures. They elect to heat their homes to a higher temperature, rather than to take improvements in savings on utility bills (Hong et al, 2007). Other researchers refer to this as a 'rebound' effect (Herring & Roy, 2007). It reflects a general tendency among consumers to use more of any product or service if it becomes cheaper (Dimitropoulos & Sorrell, 2006). As a consequence, energy efficiency measures usually result in improved thermal comfort for householders, sometimes instead of reduced carbon emissions (Jenkins, 2010).

Rebound effect may be seen in the ambient temperatures which UK residents maintain inside their homes. As can be seen on Table 2.2, this has altered substantially in the past decade, even though there has been little change in outdoor temperatures. Between 1995 and 2005, residents increased their average indoor temperatures by approximately 2^{0}C. During that same period, the percentage of disposable income which householders needed to spend on heating and power dropped by a third: from 4.11% to 2.77% (ONS, 2009). In other words, as the costs of heating declined in that decade, so residents increased the temperatures at which they maintained their homes.

Table 2.2. Outdoor and indoor temperatures: UK households 1995 – 2005

	Degrees Celsius	Degrees Celsius	Degrees Celsius		Degrees Celsius
	Internal temperatures				External temperature
	Centrally heated homes	Non-centrally heated homes	Average		
1995	16.4	13.9	16.1		6.9
1996	17.1	14.6	16.8		5.7
1997	17.4	14.9	17.1		7.3
1998	17.9	15.4	17.6		7.5
1999	17.5	15.0	17.3		7.2
2000	17.7	15.2	17.5		7.1
2001	17.7	15.2	17.5		6.6
2002	18.7	16.2	18.5		7.7
2003	17.8	15.3	17.6		6.7
2004	18.2	15.7	18.0		6.9
2005	18.7	16.2	18.4		7.0

Source: BRE, 2008

It is vital that more is understood about rebound and its deleterious impacts on carbon savings. A number of studies (see Sorrell et al., 2009 for an overview) confirm that the installation of energy efficiency measures encourage occupants to be more active with energy use. The household occupants may believe that since the building is more energy efficient, they need not be as miserly with their general energy usage (Jenkins, 2010). The Warm Front scheme demonstrated evidence of a rise in thermal comfort temperature after low-income houses have been subject to energy efficient upgrades. The mean indoor temperature of 2,500 dwellings was observed to increase from 17.1 to 19.0 °C, resulting in 79% of households reporting thermal comfort as opposed to 36% before the upgrades (Hong et al., 2009). The proportion of dwellings with mean temperatures below 16 °C also fell from 30.2% to 7.2%. These findings help explain why no reduction in energy consumption was observed following the Warm Front improvement.

The Open University monitored the People-Centred Eco-design project in England (see Herring & Roy, 2007), which was an investigation into how consumers used low and zero carbon technologies. Many people left energy efficient heating and lighting on for longer, and only 29% reported lower fuel bills (Herring & Roy, 2007). However, only a small minority (4%) reported that they took the *entire* benefit in higher room temperatures, heating more of the house, or heating the house for longer periods. In most cases the end result of retrofit was both improved thermal comfort and lower costs, which has been corroborated in almost all the studies undertaken on this issue. Furthermore, there is strong justification for ensuring that vulnerable people living in fuel poverty *do* capitalize on opportunities for improved thermal comfort, rather than being encouraged to save money and carbon by maintaining low temperatures in their homes.

2.4. Continued use of old technology

As well as payback time and the rebound effect, there are other limitations associated with retrofit work which may alter the expected reduction in energy use. For example, many of the dwellings improved through the English Warm Front scheme retained their original inefficient room heaters as well as the newly installed heating systems. Since the recipients of the pilot retrofit being evaluated here are largely elderly householders, it is possible that a combination of influences such as unfamiliarity with a new heating system, convenience of old habits, and the psychological comfort of being next to a visible flame may encourage continued use of the original inefficient room heaters as a supplement – or instead of – the retrofitted heating system (Hong et al, 2007).

2.5. Conclusions

It is factors such as these that have made programmes of work which aim to tackle hard to treat properties less popular among regional governments and private investors than many other options for tackling fuel poverty. In England, for example, EEPH (2010) point out that “during EEC2, the last supplier obligation, , not one energy supplier reached the 10% limit on the incentivized measures, with appliances strongly favoured over heating and insulation measures”. There has, as the report points out, been a consistent tendency to invest in immediately cost-effective measures or quick fixes, whilst ignoring other measures which may yield enduring value even though the initial outlay of investment is greater – EEPH refers to these more enduring measures as cost-optimal measures, amongst which are included many elements of bespoke hard-to-treat strategies.

3. The NIE Energy Hard To Treat Study

Recruitment of sample and measures installed

This project was a pilot initiative aimed at helping vulnerable households who fell outside of the statutory provision for fuel poverty programmes which were in place at the time of the initiative. The pilot was expected to focus on isolated rural homes outside of the gas distribution network. Homes were selected using pre-defined criteria to ensure that those in most need were given priority.

3.1. Recruitment of households

Recruitment took place through the normal referral processes and partners for NIE Energy's vulnerable household energy efficiency schemes. NIE Energy contracted Eaga to survey each house to assess its suitability for inclusion in the HTT programme.

In addition, the scheme was also advertised in local newspapers and on websites. A sample of one of the websites which carried recruitment advertisements can be seen in Figure 3.1. It was also hoped that, over the 2-year period of recruitment, refurbishment, and evaluation, several homes would be recruited into the project through word of mouth within neighbourhoods and through families.

3.2. Eligibility criteria

To help identify the households which were eligible for the scheme, a range of criteria had to be met. These were as follows:

- Owner occupied homes
- Homes that were primarily heated through electricity, Economy 7 storage heaters, solid fuel heating, or have no central heating.
- Homes that could not be connected to the natural gas network.
- Preference would be given to properties with solid walls which could not be cavity insulated, and to isolated rural, exposed or coastal properties which might be harder to heat due to their location.

Figure 3.1 Sample recruitment weblink

Hard to Heat Homes

Do you know any 'hard to heat' homes which would benefit from an energy makeover? If so then NIE Energy and DSD may be able to help and are keen to hear from you.

communityni
connecting the voluntary sector

Gwyneth Scott
CommunityNI.org
22 August 2008 – 8:28am 0 comments

Hard to Heat homes is a new pilot initiative which has been developed by NIE Energy and DSD in an attempt to reduce the impact of fuel poverty by exploring energy efficiency and renewable energy options for approximately 60 'hard to heat' properties throughout Northern Ireland.

The pilot project is identifying alternative energy systems for 'hard to heat' homes in addition to a package of energy efficiency measures. The 'hard to heat' homes for the programme are expected to be rural, isolated or exposed homes but they will be selected in a way which helps us to ensure that those in most need get our assistance.

We are particularly keen to support low income 'hard to heat' homes so our selection criteria reflect this focus. We would be grateful for your help in identifying potential properties to take part in the programme – we do not want to actively promote the 'hard to heat' homes programme (it must not appear in any promotional material or be advertised in any way) but would like you to flag up potential properties to Wilma Stewart in NIE Energy (Wilma.Stewart@nieenergy.co.uk or 028 9068 5071).

We are keen that referrals are only made to this pilot project if a home visit has been carried out. Following the initial referral from you, EAGA will undertake a detailed technical survey and householder follow up.

You should not discuss the programme with any householders – this will be done when the EAGA surveyor visits so that we can carefully manage expectations while also attempting to identify those in most need of our assistance. We are planning to install a package of measures in each house which will include:
Loft insulation up to 270mm
Hot water cylinder insulation
4 energy saving light bulbs
Oil condensing boiler and controls or wood pellet boiler and controls
Solar water heating or biomass room heater or solar photovoltaics or solid wall insulation.

In addition, the following vulnerability criteria were applied:

- Households of single people with an income/pension <£12,000 gross OR

- Households of couples or single parents with an income/pension <£18,000
AND
- Older or disabled people OR

- Children under 16 at home OR

- Health issues (referral had to be accompanied by a health professional letter).

For some of the refurbishment measures, there were additional eligibility criteria:

Solar water heating – This was a solution deemed suitable for only some types of household, particularly families with young children that would require an above-average amount of hot water for washing, bathing, and laundry. It also required a south facing roof that was not overshadowed, with space for panels, high hot water demand, and space for a twin coil cylinder.

Biomass boiler – Customers had to be assessed as able to manage de-ashing and weekly management of the system. This also required adequate space for a pellet store and boiler, as well as easy access for a pellet delivery vehicle.

Biomass stove – Customers had to be able to manage loading and operation of the stove. This also required adequate space for storage of pellets and external wall for flue.

Solar photovoltaics – Customers with a high electricity demand were deemed more suitable for this measure. It also required a south-facing roof not in shadow, and space for a number of panels.

Internal solid wall insulation – Homes had to have solid walls, and customers had to be willing to accept above-average internal disruption to their home.

All participants also had to be willing to take part in a variety of monitoring and evaluation activities, including the installation of monitoring equipment, interviews before and after installation, and an anonymised customer service survey.

3.3. Measures available for the HTT Homes pilot

As is evident from the previous section, there was a range of measures which could potentially be used in any one home, and the choice depended largely on the type of customer and the type of home. The choices were made jointly between the HTT home project management team, the surveyors, and the customer. Table 3.1 outlines the mix of technologies that were considered for each home.

Table 3.1 Mix of the major technology options and benefits. .

Technology	Benefit
Solar photovoltaics (PV)	Generates electricity which off-sets household electricity demand.
Solar water heating	Provides hot water – particularly beneficial for households with a high hot water demand.
Oil condensing boiler	Oil central heating system.
Biomass boiler	Wood pellet central heating system.
Biomass room heater	Provides heat for an individual room.
Solid wall insulation	New generation internal insulation for solid walls.

In addition, each home was provided with the following standard items, as and where appropriate:

- loft insulation up to 270mm
- hot water cylinder insulation
- 4 energy saving light bulbs

Details of the more advanced technologies are given overleaf.

3.3.1 Wall insulation

> *"A number of new developments being made by the insulation industry have the potential to reduce the fixed costs of exterior and interior wall insulation. All opportunities to engage and promote these developments should be taken"* (EEPH, 2010).

A key contributor to a home being harder to treat is the quality of its wall structure (NIHE, 2008). Improving efficiency usually involves improving wall insulation (DCLG, 2006). Existing solid-walled dwellings are sometimes considered 'thermally irredeemable' (Roberts, 2008). However, in cases where external insulation is possible, solid-walled dwellings can outperform cavity-walled dwellings (Lowe, 2007). Solid walls are an opportunity for, rather than a barrier preventing energy efficiency.

Table 3.2 gives details of wall insulation in Northern Irish dwellings 1996 to 2006, and indicates the extent to which wall insulation has already been aggressively targeted in the region. The prevalence of insulation more than doubled during the decade, although most of the increase was attributable to cavity wall installations. In fact, in 2006, only 8% of homes had any form of solid-wall insulation (external or internally dry lined), even though more than 16% of homes were built pre-1919 and were therefore almost certainly largely in need of it. Overall, more than 20% of homes had no form of wall insulation at all. It is likely that many of these had HTT status.

Table 3.2 Wall insulation in Northern Irish Dwellings 1996- 2006

	1996	**2001**	**2006**
Cavity wall insulation	36%	50%	62%
No wall Insulation	53%	39%	22%

Source: NIHE, 2008

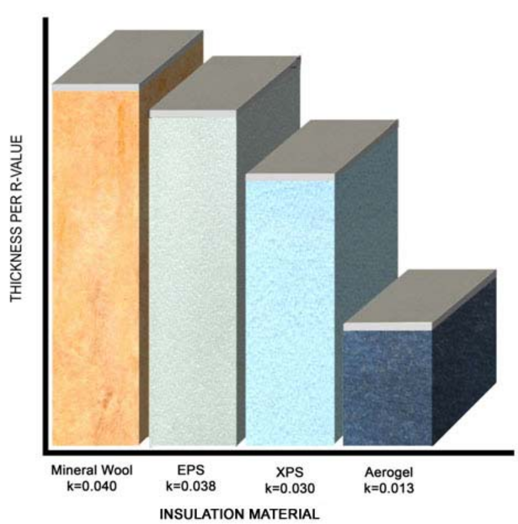
In the present project, *internal* wall insulation was the treatment of choice. It does not alter the appearance of outside walls although it slightly reduces the floor area in the rooms of the building. In terms of disruption to the household, the skirting boards, door frames and external fittings need to be removed and reattached to the new wall surface. This new wall surface can make it difficult to fix heavy items to inside walls – although special fixings are available for this purpose.

There are two main ways to insulate a solid wall internally – either with rigid insulation boards**,** or a stud wall. The current study used Spacetherm® which is a type of insulation board.

3.3.1.2 Spacetherm F (Aerogel)

Spacetherm F, which is also known as Aerogel, is a high performance thermal laminate, which consists of a layer of insulation (Spacetherm) on a Fermacell laminate. The insulation layer itself is made up of flexible aerogel blankets. The laminate is used to line interior walls prior to plastering and decoration. These lining boards achieve similar thermal performance to traditional plasterboard laminates, but are very much thinner so that less space is taken up by the insulation. The product is approved by OFGEM as an Energy Saving Measure. Figure 3.2 illustrates the relative thickness of Spacetherm and more conventional insulation materials. When compared with mineral wool, for example, Spacetherm has treble the thermal resistance (i.e. r-value).

Figure 3.2. Comparison of Spacetherm (Aerogel) and more conventional insulation materials



Several pilots of Spacetherm had already been undertaken before it was adopted for the present pilot. In February 2007, a trial was undertaken in houses owned by Angus Council in Scotland. The amount of heat transfer through the walls of existing housing stock was monitored, which is commonly expressed in terms of u-values. By using 30mm (total overall thickness) Spacetherm F, the average u-value for the walls was almost halved – from 0.628 W/m2K to 0.35 W/m2K.

Thermal images help convey the effects of Spacetherm, and can be seen in Figures 3.3a and 3.3b.

Figure 3.3a: Before Spacetherm

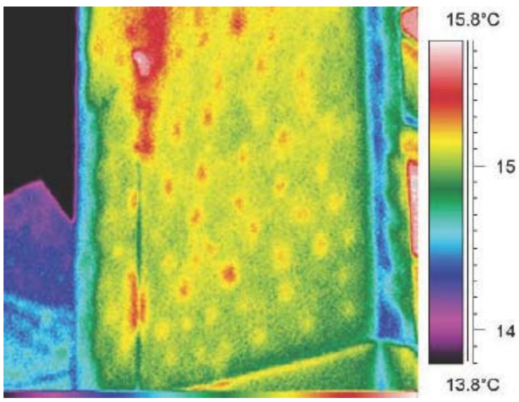
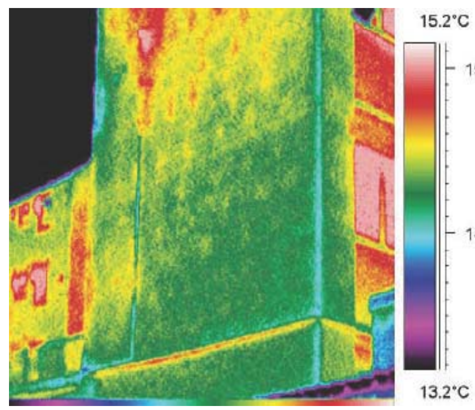


Figure 3.3b: After Spacetherm



Spacetherm has a number of "green" credentials: manufacture is from 100% recycled materials, it has zero ODP (Ozone Depletion Potential), and a GWP (Global Warming Potential) of less than five. In addition, a 50 year accelerated ageing test shows no loss of thermal performance.

Feedback from residents involved in previous pilots has been largely positive. For example the manufacturers quote the following from their Findhorn pilot in Scotland:

"..*back in November we were having a bit of teething trouble with the new wood pellet boiler…it stopped working one night. The house had been heated to about 19 degrees during the day, but was off completely overnight. It was 7 degrees outside overnight, and in the morning the temperature in the house was still 17 degrees. We were quite amazed about this, as prior to the renovation, the house had been very cold most of the time and had certainly lost the heat much quicker than this when the heating was off.*"

However, it must be noted that the installation of measures such as Spacetherm requires particularly skilled workmanship and care, especially in older homes which may have traditional features such as picture rails, intricate cornicing, and ornate skirting boards.

3.3.2. Renewable Energy and Microgeneration Technologies

> "*Recent energy statistics for the UK indicate that the contribution of renewables to domestic heating needs has shrunk by about 50% in the last decade. This decline has been attributed to increasingly stringent emission controls (DEFRA, 2007). With these now in place, there is considerable potential for sizeable reductions in CO_2 emissions associated with domestic space and water heating, but this potential is largely unrealized.*" (Lowe, 2007).

A variety of renewable and micro-generation technologies were deployed in the current study, each of which is described below. Information was sourced from a 2008 UK-GBC review.

3.3.2.1 Biomass systems

Biomass in the domestic sector generally refers to wood fuel, and there are a number of biomass technologies available for domestic use. Market research suggests that government attempts to stimulate biomass heating in the UK have been particularly unsuccessful (Jablonski et al., 2008), and currently less than 2% of heat demand in the UK comes from this source. By contrast, UK biomass consumption for electricity and transport fuels has been more significant.

The current study involved the installation of wood pellet stoves or pellet boilers in a proportion of the HTT homes. Wood pellets, which are formed from dry seasoned wood waste (e.g. from wood-processing) are used as fuel for a pellet stove. Pellet stove systems are fully automatic in terms of control of operation (including air supply via fans and fuel delivery to burner from an integral fuel hopper) which allows for efficient operation and extended periods between refills (typically every 24 hours). A mains electricity connection is required for the automatic system to run. Some pellet stoves are fitted with back boilers for water and/or space heating. These boilers are plumbed into the low pressure hot water (LPHW) circuit which heats the radiators or under-floor heating and the hot water cylinder.

UK-GBC (2008) outline a number of influencing factors to be considered regarding the use of biomass technologies. Biomass equipment requires the appropriate upkeep (e.g. inspecting and sweeping flues) and burning wood requires some effort from the user to supply fuel and remove ash, also a dry covered fuel store is required with adequate space since the wood is bulky and often bulk discounts depend on the delivery of sizeable quantities. Furthermore, there are areas of the UK without an established wood-pellet supply network which may result in heavy delivery surcharges. Equipment like biomass stoves that 'slumber' (continues to burn with a low flame) is best suited to high heat loss and a high thermal mass building. According to UK-GBC most off-gas-network dwellings could accommodate modern biomass installations, and continuously occupied homes with long-heating seasons are particularly well suited to these forms of technology. This makes them especially suitable for families with young children, and other vulnerable groups such as households with a resident who is disabled, provided there is an able-bodied person able to manage the boiler system and its refilling needs.

The HTTH project team worked with a local supplier, Balcas, to ensure good quality pellets were supplied to households after installation, and negotiated relatively small deliveries which made the pellets more affordable for households that were in fuel poverty. One-ton, rather than more routine 3-ton deliveries were offered, as well as a range of payment methods. These additional services were considered essential for fuel poor clients on low incomes.

3.3.2.2 Solar Energy

Solar energy can be harnessed through two routes. First, photovoltaics (PV) which use energy from the sun to create electricity to run appliances and lighting, and second for solar water heating, where the sun's heat is used to provide hot water for homes. These are discussed separately below.

Solar Photovoltaics (PV)

Energy from the sunlight is converted directly into electricity by photovoltaic cells which are semi-conductor devices. These cells are grouped into rectangular 'modules' which are then linked and sized to meet a particular load (need). The result is a PV array which supplies power to the building it is fitted onto. PV requires only daylight not direct sunlight to generate electricity but maximum output is achieved when the sun is shining perpendicularly onto the cells from a clear sky.

'Grid connected' solar PV allows any excess electricity to be exported to the national grid and when the house demands more electricity than the PV can provide, the grid provides the 'top-up'.

Solar PV is suited to rural and suburban areas since these areas are likely to have more sunlight than inner urban locations where other buildings can cast shadows. Ideally, PV arrays should be placed on south-facing roofs and arrays may be installed in existing dwellings with minimal disruption to the occupants. According to UK-GBC most dwellings can benefit from PV systems particularly households with high power demands that can be justified and are not the result of inefficient equipment or energy wastefulness. The maximum financial benefit is gained if all the PV electricity generated is consumed within the home.

A typical domestic 1.5 kWp installation has an annual yield of around 1200 kWh, offsetting approximately 512 Kg per annum of power station CO_2 emissions. However, few solar PV systems manage to pay back their installation expenditure over their operating lives. UK-GBC stress that the use of PV to tackle fuel poverty is not recommended as the same expenditure on alternative energy technologies can achieve better results.

Households that were supplied with PV also consented to be signed up to the NIE Energy Generation Contract. This meant that they were eligible for national subsidies associated with their total generation of electricity, and enabled them to be paid a supplement for export of surplus energy to the grid (ROC payments).

<u>Solar water heating</u>

Solar water heating panels absorb radiation from the sun and convert it to heat, which is then transferred to pre-heat water in a hot water cylinder. This pre-heated water is then further heated to usable temperatures by a supporting system (boiler or electric immersion heater). Solar panels capture heat whether the sky is overcast or clear and can provide 50%-60% of the energy required annually for water heating. As with PV systems rural and suburban sites are more suitable for solar water heating. Solar paybacks are generally shorter in off-gas–grid areas because of fuel price differentials.

A typical domestic sized installation has an annual yield of 1600-2000 kWh, reducing CO_2 emissions by approx 400-1000 kg per annum (depending on the fuel/energy displaced and conversion efficiency). Solar water heating systems can have payback times of over 10 years but the actual times are affected by many factors – such as the energy conversion efficiency of the existing hot water supply. Savings can start immediately and so panels can be useful in tackling fuel poverty (UK-GBC, 2008).

3.3.2.3. Oil condensing boilers

An oil condensing boiler is more efficient than a non-condensing boiler, as it captures more utilizable heat from the combustion process by extracting heat from the waste combustion gasses that are usually lost through the flue. Within the condensing boiler the hot combustion gasses rise up to a heat exchanger (or two) which captures a large part of the heat which is then used to help heat water for the tank.

Hence, installations involved a mix of renewable and energy efficiency measures. The choice of a particular mix for each household was managed by the NIE Energy project team in conjunction with the lead survey team who assessed the feasibility and mix of installation in each home (Eaga Ireland).

Ultimately, the choices made were those of the household, supported with advice and information from NIE Energy and Eaga Ireland.

All customers received either a wood pellet boiler, or an oil condenser boiler.

In addition those who received an oil condensing boiler received either

- solar water heating
- or PV
- or solid wall insulation
- or a biomass stove to replace a smaller room heater.

Before these were installed, an additional technical survey was undertaken by each specialist supplier.

Loft insulation was also checked and topped up to the current regulatory standard cavity

4. Evaluation of the Pilot – procedure and methods

4.1. Introduction

In total, 46 households were enrolled in the Pilot and received practical energy saving and renewable energy measures, and 34 of these were involved in the UU evaluation. These 34 were selected on the basis of when they were recruited - they were all enrolled in the Pilot within a time-frame that permitted them to be monitored before installation and a year after installation. The University of Ulster (UU) managed the evaluation, and partnered NIE Energy in the selection of procedures and methods, as well as in the collection of data for the evaluation.

The following evaluations were carried out

- An in-depth baseline survey of all households which was carried out by NIE Energy's keyworker on the HTTH project. This was done before the retrofit.
- A fieldworker's diary completed by NIE Energy's keyworker at the end of the baseline survey. This provided information on her assessment of the visit in terms of householder characteristics and interest in the scheme.
- An in-depth follow-up survey of households involved in the retrofit carried out by NIE Energy's keyworker. This was done approximately one year post-retrofit.
- Four case studies, chosen to represent the different types of households involved in the pilot. These were completed by NIE Energy's keyworker and UU researchers.
- A follow-up telephone survey carried out anonymously with households by a UU researcher.

The evaluation procedure and methods are discussed below, and copies of the survey and diary protocols are contained in the Appendices booklet which accompanies this report. Figure 4.1 provides a flow chart of the project's sequence.

Figure 4.1 Sequence of project

(areas in red denote elements of the present evaluation)

1. Identify eligible homes via referral agencies and advertisement

2. Building Survey → 3. Decide eligibility → 4. Initial cost estimate

5. Develop project plan → 6. Consult household → 7. Agree plan and timeline

8. **NIE Energy Baseline Survey** → 9. **Fieldworker Diary** → 10. Appoint installers

11. Installer Surveys → 12. Final budget → 13. Generate work plan

14. Agree plan with all involved → 15. Carry out work → 16. Support/contact as needed

17. **Debriefing of NIE Energy team**

Installation + 12 months

18. **NIE Energy Post-Retrofit Survey**

Installation + 14 months

19. **Second debriefing of NIE Energy team**

20. **UU anonymous telephone Survey**

21. **Case study building**

4.2. Baseline and Follow-up Surveys

A Baseline Survey of participants took place before refurbishment. This was undertaken by the NIE Energy keyworker on the project during a home visit. The Survey was completed on a face-to-face basis with the head of household.

A Follow-up Survey took place approximately a year after the retrofit, so that participants had an opportunity to become accustomed to new equipment and energy routines. In all cases households had experienced a winter season between Baseline and Follow-up Surveys. Copies of the two Surveys can be found in APPENDICES 4 and 5 of the Appendix booklet. The Baseline and Follow-Up Surveys took approximately 90 minutes to complete, and gathered detailed information on a variety of factors, including items in the box below. Items marked * are discussed further overleaf.

Data fields collected in the Baseline and Follow-Up Surveys

- Household composition and age of residents
- Employment status of residents
- Type of home, age of dwelling, and tenure
- Referral process
- Reasons for having applied to the scheme and anticipated benefits from it
- Worries about the scheme
- Existing heating system and its perceived efficiency
- Household income and expenditure
- Household energy consumption and expenditure
- Presence of mould, damp and condensation in home and impacts
- Physical health and smoking status of all adult residents in the home
- Mental health status of head of household and (where applicable) partner*
- Attitude to home**
- Physical health of children in the home
- Mental wellbeing of children in the home***
- Children's routines at home

*4.2.2. Measuring mental health status

The mental health status of respondents and their partners was assessed using the Warwick and Edinburgh Mental Wellbeing Scale (WEMWBS). A copy of this can be seen in APPENDIX 1 of the Appendix booklet.

The WEMWBS is a relatively new scale for assessing positive mental health or mental well-being. It has 14 items each with five response categories. It is commonly thought to be a more suitable measure than the more conventionally used SF-12, in that it is designed to measure mental wellbeing among people who are likely to be considerably above sub-clinical levels of depression and/or anxiety. It is also deemed especially suitable for interventions which are aimed at improving mental health (Tennant et al., 2007), making it particularly appropriate for this HTT Homes pilot.

The WEMWBS has been fully validated for use in the UK, and is thought to have a single factor structure (Tennant et al., 2007), high reliability, and good discriminant validity. As such it is psychometrically robust. Confirmatory factor analysis in other studies supports a single factor hypothesis. A Cronbach's reliability alpha score of 0.91 (population sample) in the early reliability studies indicated strong reliability with some item redundancy. In addition, WEMWBS was highly correlated with other mental health and well-being scales, but more poorly correlated with scales measuring overall health – this confirms its validity as a measure of *mental*, rather than general health. Research findings have also indicated a near normal distribution without ceiling effects. Test-retest reliability at one week was good (0.83), and social desirability bias was lower or similar to that of other comparable scales.

This is the first time the WEMWBS has been used in a study related to fuel poverty and mental health, so its performance in the Baseline and Follow-up Surveys is of particular interest for future work in this area.

**4.2.3. Measuring attitude to home

Attitude to home was measured using items from Buckner's Neighbourhood Cohesion Scale (1988). Buckner's scale has 18 items, although only 6 items were used for the present study, since many of the items in the original scale are concerned with neighbourhood rather than home. The items used are detailed in APPENDIX 2 of the Appendix booklet.

***4.2.4. Measuring mental wellbeing of children in the home

The mental wellbeing items were an amalgam of items adapted from several different scales, including the Child Behavior Checklist and the Vineland Adaptive Behavior Scale. Items were selected a priori to reflect minor behavioural issues that caregivers might have experienced in the past month with their children, and were aimed at assessing issues which were below sub-clinical or clinical levels i.e. the items were selected with entirely normal or average children in mind. APPENDIX 3 provides details of the items that were used.

Although the Baseline and Follow-up Surveys were very similar in content, some additional Follow-up questions evaluated aspects of the retrofit process and the management of this. These included items on customer satisfaction with the recruitment process, installation, and after-care service.

4.3. Anonymised Customer Survey

Some weeks after the NIE Energy Follow-Up Survey had been completed, participants were contacted by a University of Ulster (UU) researcher to complete an independent survey. The researcher had only telephone numbers for participants, and was not aware of their names, personal details, or any other aspect that could identify them. All participants had consented to being contacted when NIE Energy first enrolled them in the scheme, and telephone calls to complete the survey were scheduled at times requested by participants.

The Anonymous UU Survey was completed on the telephone, and contained questions concerning recruitment, the installation, and their overall experience as part of the HTTH project. A copy of the UU Survey protocol is contained in APPENDIX 6.

4.4. Fieldworkers Debriefing Questionnaire

As soon as the Baseline Survey had been completed, the NIE Energy project keyworker (who had completed the Survey) was asked to complete a debriefing questionnaire. This assessed the keyworker's overall impressions of carrying out the Survey with the household, the household's expressions of interest and motivation in the scheme, and any remarks which householders made about their home, if remarks of that kind were made. The fieldworker completed one of these for each household. A copy of the fieldworker's debriefing questionnaire can be seen in APPENDIX 7.

The primary areas of interest in the Debriefing Questionnaire concerned:

- Fieldworker's satisfaction with visit and perceived client satisfaction with visit
- Fieldworker's perception of the general atmosphere and wellbeing of the home
- Fieldworker's perception of the household's interest in, and potential to cope with, an energy efficiency refurbishment of their home.

4.5. Case Studies

Several households were asked by the NIE Energy Project team if they would be willing to become case studies for the pilot project. The procedure for this was outlined to participants before their consent was sought, and attention was paid to explaining to each participant that participation as a case study meant waiving their right to anonymity. All participants who were approached consented to become involved. An additional case study participant was chosen at random from the sample by the University of Ulster team, and this case study was added to the portfolio after consent was given. Efforts were made to ensure that the households which were included in the case study portfolio represented the three main types of household that had been recruited into the study, namely pensioners living alone, pensioner couples, and families with children.

A confidentiality agreement was signed between NIE Energy and University of Ulster which covered University staff who would be working on case studies. These were the only clients whose names were known to the UU team. Following this, arrangements were made for

University staff to visit the homes of each case study participant in order to complete data collection.

A set of core questions were asked of each case study participant. These can be seen in APPENDIX 8.

5. Baseline results

5.1. Recruitment

There were many applicants who proved to be ineligible for the scheme once their details were scrutinized. Inevitably with a scheme which involved refurbishing and altering a home, there were also several refusals, some of them after a fairly extended period of negotiation and assessment. The ability to cope with disruption was a primary consideration on the part of putative participants. People experiencing long-standing or acute ill health were most often likely to decline participation even when eligible. In addition, some homes were eligible in terms of all the criteria, but the technical survey revealed that these were not so much *harder to treat* homes, but more accurately, *impossible to treat* homes within the constraints of the pilot's budget.

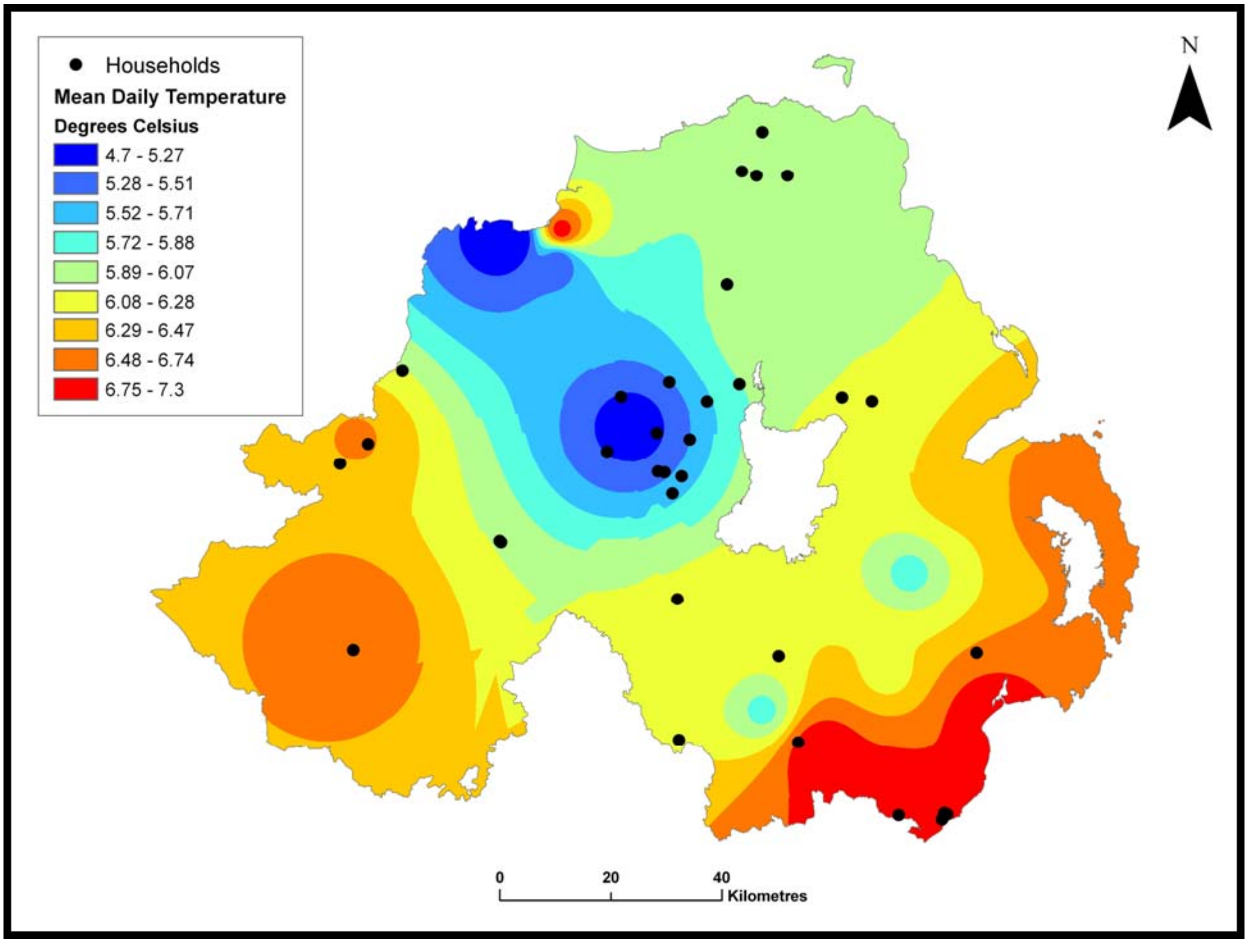
In total, 34 households completed both baseline and post-retrofit interviews. Table 5.1 provides details of the households, and indicates that the majority were pensioners, with 14 lone pensioners and 12 pensioner couples. There were only two families with children and a total of 4 children under 18 years old were recruited in the sample.

Table 5.1 Households which participated in the study.

Household type	Number in sample
Lone pensioners	14
Pensioner couples	12
Couples with child or children	2
Other household constellations	6
Total households	**34**

Map 1 provides details of the locations of homes that were recruited into the study. The map also indicates average January temperatures, and illustrates the extent to which the households recruited were concentrated in some of the coldest areas of Northern Ireland.

Map 1. Location of households recruited into the HTT Homes study



Almost one-third of the participants first heard of the scheme through NIE Energy's appointed contractor, Eaga Ireland, as part of the routine referral to NIE Energy's schemes. A further 9 were told of the scheme via energy efficiency advice teams in local Councils or Health Action Zones, and 6 first heard of the scheme through their family or neighbours. The Northern Ireland Energy Advice Centre informed 4 of the households, a building contractor informed one, and 3 read of the scheme in a newspaper.

Almost all of the respondents (32 of 34) found the referral process very easy or easy. Of the two exceptions, one believed that they had applied some years ago and had therefore had to wait a very long time for it. The other felt that there might not be any energy savings, which would render the disruption a waste of time and effort on their part, and this concern clouded the referral process as a whole.

5.2. Why households applied

Respondents could select from a list of 10 reasons those that best reflected their motives for applying to the scheme. The reason that householders nominated most often for participation in the scheme was as a means of *resolving damp* – two-thirds of respondents selected this as a reason. In addition, half the respondents selected *reducing condensation*. This is not surprising when viewed in the light of other items which householders responded to in the Baseline Survey. Three quarters of the respondents reported having damp in the house, half reported mould growth, and half reported condensation. The most common site of these problems was the main bedroom of the house, where damp was found in more than half the homes (n = 18). Living rooms were the next most common sites, with 12 living rooms having evidence of damp, mould, and/or condensation.

Furthermore, cold and damp worried householders. For two-thirds of the respondents who had problems with damp, mould, and/or condensation, the issue was rated as a *serious* or *fairly serious* one. For one-third, it was something they either worried about a lot or – still worse – found very distressing. Respondents also identified 7 other people that lived in their homes who found the presence of damp, mould, and/or condensation problematic.

Another common reason for having applied to the scheme, which was selected by half the householders, was *energy cost savings*. This too is not surprising given that the affordability of heating was an issue for almost all of the respondents – the majority had foregone heating in the previous year as a result of heating being too expensive (only 7 had not). Of the group who had gone without heat in the previous winter, a quarter of them had done so *often* or *very often*. Furthermore, most of this group had also gone without other commodities in the previous winter in an effort to keep their homes warm. When asked whether they worried about the cost of heating their home, two-thirds said they did so *almost all of the time* or *quite a lot*.

The next-most common motive was *health benefits*, which was selected by 10 households; in 7 of these, asthma was mentioned as a primary motivation for applying to the scheme.

Although cost savings had been mentioned by half the sample, relatively few (n = 9) selected *energy efficiency* as a motive. Only 1 considered *benefits to the environment* as a motive. Interestingly, only 6 of the 34 households felt that *having a warmer home* would be one of their primary motives for applying to the scheme. This was surprising given that *difficulties in keeping the house warm* during the winter months was nominated as a very serious or fairly serious problem by more than two-thirds of the respondents (n = 25). For almost all of them (n = 23) this was something which either *worried them quite a lot* or was something they found *distressing*. An even larger number of respondents found it difficult to keep the house warm on a chilly summer's day (n = 28), and for almost all of these too (n = 25), this was something which *worried them quite a lot* or was *distressing*. In addition, the respondents nominated an additional 18 people who also found it problematic that there were difficulties in keeping the home warm. What these responses suggest is that the lack of a warm home caused considerable problems for householders, although they did not see the retrofit as offering them a primary route to solving this.

> Respondents did not perceive improved thermal comfort as their primary motive for applying to the scheme, but nominated a resolution of damp and mould as the principle reasons for becoming involved in the scheme.

5.3. Household types

Reflecting the age profile of the households, only 14 residents of the households were employed. This meant that the majority of homes which were retrofitted were lived in for long periods at a time by at least one householder. This was confirmed when weekly energy patterns were assessed, which indicated that, in more than half of the homes (n = 18), heating had *always* been on during the day on weekdays in the previous winter. In 8 homes, heating was usually or always on throughout the night as well.

5.3.1. Tenure

All homes were inhabited by owner-occupiers, in keeping with the eligibility criteria. Almost all of the households were owned outright by the residents. Only 3 were mortgaged, one of which involved only a nominal repayment each month.

5.3.2 Age and type of dwellings

Most of the homes were built before 1919 (n = 29) and only 3 were less than 60 years old. All were houses.

5.3.3 Income

The households as a whole were relatively poorly resourced, with 85% being on an income of less than £15,000 per annum. A total of 10 households received a disabled person's tax credit, and 8 received an attendance allowance. 9 received a rate rebate, 4 were on income support and 2 received housing benefit.

5.3.4. Energy costs

The costs of domestic fuel bills are illustrated on Table 5.2. They were extremely high compared with disposable income. The average cost of fuel per annum was almost £1800, and ranged from £650 per year to £3,100 per year. The table also makes clear the extent to which a single person living alone is most at risk of inordinately high fuel bills, since their average costs (£1663 per annum) exceed the costs for a couple (£1633). Given that a single person living alone is likely to have one source of income rather than two, the economic burden of heating and lighting is particularly heavy for them.

This is further reflected in the fact that people living alone were paying an average of 20% of their income for their heating and lighting. The comparable percentages for two- and three+ -person households was 14% and 15% respectively.

Table 5.2. Cost of heating and lighting

Number in household	**Average cost of heat/light per annum and *range***	**Average percentage of income on heat/light**
1 person	£1663 *£650 to £2500*	20%
2 people	£1633 *£900 to £2600*	14%
3+ people	£2357 *£1200 to £3100*	15%
Overall	**£1795** ***£650 to £3100***	**17%**

In terms of fuel poverty, more than three-quarters (26 of 34) of the households were spending 10% or more of their income on heating and light. If the Scottish fuel poverty index was applied to these households, a quarter of the recruited sample were in moderate fuel poverty, a further quarter were in severe fuel poverty, and a further quarter were in extreme fuel poverty. It must be noted that these estimates could not take into account the "needs to spend" element of fuel poverty, and so will have resulted in an underestimate of actual fuel poverty prevalance in the sample (Boardman, 2009). Most likely, all of the participants were experiencing fuel poverty under a "needs to spend" criterion.

The households enrolled in the study were largely fuel poor, and some extremely so. Using the Scottish index of fuel poverty, at least a quarter were in extreme fuel poverty – the most serious level of fuel poverty of all. Of these extreme fuel poor households, all but one was spending more than a quarter of their annual income on heating and light.

5.3.5. Existing heating regimes and attitudes to these

Approximately half the homes used oil for heating purposes, with a further one-third of the homes using solid fuel. Full central heating was only available to half the homes. There was little if any detectable satisfaction with the existing heating systems: during the previous winter, only 2 respondents felt their home had ever become too warm for comfort, although even for them this was a rare event. By contrast, more than half the respondents (n = 19) felt that their home had *always* or *usually* been too cold for comfort. Even in summer, almost half of respondents (n = 16) felt their home was rarely if ever too hot, and half felt it remained *always* or *usually* too cold in summer.

In terms of specific aspects of the heating system, half of the respondents were either *dissatisfied* or *very dissatisfied* with their hot water arrangements. Half also found it *difficult* or *sometimes difficult* to manage their heating systems.

Relatively few of the respondents had considered the quality of the air in their home as an issue – 15 had never thought about it before. Only 8 respondents expressed dissatisfaction with this domain. Similarly, 14 had never considered the quality of their home's ventilation, and only 6 expressed dissatisfaction with this domain.

5.4. Wellbeing at baseline

The Warwick and Edinburgh Mental Wellbeing Scale (WEMWBS) performed exceptionally well. The overall Cronbach's alpha for the scale (α) was 0.91, indicating strong reliability. The WEMWBS also performed well on factor analysis, although 3 factors rather than 1 emerged (KMO = 0.75). Table 5.3 gives details of the rotated matrix. Items in red on Table 5.3 load strongly on a factor. Factor 1 had 8 items; these reflected positive self-concept (α = 0.90). Factor 2 had 3 items and reflected sociability (α = 0.74). Factor 3 had 2 items and reflected mood (α = 0.64).   All items loaded satisfactorily on a single factor, yielding a solution in 7 iterations. All of these indicators suggest a good factor structure and sound reliability.

Table 5.3. Factor analysis of the WEMWBS

	Component		
	1	2	3
Optimistic about future	.555	.107	.089
Feeling useful	.797	.165	.349
Feeling relaxed	-.199	.443	.743
Interested in other people	.165	.610	.178
Energy to spare	.385	-.031	.693
Dealing with problems well	.622	.489	.231
Thinking clearly	.542	.359	.184
Feeling good about myself	.605	.531	.296
Close to others	.492	.788	.114
Feeling confident	.729	.448	.250
Can make up my mind	.595	.137	.562
Feeling loved	.141	.806	.012
Interested in new things	.430	.136	.660
Feeling cheerful	.821	.194	.057

5.5. Attitude to home

The 6 items from the Buckner Neighbourhood Cohesion Scale factored into two factors, one reflecting perceived positive aspects of the home (4 items), the other perceived negative aspects (2 items). The 4-item factor showed good reliability ($\alpha = 0.85$), although the 2-item scale did not ($\alpha = 0.38$). Both are used in the present study.

5.6. Self-reported health of householders and their partners

Health was rated in 2 ways – first a general question concerning how respondents rated their health on a scale of 1 to 10, with the same rating then being made for their partner's health. Second, a more detailed measure concerning health services use; this contained five items related to medications, GP and hospital visits in the past month. One of the items in the more detailed measure ("*missed days off work*") was excluded because of the preponderance of senior citizens in the sample.

As indicated in the Methods section, children's health and wellbeing was also assessed in the study. However, since there were only 4 children recruited into the study, it is not possible to make any reliable estimate of potential impacts of the intervention on children's status. Consequently, no further analyses are made on the children recruited into the study.

5.7. Field researcher's diary

As soon as possible after completing the Baseline Survey, the field researcher was asked to estimate her own satisfaction with the Baseline Survey visit, and her assessment of how satisfied the clients were with the visit. Ratings were on a scale of 1 (*very*) to 5 (*not at all satisfied*). Results indicated a mean "*own satisfaction*" score of 2, which was also the case for the researcher's estimate of "*client satisfaction*". This indicates relatively high levels of perceived satisfaction with the progress of the Baseline Survey.

The 9 items which measured the generally observed wellbeing of the household (*relaxed, organized, happy, focused, welcoming, coping, warm-feeling, positive comments, lack of negative comments*) were summed to create a single *observed wellbeing* score. Reliability analysis indicated excellent reliability of this 9-item scale ($\alpha = 0.82$). Table 5.4 provides information on the results. From this it can be seen that scores showed a satisfactory distribution and no evidence of a potential for floor or ceiling effects.

Table 5.4 Fieldworker home wellbeing rating

	Mean	**Standard deviation**	**Minimum score**	**Maximum score**
Observed wellbeing Maximum possible score = 78	32.60	9.41	19	55
Interested in energy efficiency Max. poss. = 10	5.71	1.90	2	9
Keen on HTT scheme Max. poss. = 10	7.92	1.33	3	10
Potential to cope with retrofit Max. poss. = 5 (well)	3.82	0.64	2	5

The fieldworker also assessed homes in terms of their level of expressed interest in energy efficiency, how enthusiastic they seemed about the possibility of being involved in the HTT Homes pilot, and how well the fieldworker estimated they would cope with the new system. From Table 5.4 it can be concluded that the householders were no more than moderately interested in energy efficiency, although they were very keen on the pilot scheme. In terms of their potential to manage a new system, the households scored highly and were, therefore, perceived to be suitable for the demands of adapting to a refurbished heating system.

6. Effects of the Intervention

Comparison of Baseline and Follow-up Surveys

6.1. Interim between baseline and follow-up

The interim between baseline and follow-up surveys included an extremely severe winter. As illustrated on Table 6.1 all regions of the UK suffered significantly lower temperatures than average in winter 2009/2010. Northern Ireland usually has the mildest average winter temperatures of all the UK regions, but this was not the case in the winter 2009/10, when NI temperatures were colder than in England and Wales. For NI and Scotland, the 2009/10 winter was the coldest for almost 50 years. This put the retrofits under particular pressure.

Table 6.1Winter temperature data for the regions of the UK

Region	Mean Winter temperature 1971-2000	Mean Winter temperature 2009/2010	Coldest winter since
Northern Ireland	4.3^{0}C	2.05 ^{0}C	1962/3
Wales	4.2 ^{0}C	2.09 ^{0}C	1978/9
England	4.1 ^{0}C	2.12 ^{0}C	1978/9
Scotland	2.7 ^{0}C	0.24 ^{0}C	1962/3

Source: UK Meteorological Office, 2010

All homes anticipated being supplied with a standard package of loft insulation (if appropriate), insulation for their hot water cylinder (if needed), and 4 energy-saving light bulbs. At baseline, 13 households also anticipated being supplied with an oil condensing boiler, and 10 with a wood pellet boiler. One home was listed for a wood pellet room heater, and an additional 4 for the same heater fitted with a back boiler (i.e. 15 wood pellet heating systems in total). Eight homes expected solar water heating to be installed. And 4 homes solar photovoltaics. Two homes were listed for solid wall insulation.

In the end, what clients had installed was slightly different. Fewer households received an oil condenser boiler than had expected one (10 were installed rather than 13); correspondingly more received a wood pellet system (17 were installed rather than 15). Two additional households received solar water heating than had expected it, 1 fewer received solar photovoltaics, and 1 additional household received solid wall insulation.

The HTTH packages installed across 34 homes were as follows:

10 households had an oil condensing boiler and controls installed

17 households had a wood pellet heating system installed

10 households had solar water heating installed

3 households had solar photovoltaics installed

3 households had Spacetherm wall insulation installed

Insulation to lofts and hot water cylinders was also checked and upgraded where appropriate

The average cost of refurbishment per household was £6,000.

6.2. The impacts of retrofit

Two post-retrofit surveys were completed, the first by NIE Energy personnel via a home visit, and the second by the University of Ulster (UU) over the telephone. All 34 households completed the NIE Energy post-retrofit survey. The UU survey was completed under anonymised conditions, with the UU researcher knowing only the telephone numbers of the respondents. Twenty of 34 households participated in the UU survey; the remainder either declined to be interviewed (n = 5) or did not pick up the telephone on five consecutive occasions.

6.2.1. The UU Survey

The UU Survey probed participants about the HTTH experience as a whole. The same researcher carried out all of the survey calls, and section 6.2.2. is her account of the surveys as a whole.

6.2.2. Researcher's account of the Survey participants

"*The general feedback from the telephone survey was effective in revealing participants' thoughts and evaluations of the HTTH project as a whole. Most appeared confident of their anonymity, and spoke freely of their experiences. My table below summarises the general content of the calls, from which it is evident that 20% of individuals were extremely satisfied with this entire project, from start to finish, without any complaints whatsoever. These people were incredibly enthusiastic on the phone, very willing to talk at length about their positive experiences and willing to speak to others about it in recommendation. These individuals did not have a single negative comment to make of any kind regarding the entire process.*

Table 6.2. Researcher's summary of the anonymous survey calls

Call experience:	*Very Angry Individual/Very unpleasant Call*	*Quite Dissatisfied Individual*	*Neutral*	*Quite Satisfied Individual*	*Exceptionally happy Individual/ Very pleasant call*
Freq	*3/20*	*0/20*	*1/20*	*12/20*	*4/20*
%	*15%*	*0%*	*5%*	*60%*	*20%*

The majority of individuals wished to express their gratitude for the service. Although many individuals did have complaints about the service e.g. lack of contact number, disruption etc. these individuals made it very clear at the end of the call they would still recommend the programme and would be inclined to more strongly recommend it should these 'teething problems' be ironed out for future individuals. These individuals fall into the 60% 'Quite satisfied' category.

When the complaints became more severe for example about rude contractors or very severe disruption to the home there was a general sense that people don't like to complain when they were getting something for nothing. Of the individuals that reported any complaints (apart from the 15% that were very angry about their experience in the call) many were very pleasant to speak to on the phone and many reported that they were satisfied overall usually due to the fact that their home is much warmer and that this is worth some degree of upset during the process. A number of *individuals expressed that for such a big job to be done on their home, with such benefits, that these types of problems are 'to be expected.' Therefore these individuals also fall into the 'Quite satisfied' category.*

One individual experienced severe disruption to the home and expressed very negative feelings about the procedure - yet still insisted at the end of the call that they would "recommend the service 100%". This highlights another general view from the individuals with complaints/negative comments – the feeling that you need to sacrifice something in order to obtain the benefits of the service.

Disruption to the home was a strong theme running throughout the responses to the survey calls - however, the reports were quite mixed. Many gave the sense that it is something to be expected and you should 'make do with it' others were extremely upset at the lack of respect for their homes and the inconsiderate workmen.

15% of those surveyed were extremely dissatisfied with the process and expressed this fully when on the phone. These calls were unpleasant to listen to yet provide some valuable information about possible problems with a programme like this. Two of these individuals had to pay for someone to sort problems that had arisen from the service, had experienced major disruption to their homes, complained about the workmen, the equipment and more. These individuals had a wide array of complaints - not just complaints about one aspect of the service - they complained in general about a wide variety of things. One individual mentioned that they would never recommend the service to anyone.

Many individuals expressed that heat was the main benefit of the scheme and enjoyed reporting this. Many individuals wanted to express their satisfaction with the equipment installed, quite a few with a sense of pride. Many individuals were pleasantly surprised at the speed the work was completed - many were almost in disbelief.

A sense of confusion was evident amongst a number of callers, mainly about who to contact when they needed assistance, this was mentioned by a significant number of callers as something that would improve this service. People are very happy with their new technologies in general but a number who experience problems are upset when their system/equipment breaks down or needs serviced and they either don't know who to contact or fear they may have to pay for these additional *services themselves. Some felt a little lost and that they didn't have enough information/confidence. There was a sense of disappointment from these individuals - they were very satisfied with the work and their new technologies but it was like they had just been left to manage it without any support."*

It is apparent from these impressions that the householders involved in the retrofit programme had experienced a very intensive and customer-centred experience, which they missed when it was no longer there. Getting to know each household intimately was an essential part of the pilot programme, since through this process it was possible to assess client eligibility, ability to cope with disruption, and ability to manage controls effectively post-retrofit. The fact that all 34 households were subsequently found able to cope with the retrofitted equipment, and very seldom reverted to old heating systems where these were still in place, is testimony to the effectiveness of this screening process and the building of relationships that this necessitated.

Three dissatisfied householders represent a small minority whose experiences do not reflect the larger cohort. Nevertheless, each of these complaints were well-known to the NIE Energy team and had been extensively investigated in accordance with customer service and aftercare protocols. Making what were sometimes very major and invasive alterations to a home (which these installations inevitably required) meant that the HTT programme was disruptive to *all* householders. The fact that all 34 were also vulnerable households made this even more challenging to carry off effectively and without wide-scale perturbation. For future programmes, a flier is planned which will give more detail of the disruption which clients *may* find difficult, although the majority of those involved in this pilot were fully able to tolerate it. This probably reflects several qualities of the pilot, including:

- an excellent quality of workmanship overall, which NIE Energy helped ensure through careful selection of partners,
- an astute selection of clients by NIE Energy and their referral partners,
- a close relationship between NIE Energy's keyworker and her clients, which was maintained throughout the pilot and beyond.

6.2.3. Survey results

Results from the survey questions are contained in Table 6.3. Participants recalled low anxiety before the retrofit took place, perhaps reflecting the personalised mentorship they had received from the NIE Energy keyworker, who had been available throughout the planning stage for consultation, and who had visited each household at least twice before work commenced. The installations were, largely, carried out in a timeframe which the householders expected (in 90% of cases), and the speed to completion appears to have been excellent. However, 35% of households reported a high level of disruption during the 1-2 days of retrofitting, and most did not feel sufficiently "listened to" whilst the work was being undertaken. This suggests scope for a more personalised service from fitters, along the same lines as what they experienced from the NIE Energy keyworker.

Further on this theme, when respondents were asked about any unsatisfactory elements of the retrofit, this often raised high levels of emotion from respondents, despite many months having elapsed since the work had been completed. In particular dissatisfied respondents resented their home and possessions having been treated with a lack of respect. Given the cost and scale of installations in each home, with extensive changes often being made within a day, the importance of a professional approach to customer care was highlighted by these occasional negative experiences.

Despite these difficulties, the overall level of satisfaction with the retrofit was high amongst those who could be surveyed (average score of 4.34 out of 5), and the quality of the equipment which was installed was rated excellent (4.82 out of 5). In addition, the respondents largely felt capable of managing the new equipment immediately after retrofit, and manageability improved further a few weeks later: manageability scores improved from a mean of 3.87 in the first month to 4.27 at the time of UU survey. Many respondents felt their home was different post-retrofit, mostly in a positive or benign way; however, 2 respondents did not like the changes they perceived. Most felt their home was more environmentally friendly, and most felt they were using their home in a different way. Virtually all respondents felt that winters would be "easier" or "much easier" post-retrofit (average score of 4.83 out of 5), and all but 2 of the respondents would recommend others to avail of the scheme.

Table 6.3 Overall experience of the retrofit – anonymous UU survey results (n = 20 respondents)

Survey question	Frequency or average score
Anxiety about the retrofit beforehand (1 = very anxious 5 = not at all)	4.45
Longer than promised wait for retrofit	10% of respondents
Level of disruption during retrofit (1 = intolerable 5 = not a problem)	3.87
I felt listened to during the retrofit (1 = A lot 5 = not at all)	3.05
Speed of retrofit to completion (1 = very slow 5 = very quick)	4.22
Satisfaction with quality of retrofit (1 = very dissatisfied 5 = very satisfied)	4.34
Quality of equipment installed (1 = very poor 5 = very good)	4.82
Work has changed the look of my home	13 respondents
In a good way?	5 respondents
In a bad way?	2 respondent
Neither, just different	6 respondents
Home seems more environmentally friendly?	26 of 34 respondents
Easy to use the new equipment in the first month? (1 = very difficult 5 = very easy)	3.87
Easy to use now? (1 = very difficult 5 = very easy)	4.27
I use my home differently post-retrofit (1 = not at all 5 = very much so)	3.86
Winters will be easier post-retrofit (1 = not at all 5 = very much so)	4.83
I would advise others to take up scheme	32 of 34 respondents

6.2.4. NIE Energy's Post-Retrofit Survey

This was designed by UU, and completed by the NIE Energy keyworker during a home visit.

6.2.4.1. The retrofit experience

In the NIE Energy Survey, more than three-quarters of the respondents said they had found the process as a whole "very easy", with only 2 participants reporting the experience as having been difficult. When asked about how the house was different, if at all, post-retrofit, 22 of 34 reported that the house was warmer. For one-third of all participants, this was the primary benefit from having participated in the scheme. Even though the home was warmer for many, half of the participants believed that their energy bills had been lower post-retrofit. Given the harshness of the winter that households had experienced between baseline and post-retrofit surveys, this was encouraging.

For an additional 20% of participants, improvements to hot water was rated as the primary benefit.

At baseline survey, participants had been asked what they ***thought*** would be the impacts of the retrofit. Post-retrofit, they were asked to describe what had, ***in fact***, turned out to be the impacts. From Table 6.4 it is clear that the impacts exceeded their expectations in most but not all respects. The only exception was that the scheme had not yielded as much impact on mould and damp as householders had anticipated. This may reflect the fact that householders may not be ventilating their homes in the recommended manner, although it is also possible that signs of old mould and damp had not yet been treated through redecoration. It must also be pointed out that the treatment of damp and mould were not part of the project's aims and objectives. Despite this, 10 households did report satisfaction with the impacts on mould, and a further 18 reported satisfaction with impacts on damp. However, since this evaluation has uncovered a mismatch between what Harder To Treat programs can achieve in the real world (which will almost always be somewhat limited in terms of treating the complexities of mould and damp) and what householders themselves thought the HTT project would achieve, attention could be given to finding ways of preparing householders for the effects of treatment, so that they are aware that the installation of new heating and insulation may not always result in damp and mould problems being resolved to their satisfaction.

Table 6.4 Expected and actual outcomes of the retrofit, as reported by participants

Impact	Number who thought it would be an impact beforehand	Number who found an impact after the retrofit	Difference
Energy savings	16	20	+4
Warmer home	6	33	+27
Improved energy efficiency	8	15	+7
Less condensation	17	17	0
Less mould	14	10	-4
Less damp	21	18	-3
Better health	8	12	+4
Total positive impacts	**90**	**125**	**+35**

Householders had greatly underestimated the impacts retrofit would have on thermal comfort and energy efficiency. The unexpected impacts in terms of a warmer home and better energy efficiency are particularly noteworthy. All but 1 participant reported a warmer home, although only 6 had anticipated this impact. Fifteen reported improved energy efficiency, although only 8 had anticipated this impact.

In total, householders anticipated 90 impacts, but post-retrofit realized 125. A total of 57 perceived impacts were outside of the usual remit of impacts anticipated from a conventional HTT programme. These were perceived impacts on condensation, mould, damp, and health, and indicate a broader *value-added* range of impacts than those usually associated with HTT programmes (i.e. thermal comfort, energy efficiency and energy savings).

When asked what advice they would give other householders contemplating participation in a HTTH scheme, all but two of 34 householders responded that they would recommend the scheme to others. Comments included:

> "Very happy with the pellets, if you get the chance go for the pellets"
>
> "Don't worry about disruption it is worth it"
>
> "Well worth it, makes life easier for you"
>
> "Take the scheme, best scheme ever brought out"
>
> "Take it on with both hands"
>
> "We think we have died and gone to heaven"

6.2.4.2. The Contractors

Householders were asked to rate the quality of contractor work that had been undertaken, and their views reflected two extremes. Contractors were perceived as either exemplary or disastrous. Favourable comments encompassed their speed, hard work, responsiveness to queries, and their tidiness. Comments included:

> "Company was excellent, very well mannered and helpful"
>
> "Very quiet and reasonably tidy"
>
> "Came back to sort out problems"
>
> "No they were spot on. They worked hard all day"
>
> "Did a great job, very helpful-came back and explained everything"
>
> "More than happy, always respond to queries"

Negative comments, which were made by 3 of the 34 householders, mentioned damage, poor workmanship, and lack of respect for people's belongings. As has already been indicated, the last-mentioned also emerged strongly in the University's customer survey, in which householders became particularly upset when recounting experiences that reflected damage to their possessions. Negative comments about contractors included the following:

> "Lifted floorboards and did not replace as promised."
>
> "One guy in particular was very rude."
>
> "No coordination between contractors."
>
> "Left from Friday to the Wednesday without boiler being linked up."
>
> "Left with leaky radiators."
>
> "Install of wall insulation could have done a better job."
>
> "Look at who is doing the work, Neater and tidier - not as rough."
>
> "Floors and carpets torn up"

In addition, some participants were not clear who to contact when they had queries concerning the work after retrofit. They felt that there was often no obvious lead contractor. Others expressed some concerns at having to leave the house whilst the work was being done, and one remarked (without rancour) that there were 12 workmen in the house simultaneously which made any other activities impossible. Another participant noted 7 workmen in the house at once, although only in the context of them being "no bother though".

When work was being done during cold weather, the thermal discomfort experienced because of open doors and exposed roofs was also noted.

6.2.4.3. The equipment installed

Overall, respondents were very satisfied in this domain. Mention was frequently made of the high quality of equipment: radiators were "good-looking" and units were of "exceptional quality". The wood pellet boilers received particular praise during the UU telephone survey, and the savings made from purchasing pellets as compared with oil were also noted by several participants. One participant noted that they were buying the highest quality pellets, in order to "avoid damaging such a lovely machine", but that this was still cheaper than heating their home through oil.

The solar panels were also favourably reviewed by most participants who had received them, with people being particularly surprised at the ease with which they had been fitted, and the ease with which they could be used. Nevertheless, there were some notable exceptions, and people who could not manage the panels successfully ended up becoming both frustrated and disillusioned with them. The return from NIE Energy in terms of their export and ROC payments for excess renewable electricity from the solar PV was (not surprisingly) especially welcome. The amount one householder estimated this had saved (£380) was substantial. Comments on the equipment installed included:

"Pellet burner is of very good quality"

"Nice looking stove"

Wood pellet boiler is the 'best thing ever', would really let anyone come to see it if they wanted"

"Fantastic - must be top of the range because it works so well."

"Husband showing it off to a friend today"

"Once you catch on after using it (solar panel) a few times it is very easy after that."

"Solar panels work themselves."

"Solar panel - clicks on itself, very pleased with the hot water"

"Have told others about solar panels and how good they are"

6.2.4.4. Energy affordability and use

Respondents estimated how much they had spent in the previous year on heating sources, and this was compared with the amount they had estimated in the baseline survey. Table 6.4 provide details. At baseline households estimated that they were spending £1092 on heating fuels. In a study undertaken at roughly the same time as this evaluation, Northern Ireland households were estimated to be spending an average of £1040 on heating fuel (NIHE, 2010). Given that the present sample were all on low incomes, it is noteworthy that their expenditure on heating was, in fact, above the NI average.

Post-retrofit, however, this had reduced to £837 according to householder estimates. Heating fuel costs reduced by 23% post-retrofit, and electricity bills by 6%. Savings per household on primary heating fuel and electricity averaged £297. For houses of similar size and composition, the Energy Efficiency Partnership For Homes estimates that savings *without* rebound effects should approximate £900 per annum (EEPH, 2009). What this suggests is that the households in this evaluation were taking two-thirds of the benefit in warmth and hot water, and the remaining one-third in savings. Rebound effects are further confirmed by the fact that most respondents reported heating more of the house to a higher temperature after the work had been completed. In this sense, the results are positive in that households were able to attain significant savings despite a colder than average winter in their first cold season, and using more heating and hot water.

As the later rows on Table 6.5 indicate, the percentage of participants who recalled having foregone heating because of affordability issues halved after retrofit. Similar results emerged for having foregone treats and luxuries in order to pay for heating. Whilst 20 households reported having worried a lot about the cost of heating before, only 7 did so after retrofit.

Table 6.5 Affordability of heating (householder estimates)

	Before retrofit	**After retrofit**
Average annual spend on main heating fuel	£1092	£837
Average annual spend on electricity	£703	£661
Household went without heating last winter because of cost	26 households	13 households
Household did without treats and luxuries last winter because of cost of heating	27 households	15 households
Respondent worries about the cost of heating a lot	20 households	7 households

6.2.4.5. Thermal comfort

Levels of satisfaction with heating in the home increased dramatically, both in winter and summer, as can be seen on Table 6.6. A repeated measures ANOVA test for statistical significance indicated a highly significant order of change for all variables on this Table ($P < .001$), with the exception of satisfaction with and manageability of hot water system. Given that relatively few of the retrofits targeted hot water (only 11 had solar water heating installed), whilst all of them targeted heating, this is not surprising.

Comments related to improved thermal comfort included:

> "All of the rooms in the house warm, not just some"
>
> "Warm house, great to have a warm bathroom"
>
> "Warmer house all through not just living room"
>
> "It just feels more comfortable in the house"

Table 6.6 Mean satisfaction scores for heating systems before and after retrofit
(1 = rarely satisfied, 5 = very satisfied)

Survey question	**Before retrofit**	**After retrofit**
Indoor temperatures in summer	1.77	4.25*
Indoor temperatures in winter	1.86	4.70*
Ability to keep house warm in winter	2.11	4.70*
Manageability of heating system	2.29	3.14*
Worry about heating management	2.29	3.81*
Satisfaction with hot water	2.68	2.20
Manageability of hot water system	2.43	3.15

*statistically significant differences before and after retrofit

While the participants in the HTTH project were largely very satisfied with the retrofit, the survey also indicated that many of them were still using some of the same heating appliances as they had done in the past. For example, 13 households retained the use of an open fire. When asked for more information on their use of auxiliary heating, 9 respondents said they lit a fire "for company", especially on a weekend, or a wet day, with only 2 citing the cost of oil/pellets as a reason. Hence it seems that the primary explanation for using old forms of heating post-retrofit lies with the attractions of an open fire and a warm hearth, rather than affordability.

6.3. Wellbeing Impacts

Statistically significant impacts associated with the retrofit were found for mental wellbeing, but not for physical health or attitude to home. Results are detailed below.

6.3.1. Physical health

Table 6.7 indicates the overall health-related activities of the survey respondents and their partners before and after retrofit. It includes data for 47 people (34 respondents and their respective partners). For self-reported health, repeated measures ANOVA indicated that the difference in mean scores (which is in the expected direction) failed to reach significance, suggesting that the retrofits had no discernible impacts on respondent's ratings of their own and their partner's health. Similar results pertain to their combined scores for medical interventions in the previous month.

Table 6.7 Health-related activities in the past month for all respondents and their partners

In past month	Before retrofit	After retrofit
Self-reported health score (scale of 1-10 where 1 is very poor)	6.33	6.80
Combined score for medication, GP visits, accidents, and hospital admissions	7.09	6.93

6.3.2. Mental wellbeing

Table 6.8 provides details of mental wellbeing scores for respondents and their partners before and after retrofit. From this it is evident that there were significant gains in wellbeing after the retrofit. These appeared across all three factors in the Warwick and Edinburgh Mental Wellbeing Scale (WEMWBS), and therefore also in the overall average WEMWBS score. However, there were no discernible changes in the Buckner attitude to home scale, with scores for both positive and negative aspects of home remaining unchanged after retrofit.

Table 6.8 Mental wellbeing scores of respondents and their partners before and after retrofit

	Before retrofit	**After retrofit**
WEMWBS Self concept	27.69	30.08*
WEMWBS Sociability	10.63	11.68*
WEMWBS Mood	9.00	10.38*
Average WEMWBS score	**47.31**	**52.86***
Attitude to Home - positive	6.58	6.12
Attitude to Home – negative	7.06	7.00

(* denotes a statistically significant difference before and after)

In terms of overall health, wellbeing, and attitude to home, therefore, these results indicate measurable impacts on mental health, although no impacts on physical health or attitude to home. The fact that the sample size was small makes this pattern of results unsurprising. In most studies investigating impacts of energy efficiency measures, health impacts are classified as small to medium-sized effects; as a consequence, they require sample sizes exceeding 100 in order for impacts to be detectable (Liddell & Morris, 2010). The present study was not of sufficient size to detect any potential physical health impacts. By contrast, mental health impacts were both positive and statistically significant, which reflects the findings of many other studies in which mental health is found to be the principle beneficiary of home upgrade programmes that target energy efficiency (Green & Gilbertson, 2008).

7. Case Studies

Four case studies were completed towards the end of the evaluation. Three were completed by an independent researcher recruited by the University of Ulster. The fourth was completed by the NIE Energy keyworker. Case studies were selected at random from the database by University of Ulster researchers, although care was taken to select different types of households. Case studies were completed in the client's own home, and were semi-structured, that is, a core set of questions acted as a standard protocol, although clients were encouraged to add other thoughts and experiences as the case study interview progressed.

7.1. A lone pensioner actively involved with her grandchildren, Mrs A

Mrs A is a very active 77 years old. She has twenty five grandchildren, two of whom have Down's Syndrome. Mrs A plays a pivotal role in the lives of her grandchildren as they do in hers. A teenage granddaughter sleeps over every night and many of the others stay frequently.

Mrs A's home is located in a rural area, has mostly solid walls and was previously heated with Economy 7 and coal fires. She wakened to a cold house each morning. The bathroom was particularly cold. Two hours before Mrs A had a bath, she plugged an electric heater into a socket in the hall and kept the bathroom door open to let the hot air circulate. The heater was on for two hours before she had a bath. She avoided having a bath many times. Her bedroom was very cold and she often went to bed wearing a jumper. She found the Economy 7 did not hold the heat in the house and wore extra clothing for warmth during the day and practically sat on top of the fire to keep warm.

Mrs A found her older grandchildren were reluctant to come and stay as the house was so cold and there was little warm water. When the younger children slept over Mrs A got up before the children and lit the fire in the living room. She did not want them coming into a cold room. She also worried about the children having an accident with the fire.

Mrs A heard about the HHT Homes scheme through an advertisement in a local newspaper. She contacted the energy efficiency adviser for the area and was advised she was eligible to apply for the scheme. She discussed her concerns about the mess any workers would create. She had visions of kango hammers and dust all over the house. She had just finished decorating and was worried she would have to do it again. The energy efficiency adviser "gently persuaded" her to register for the scheme and talk it over with her family. They encouraged her to go ahead and jokingly told her she could move into a caravan. Mrs A was offered a wood pellet boiler and loft insulation.

Mrs A was happy when she had a start date for the work and moreover could not believe it was free. The work started in the third week of January and lasted one week. She was really impressed with this. The men gave 'no hassle' whatsoever. She hardly knew they were in the house. They did not touch a wall with anything and everything was intact when they left. They vacuumed and swept up every evening. This was a big relief to her. There "wasn't a drop of water anywhere" during the draining of the tank in the roof space, hot water tank cylinder and back boiler. She did not have to redecorate when the work was finished. The after service from the contractors was excellent.

Since the heating was installed it has functioned well. The system is fuelled by wood pellets which Mrs A purchases from a firm in Enniskillen. On the recommendation of the firm she places her order for fuel about 10 days before her supply runs out. This works well. The boiler and fuel storage facility are located externally at the side of the house. Mrs A empties the ash pan of the boiler once a week. She doesn't mind doing this, though she thought it might not suit everyone. Mrs A has been shown how to reset the boiler in the event of a power cut. She is comfortable doing this. She still likes to light a small fire in the evenings in her living room. Her electricity bills have reduced dramatically.

Mrs A experienced difficulty setting the digital programmer in the kitchen. Once the work had been "passed" she had this changed to a manual programmer which she finds easier to use. When the work was finished Mrs A said she felt she was "in heaven" and "it was such a relief to know she was getting up to heat and warm water". It is a "pleasure getting out and going to bed now" and a "pleasure in the bathroom…it's great now for the children having baths". Her home is safer for her younger grandchildren and she doesn't have to worry about them walking about the house in their bare feet and pyjamas first thing in the morning. Her teenage granddaughter who stays with her each night is delighted with her warm bedroom and a plentiful supply of hot water. Her older grandchildren are coming to stay more often now.

Mrs A has no suggestions as to how the scheme can be made better in the future.
"For me, no - from the first contact to the end it was excellent."

She also commented:
"This is the first grant I ever got … and for my comfort."
"I have worked hard all my life."
"The controls are so handy."
"I have hot water at my fingertips"
"Everything is there and the children and I are warm."

7.2. A couple with children, Mr & Mrs B.

Mr & Mrs B and their children ages 2, 10, 15, 16 and Mrs B's mother live in a rural area by the sea. Mrs B is the main carer for her mother who suffered a stroke 15 years ago. Domiciliary care workers visit Mrs B's mother four times daily to assist with her personal care.

The B family heated their home with an old oil-fired central heating system, a solid fuel range in the kitchen and open fire in the living room. The kitchen range served the dual function of heating the kitchen and hot water. The oil system was just 30% efficient and did not heat the house or water adequately despite being on most of the day. The immersion heater was used to supplement the hot water supply. The living room fire was lit for nine months of the year as the room was not warm enough to sit in. Mr & Mrs B's energy bills were prohibitive. Over a one year period from winter 2006/7 they spent £1,500 on oil and £720 on coal. In addition they had high electricity bills.

Mrs B's mother's domiciliary care workers make their first call early each morning. Such is her mother's incapacity, she requires two carers for her personal care which involves hoisting, toileting, bed bathing and dressing. The care workers require hot water for their morning call. Mrs B has a hectic morning routine and she sometimes forgets to turn on the immersion heater to heat the water for the carers' arrival. When this happens she has to boil kettles of water on their arrival. On these days the carers would exceed their allocated time and were under pressure as they were now running late for their next client. Mrs B felt very guilty 'not being prepared' for the carers and "holding them back".

The lack of hot water made for many complaints within the family. The teenage girls complained to their mother that they didn't have enough hot water for showers and Mr B complained about the cost of heating the water with the immersion.

Mr & Mrs B heard about the HTT Homes scheme through an advertisement in the newspaper. They were offered a wood pellet boiler and a solar panel. They decided against a wood pellet boiler as they felt the supply of wood pellets might be an issue, given that the only supplier in Northern Ireland is some eighty miles away from where they live. They also felt they would be taking a leap into the dark as they didn't know how much the servicing and aftercare of the boiler would cost. They accepted the alternative offer of a new oil-fired boiler, programmer and thermostats.

Mrs B worried about how she was "going to cope" with the work as the "carers were coming in" and it wasn't possible to move her mother away from the house. In addition she had a one year old to look after. She felt a sense of panic "because of mummy".

On the day of the work Mrs B's mother stayed in her bedroom and Mrs B "managed" despite not having any heat or hot water. Mrs B described the workers as the "A team". They arrived at 7.00 a.m. and completed most of the work that day. Mrs B said she had "never seen anything like it in all her life"; it was like a "60 minute makeover". There were "suppliers, plumbers, electricians; everything was so co-ordinated". When they left that evening the family had hot water and heat and there "wasn't even an airlock". There wasn't a "scrape on the wooden floor" and everything had been cleared up". "The men stayed until the job was done".

Mrs B said she is "delighted now"; "it has made life easier – especially for water", "there is hot water all the time now" and the house "heats up really quickly" and heating is only on for timed periods in the morning and evening. Between April and September the solar panel provides for the family's hot water requirements and "at this time of the year the water is still warm in the morning". Mrs B's two year old often gets an extra bath to use up the surplus!

All the family has benefited from the HTT Homes measures though Mrs B more than most. She remarked that she got the “backlash” from the “the girls” when there wasn’t enough hot water and she doesn’t have “a husband rumbling on about the heat on all the time”. She no longer has to worry about keeping the carers waiting and they are able to keep to their schedule.

Mr and Mrs B are happy to recommend the scheme to anyone. They offered the following thoughts:

“It is a big thing to let people know they were coming”.
“We can pay the electricity bill now”.
“What more could they have done?”
“A great job!”

7. 3. A pensioner whose children live with him, Mr C.

Mr C is a retired widower. His adult daughter and son live with him. His daughter is at home each day and takes responsibility for household tasks and his son who is in paid employment has a heart condition.

Mr C’s home is located in a rural, upland area. He lives in what was formerly a labourer’s cottage. Some forty to fifty years ago it was the practice to offer the sitting tenant the opportunity to purchase the cottage and if this offer wasn’t taken up, it was then offered to the farmer on whose land it stood. Mr C did purchase the cottage and at that time it didn’t have electricity or a bathroom. It was improved with the help of grant aid.

Mr C’s former heating source was an old oil-fired central heating system. It did not have the facility to heat the domestic hot water separately nor did it heat the house adequately. The coal fire was lit to supplement the heat. It was prohibitively expensive to run the old system and it was only on when necessary. As a consequence the house was often cold.

Mr C heard about the HTT Homes scheme from a heating contractor who was carrying out a survey on the old oil heating system. He recalled being offered replacement oil heating and a solar water heating system (although records indicated that he also received a full 270mm loft insulation, since he had none). At this stage he felt he had nothing to lose though he did think about the solar heating “for a while”. He had some worries about it; for example he worried that frost might freeze the water in the solar panel and burst a pipe when thawing. The contractor explained that a liquid was added to the water which meant it would not freeze.

While Mr C and his son did not worry about the commencement of the work, his daughter was anxious about it. Arrangements were made for her to go to another house on the day the workmen were coming. The work was mostly done in one day. The workers “did a good job”, there were “no leaks, no anything”.

Mr C felt really good about the new heating system and that he “didn’t have to do it myself” and “spend money”. He said it is a “great job” and he “would have found it difficult to finance”. The new system did break down twice after it was installed and the slow response in fixing it meant the family had no heating or hot water for three days. Although the contractor had left contact numbers there was confusion as to who was the first point of contact which may have led to the delay.

Mr C finds the solar water heating system is “not a great job”. The water temperature rarely gets hotter than 35 degrees C and he said this is not hot enough even for shaving; “when shaving a man needs good hot water and it’s not that good … there was only one day it was hot enough”. The temperature has not been more than 50 degrees C and this is “very seldom – it is usually lower”. The water runs cold quickly and he has to use the boiler to heat the water to the required temperature. Mr C doesn’t understand why the system is performing poorly especially on days when there is a lot of sunshine. Mr C is asked a lot about the solar system and would love to say it is a great job as he is committed to the idea of it but can’t because of its poor performance. He doesn’t want to put other people off but feels he can’t endorse it totally.

The new heating system has made a big difference to Mr C and his daughter – "life is easier", "the house is toasting now", "heat meets you in the face", "we are using less oil" and "the heat puts me to sleep when I come in from outside". Mr C's daughter said she feels her brother who has a heart condition finds "it really good".

Mr C said there was "one thing missed out". His bedroom has a single radiator only and "it is not as warm as the rest but better than it was". Mr C feels the scheme could definitely be improved by giving information on the expected performance of the solar water heating system – perhaps a table to say what temperature "it should heat". More information on responsibility for 'after care' of the boiler would be helpful as he is not sure who is due to carry out the next service.

On the scheme generally Mr C commented that apart from the solar panel, he "couldn't say it can be any better than it is".

7. 4. A lone pensioner, Mr D

At the time of the case study visit, Mr D was 80 years old and had suffered ill health for some time, particularly shortness of breath and coughing. He used inhalers throughout the day, and had difficulty sleeping at night because of problems he had with breathing. He visited a local NHS chest clinic regularly, and was scheduled for an operation to attenuate his breathing difficulties.

Mr D lived alone. He was visited regularly by his nephew, who took care of many of Mr D's essential needs. He heated his home through a coal fire, which he was no longer able to manage on a daily basis by himself. The fire was set every evening, sometimes by Mr D and sometimes by his nephew, but it was frequently out by morning. This meant that the house was cold most mornings, and Mr D found it difficult to get up and dressed in the cold. His nephew often coaxed him to rise. Once dressed, he spent much of his day in his strawberry sheds where it was warmer during the day.

Mr D and his nephew heard about the HTT Homes scheme through an advertisement in the newspaper. He recalls being offered a solar PV system, and a new central heating system (although records indicated that he a loft insulation top-up of 170mm was also installed). Mr D was concerned initially about how much these were going to cost to install. He could not believe that "he was going to get a new heating system and a PV panel for nothing". He thought there must be some kind of a catch. His nephew was able to convince him otherwise, although he was still a bit sceptical and told his nephew that "if it costs anything, you pay for it". The role of Mr D's nephew was pivotal in the refurbishment, since he looked after the application process and the timing of contractual work. He remarked: "the process was very easy and the majority of it was carried out over the phone".

The extent of trust between the elderly gentleman and his nephew is reflected in the readiness of Mr D to participate in the scheme, despite disabling ill health. Although there were three different sets of contractors involved in the refurbishment, he was not worried about the upheaval given the support he knew he could rely on from his nephew. There was one false start, when a contractor told them they could not have roof insulation in a roof extension. NIE Energy were contacted about this, resolved it by recruiting a different contractor, and all the work was carried out as planned. Mr D and his nephew were very impressed with the workmanship of the heating and PV contractors. The heating contractors in particular were speedy and worked very neatly.

Since the refurbishment of his home, the new heating system has functioned as had been promised, and on some days he thought that the PV system had generated a profitable amount of energy in terms of repayments. Mr D's nephew has noted that Mr D has been rising earlier, without any need for encouragement. He is much less often found spending the day outside in the strawberry sheds, since the house is now warmer than the sheds. His nephew also remarked that Mr D is more optimistic about the future.

Mr D himself remarked that the house is now "cosy and warm. There is no damp. I am happy to get up in the morning and enjoy coming in after my days work. I still light a fire but it is more for company. My health is very much better. I have not been to the chest clinic since March, but I still use an inhaler."

For the remaining questions in the case study protocol, these were Mr D's replies were:

If there was one thing you would have liked done differently what would it be?

"That I would have had the heating replaced years ago."

If someone else were thinking about joining the scheme, would you have any advice for them?

"Don't be afraid to take what is on offer."

Anything else at all I should write down?

"Thank you."

8. Conclusions

8.1. General points

The HTTH scheme was a fully subsidized retrofit, in which the main commitment from participants was to endure the disruption of installations and the potential difficulties of coping with new heating systems. Since the cost of installations was, in all cases, several thousands of pounds, and levels of disruption and adaptation were – according to the respondents themselves – minimal, it is not surprising that levels of satisfaction were high, and that all but two respondents said they would recommend the scheme to others.

Only 3 clients reported any dissatisfaction with the scheme, and in all cases this related to the disruption caused by what were – inevitably and in all cases – major retrofits. This was testimony to the thoroughness with which clients were scoped, prepared, and led through a process of refurbishment that in some cases meant 12 workmen in a house at one time. For the trio of clients who were less than satisfied, each case was fully investigated by NIE Energy and their contractors, to ensure that a protocol of reparation and full customer service was implemented. Preparing clients for what to expect had been given priority in this pilot, and the importance of paying attention to that was highlighted in the few cases where clients felt the process could have gone better. The development of an information leaflet which explains to householders the likelihood and scope of disruption is recommended on the basis of this pilot. In addition, details which make clear what effects can (energy savings) and cannot (damp) be expected from the retrofit is also recommended. Both of these changes are already underway at NIE Energy, and it is intended that this leaflet will be left with householders following their preliminary survey, so that there is time and opportunity for them to digest the information before agreeing to retrofit work.

The pilot undertook retrofits along the lines of best practice, using a bespoke whole-house solution. This was reflected in the mix of measures and installations that were selected for each household depending on the composition of the household and their lifestyles. The selection of participants was entirely appropriate in that all were on relatively low incomes: 85% of the sample were on household incomes of less than £15,000 per annum. All of the households were likely to have been experiencing fuel poverty, with many in severe fuel poverty. There was also a clear focus on finding homes in the colder parts of Northern Ireland.

The 4 case studies that are part of the report illustrate the level and range of vulnerability which was prevalent in the sample as a whole. However, the fieldworker's diaries also indicated that the families were deemed to be committed to the retrofit, and were assessed as being able to cope with it. These assessments proved to be sound in retrospect. For a study of this nature, what is required is not only targeting towards those most in need, but towards those most in need *who can cope with a retrofit;* this appears to have been largely successful. Further evidence of tailoring the retrofits was evident in the negotiation of smaller and more affordable deliveries of wood pellets, and in the arrangement of flexible means of payment. The extent to which the sample as a whole felt little anxiety before installation is testimony to careful recruitment, but also to a programme of mentorship, support, and advice which the NIE Energy keyworker and the lead surveyor team seem to have engendered.

The impacts which respondents reported in terms of

- improved thermal comfort
- reduced energy costs

greatly exceeded their expectations.

Indeed, data from the baseline survey illustrated just how poor the levels of thermal comfort and affordability were before the retrofit, so these improvements are being made from a very disadvantaged base. Before the retrofit, householders reported difficulties in keeping their homes warm enough even in the summer months and often went without heating or other commodities as a result of the costs which a warmer home incurred. Significant gains in thermal comfort after the retrofit were to be expected, even if these took most householders by surprise.

The study confirmed many of the mitigating factors first reported by the English Warm Front evaluation of fuel poverty interventions (Green & Gilbertson, 2008). Coal fires continued to be used, there was a strong rebound effect, and the length of payback from the scheme was expected to be very long given relatively small savings on energy bills.

There may be room for some additional savings in terms of thermal comfort, since many of the comments made by respondents suggested that homes might have become overheated post-retrofit (for example "the heat hits you in the face"); there may be scope for turning thermostats down as a means of maintaining better thermal comfort whilst saving more money on energy bills. In future, providing households with more information about thermal regulation, and easy-to-read temperature loggers for different parts of the house, might help recoup any savings which are left to be made in this domain.

As outlined in a previous chapter, the rationale for treating HTT homes is said to include:

- impacts of treatment on regional carbon emissions
- reductions in regional fuel poverty rates
- improvements in people's attitudes to their home and its upkeep
- improvements in the health of people living in HTT homes.

In this pilot, impacts on carbon emissions are likely to have been minimal given the fact that households reported taking savings in thermal comfort, and that their average saving on energy bills (following a *major* retrofit) was under £300 per annum. Of course, this was a substantial saving for the families themselves, and had also been possible during the most severe winter for 50 years. Such savings are significant in the context of the income of these families and the winter that had been endured. However, in cost-benefit terms, the cost of retrofits across all 34 homes averaged £9,441 which meant that the payback period from investment would approximate 30 years. This probably also approximates the lifetime of the installations, making the installations broadly cost-neutral overall. Similar conclusions have been reached about schemes operating in countries such as Canada, New Zealand, and England.

However, such estimates do not take into account:

- increases in the cost of domestic energy for householders during the next 20 year period, which are unlikely to be benign, and could be prohibitive;
- increases in ROCs tariffs and the introduction of other reward schemes, which may mean that customers will be able to avail of additional discounted tariffs and may receive increased rates of payment for surplus energy sent back to the supplier.

If costs of domestic energy increase, and/or enhanced repayment options are introduced, the time required for payback on investment may diminish considerably.

The retrofits made significant impacts on the fuel poverty status of households, although they were unable to resolve the high cost of heating and energy altogether.

The financial savings households estimated averaged £297 per annum. This suggests that households were probably moved from severe to less severe fuel poverty post-retrofit. Few if any would have been removed from it altogether. Nevertheless, this greatly eased the self-reported stress that households had previously felt about their energy bills.

This easing of anxiety about energy bills may help account for the positive impacts on people's mental wellbeing which were found in all 3 measures taken of mental health (self-concept, sociability, and mood).

In future, perhaps mental health impacts and energy affordability should be included in the standard "Rationale" package for treating HTT homes, since they have emerged from this study as primary areas of impact.

There were no detectable improvements in people's attitudes to their home and its upkeep and also no improvements in physical health.

8.2. Critique of methodology

The study had many methodological shortcomings which should be taken into account when interpreting the results.

8.2.1. The sample

There were 34 households in the before and after segments of the survey, which was a small sample. The study was underpowered, and so could not detect anything other than the largest intervention effects within a repeated measures design. A sample of 100 or 150 households (with at least a quarter containing young children) would almost certainly have detected more effects, especially for physical health. In this sense, the findings reported here probably underestimate the potential health impacts of treating HTT homes. For this pilot, NIE Energy balanced concerns about cost against concerns about sample size for statistical analyses. The organisation's primary aim was to undertake a cost-effective pilot which could guide future planning, and for this the size and diversity of the sample was more than sufficient. In larger projects further down the line, the inclusion of bigger samples will permit a more comprehensive assessment of potential health impacts. It should also be noted that few HTTH projects include large samples. The EEPH Case Study Directory for the UK (2009) indicates that two-thirds treated fewer than 50 homes.

The sample was largely made up of pensioner households. The prevalence of pensioner households in the pilot is probably a reflection of the types of referral partners that were used to recruit participants, most of whom have a traditional focus on the welfare of senior citizens. It was also justifiable in the context of pensioner households being significantly over-represented in Northern Ireland's HTT homes. However, with the exception of the case study work reported in this study, little light was shed on the potential of HTTH interventions for younger households.

There were too few children involved in the study for any formal assessment to be made of the impacts on the youngest group, although the case studies reported here indicate excellent potential for impacts in households with children. What is particularly striking about the case studies where children lived in the house is the extent to which parents are concerned about the impacts of cold and damp conditions on the young. More focused work with young families is clearly needed.

The study also focused exclusively on rural households, which precluded any understanding of the potential issues and impacts for urban HTTH dwellers, particularly those in high-rise apartments. This focus was justified, since twice as many HTTH's are located in rural areas in Northern Ireland, but the emphasis should nevertheless be noted.

There remains important work to be done in urban contexts. In the month this report is published, the PPR Inquiry into the Seven Towers Housing Project in North Belfast was held in Grosvenor House (see PPR 2009). Residents of these HTT apartments were represented by a number of WHO officials who gave evidence concerning the deleterious impacts that the cold and damp conditions were likely to be associated with.

8.2.2. The measures

Whilst householders perceived considerable savings in heating costs, as well as some savings in electricity bills, these are estimates of savings which cannot be corroborated from actual client accounts. Evidence from many other studies (e.g. Green & Gilbertson, 2008 and Howden Chapman et al., 2009) indicate that participants in trials of this kind overestimate the savings made. In some cases, more rather than less is *actually* spent on heating and lighting post-retrofit, although customers perceive the opposite. However, given that the majority of respondents in this study were fuel poor, and many of them in severe fuel poverty, it is probably more important that homes *were* made significantly warmer – energy savings are a secondary priority. Nevertheless collection of utility consumption data in future studies is recommended.

8.2.3. The pilot

The retrofits were expensive to undertake. Without subsidy or low-interest loans, they offer no realistic solutions for many landlords, housing associations, or low-income home-owners. It is even unclear whether these results would translate into "able to pay" or equity-release markets. However, market segmentation of better-off households in HTT homes could be used to identify families who are already contemplating retrofits of this kind. For them, an awareness of the experiences of the present group might increase the chances that some would opt for the investment required. Since fully subsidized retrofits of the kind evaluated here are unlikely to be taken to scale in the medium term, using these results for leverage with able to pay and equity release households in HTT homes comprises perhaps the most important contribution of the present evaluation. Most of the households involved in the present study had told many other people about the success of their retrofit, and claimed they would be glad to tell more. They comprise a valuable group for marketing and outreach work among the able to pay and equity release markets. As noted by other agencies, there is an urgent need for promotional work of this kind to be undertaken in the UK because of the scale of uptake that is required to meet carbon reduction targets (e.g. EEPH, 2009). In the case of the present evaluation, the case studies offer illuminating accounts of the HTT home, and what life is like when it is no longer HTT.

That being said, area-based approaches to tackling HTT homes, particularly in urban areas where there may be pockets of high HTT concentration, would produce considerable economies of scale.

> A realistic costing of an areas-based approach is worth exploring for HTT homes, especially for areas of HTT concentration such as the cities of Belfast and Derry, and towns like Ballymena and Cookstown.

8.3. Ten recommendations for future work

8.3.1. The accuracy of targeting suggests that recruitment through experienced partner organisations should remain the strategy of choice for obtaining referrals to HTTH schemes in the future. However, the inclusion of additional agencies which have a more explicit focus on young families and children is recommended. Ensuring that consideration is given to whether vulnerable households, all of whom might be eligible for HTT interventions, are in fact able to cope with the refurbishment and new controls is essential. The present intervention gave evidence of best practice in this regard.

8.3.2. The confusion which some households experienced in knowing who was in charge, and who to contact when they encountered difficulties post-retrofit, indicates the need for a one-stop service, led by a single agency. Ideally, this should include a helpline telephone, whose number is displayed on stickers attached to equipment that is newly installed. An information leaflet which explains what the retrofit can achieve (energy savings and thermal comfort) and probably cannot achieve (e.g. cures for complex damp problems), as well as giving customers details of what to expect on the day of retrofit (i.e. disruption and some turmoil) is also recommended.

8.3.3. Given the extent of satisfaction with the scheme, opportunities for furthering household commitments to energy efficiencies and cost savings remained unexploited in the present scheme. It is recommended that a supplementary mentorship and support program be developed which partners households post-retrofit, so that any opportunities for *further* savings (through lifestyle changes or energy efficiency purchases) can be identified.

8.3.4. Whilst complaints were relatively few, an independent quality control service which is able to handle complaints and monitor standards is recommended.

8.3.5. The fact that open doors and exposed roofs caused considerable thermal discomfort, if only for a day, indicates a need to ensure that work of this nature is completed in the summer months for vulnerable households.

8.3.6. To the extent that householders might be persuaded to "decamp" for the day, the experience of disruption and being overwhelmed might be reduced, although this would require a great deal of confidence in the contractors, which this evaluation indicates room for improvement in.

8.3.7. Contractors could be encouraged to enhance the professionalism and customer-care elements of their work, at least in some cases, and training programmes which offer contractors opportunities for gold standard accreditation in HTTH customer care are recommended.

8.3.8. The Warwick and Edinburgh Mental Wellbeing Scale (WEMWBS) should be adopted as an instrument of choice for measuring mental health impacts. It offers a more multi-dimensional assessment of mental health than any other measure which have been used to date in the evaluation of fuel poverty schemes, since it measures three aspects of wellbeing, whilst the alternatives measure only one. It proved to have good reliability and a clear factor structure.

8.3.9. Affordability of energy and impacts on mental health should become incorporated into the core rationale for evaluating HTT home interventions in future. Exploration of their use as part of the rationale for tackling fuel poverty more generally could also be explored.

8.3.10. Actual as well as estimated utility bills should be monitored before and after retrofit, and care should be taken to ensure that householders do not over-heat their homes after installations have been completed.

8.4. In summary.

Up until this study was undertaken, Northern Ireland had only 1 published study on HTT homes. It had contained 5 case studies of subsidized retrofits, and reported 100% satisfaction, lower condensation levels, and reduced energy bills. Does the present study add more to these findings? It provided a first opportunity to test a variety of in-depth measures that were deemed to have potential for evaluating impacts from treating HTTH's. The measures that were used to estimate impacts in the surveys performed to a high standard in terms of factor structure and reliability, and highlighted a wide range of newly reported impacts.

The before- and after- nature of this study meant that households could be monitored in terms of their expectations of the scheme, and the realities that followed. This helped highlight the fact that householders greatly underestimated how much the retrofit would improve thermal comfort whilst also saving them money. In fact, the most common reason participants cited for becoming involved in the HTTH Pilot was the possibility of getting rid of damp and mould, even though the treatment of damp and mould were not part of the programme's portfolio of aims and objectives. In more cases than not, householders did notice improvements in damp and mould, but this was not unanimous and caused disappointment for some participating households. Ensuring that householders are informed that damp and mould may not improve post-retrofit is flagged as an important point of learning from the present study. Indeed, the importance of managing a wide range of householder expectations emerged as having been a vital component of the programme. Given that many HTTH residents are likely to be vulnerable through age, infirmity, and/or poverty, the programme's attention to detail in this respect is an important point of learning, What emerges strongest from this evaluation are the pictures painted by participants in the case studies. Their accounts are given without rancor or resentment, and they help us understand how living in cold and hard to heat homes presents vulnerable people with intolerable burdens. These are not of their own making, and they can see no solution to them. A greenhouse offers more comfort than the home it belongs to, and a mother spends the day feeling guilty because there was insufficient hot water for the needs of her mother's carers. These are households made fragile by a lack of the most basic amenities of warmth and hot water in their home. Returning to the three questions that were set out at the beginning of this report:

What are the experiences of agencies and householders involved in the delivery of a Harder To Treat refurbishment programme?

From the debriefing sessions undertaken with NIE Energy, three primary learning outcomes could be identified. First, ensure that householders are fully informed about what the retrofit will involve and what they should be prepared for when it takes place. Second, ensure that there is a clearly identified chain of responsibility between project management, surveyors, and fitters, with householders having a simple line of communication through which they feel empowered as partners in the process. Third, recruit installers who provide the highest quality of workmanship and customer care, without which participants will feel vexed long after the process has been completed.

What are the impacts of a Harder To Treat refurbishment programme on energy efficiency, energy affordability and energy management in the households?

From the points of view expressed by participants, the short answer is: profound. Participants reported warmer homes, more easily affordable energy, less anxiety about energy bills, and significantly more thermal comfort at home. They felt their homes – previously labeled hard to treat and eligible for demolition – now fitted an environmentally responsible agenda. It remains uncertain whether savings had been made in terms of operational carbon, since the study was unable to assess these. However, since respondents reported that they were heating more of their home and to a more satisfactory temperature, this evaluation estimated that at least half of the improvements were being taken in thermal comfort rather than carbon savings. Given the status of the participants, all of whom were in fuel poverty and some severely so, this seems entirely appropriate.

What impacts, if any, are to be found on the wellbeing and broader daily living patterns of householders involved in HTT refurbishment?

The mental wellbeing of participants was significantly improved post-retrofit. Although the study found no effects on physical health it is concluded that this may be the result of the sample being too small for trends in this domain to reach statistical significance. Attitudes to home did not change. Overall, homes were made more comfortable for families on low income, and the case studies in particular highlight how the lifestyles of participants improved. Prior to retrofit, households had been spending an average of 17% of their income on heating and electricity, and this reduced to 14% post-retrofit. This reduction in spend was accompanied by significant improvements in the ability to access decent heating and hot water. The intervention alleviated the severity of their fuel poverty, and significantly changed their perceptions of energy affordability and efficiency.

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