LOUGHBOROUGH UNIVERSITY

Energy Efficiency Refurbishment in UK Owner-occupied Homes: The Occupant's Perspective

Second Year Report

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Contents

1. INTRODUCTION

This is a re-submitted second year report, as requested by the Post Graduate Progression Board. It presents the progress to date as well as specifically addressing the feedback provided by the internal assessor during the second year review.

The assessor identified four areas to develop:

A. **Urgently revisit research questions in relation to the academic literature to identify a clear gap in the existing knowledge. In particular review how retrofit measures are currently being evaluated from a householder's perspective.**
   This is addressed below in section 1: Introduction.
B. **In particular, review the nature of the qualitative and quantitative data collected by the Retrofit for the Future projects and clearly identify how this study builds on this body of existing knowledge.**
   This is addressed within the literature review in section 3.3.11: Satisfaction from energy-efficiency refurbishment.
C. **Review how the planned data collection activities (both qualitative and quantitative) are addressing these research questions and amend where needed.**
   This is addressed within the Methods section 4.3: Data analysis outline, specifically in Table 3.
D. **Review case study methodologies and sampling strategies. The household sample is currently very skewed towards energy aware households. The examiner will need to understand why the case study households have been selected and the research data needs to be interpreted in relation to the characteristics of the sample.**
   This is addressed within section 5.1.1 and 5.1.2.

The refurbishment of the UKs homes, to improve their energy efficiency, is an essential part of the UK's carbon emissions reduction strategy. This research seeks answers to key questions:

a) What are the occupant expectations of an energy efficiency installation and what do they actually get?
b) Do the occupants perceive an internal environment improvement?
c) Do the householders actually save money, energy and carbon?

This research focuses on privately funded refurbishment, whereas much of the previous research has been based on funding by government schemes such as the Carbon Emission Reduction Target (CERT) and the Community Energy Saving Partnership (CESP). However, social housing occupants often have either no or little choice of their refurbishment measures (Chiu et al, 2012). Social tenants do not provide their own funding nor select contractors and usually have little part in the timing and planning as the works have usually been part of a community refurbishment project. Therefore, it is argued that the occupant experiences of social tenants will differ greatly from that of an owner-occupier. This research is well timed to capture the experiences of owner-occupiers in the early stages of the Green Deal.

The experiences of the early owner-occupier adopters may affect the future adoption of measures. Research by Crosbie and Baker (2010) found that occupants can develop negative attitudes towards an installation experience due to technological faults or internal disputes leading to problems with contractors' workmanship (Crosbie & Baker, 2010). Faults and disputes are unexpected complications. Householders are often willing to tolerate surprising levels of disruption, but unexpected delays or complications can cause considerable stress (Vadodaria et al, 2010).

Owner occupiers have featured in related research. This includes an exploration of decisions to refurbish (Wilson et al, 2013), motivations (Organ, 2013) and barriers to domestic refurbishment (Mallaband et al, 2012) in addition to timescales for refurbishment (Fawcett, 2013). The present research focuses somewhat on why people decide to install measures in the home in order to find out what they expect as a result of the installation. The expectations also incorporates the expected time the measure takes to install. Studies have also been carried out to measure the experiences of UK owner-occupiers in new homes with low-carbon technology such as the NHBC report by Sexton and Lees (2013). This research is useful as it focuses on the experience of the householders in a more holistic way encompassing the usability of their home in addition to comfort and energy consumption. More specifically related research has been carried out further afield. One study in Norway focused on the success of energy efficiency renovations of owner-occupied dwellings (Risholt and Berker, 2013). This research did take into account the internal environment and actual energy consumption in addition to occupant behaviour, decision making and experiences. However, the majority of data was collected during one visit, post-installation unlike the continuous monitoring and multiple visits used here.

The refurbishment industry has increased pressures as a result of sustainability targets (Juan, 2009). Focus on customer satisfaction is still at the early stages of development (Holm, 2000 and Karna, 2004).

Related research has primarily taken pace in Sweden, Finland and other European countries. Therefore, research on the owner-occupied experiences of an energy-efficient refurbishment process, has not yet been carried out to a great extent in Europe or at all in the UK. This introduction demonstrates that there is a gap in the knowledge that is addressed by this research. More detail on how retrofit measures are currently being evaluated from a householder's perspective can be found in the literature review in Section 3.

2. AIM AND OBJECTIVES

The aim of this project is to identify the key factors influencing the success of energy efficiency improvements to UK owner-occupied dwellings from the occupant's perspective.

This will be explored through the following objectives:

a) To identify the householders' expectations of the energy efficiency improvement process. This will incorporate their understanding on the installations, their estimation of time and financial costs, their existing knowledge of available measures, their expectations of the process of fitting and expected disruption. This will be later compared with the actual process.

b) To ascertain what happens during the actual delivery process of the installation. This will cover the occupant's experiences throughout the process. Particular focus will be paid to the installation of the measures, time taken and cost, disruption or any additional unexpected factors experienced.

c) To evaluate and compare the levels of thermal comfort and quality of living environment before and after the refurbishment. This will include the occupant's perceptions and quantitative measurements of temperature, relative humidity and building fabric air-tightness.

d) To quantify the energy, fuel and subsequent CO_2 and financial cost savings using measured and modelled data. This will focus on the energy consumed for space heating by comparing usage before and after the refurbishment using meter readings.

e) Identify where the occupants' expectations are not met and where they are exceeded, to ensure householder satisfaction and help encourage future adoption. This will detail how the process of energy efficiency refurbishment can be improved to maximise the benefits to the occupant - both perceived and actual.

3. LITERATURE REVIEW

This literature review builds on the work previously presented in the first year report. In particular, it focuses on how retrofit measures are currently being evaluated to consider the householders' experiences and how this study builds on the body of existing knowledge.

3.1 Housing refurbishment in the UK

Housing refurbishment is becoming increasingly demanding within the construction industry due to more emphasis on sustainability over the last decade (Juan 2009). The industry needs to shift from providing basic repair and renovations to installing up-to-date energy efficient technologies which are user-friendly and perform well. Refurbishments require more complex co-ordination than new buildings in addition to risk and uncertainty. In addition to this, a key report by Egan in 1994 set out five drivers for change for the whole industry which included a focus on the customer, a quality driven agenda and commitment to people (Egan, 1994). Construction has become a service industry across Europe and now adopts measurement tools from the field of service management. There is however, still a lack of research on the UK owner-occupied occupant perceptions of housing refurbishment, especially the installation of energy efficiency measures (Karna, 2004).

3.2 Occupant demand for housing refurbishment

As the majority of UK housing stock is currently owner-occupied, the occupants have a responsibility to ensure their homes are well maintained and fit for future generations. Variable levels of householder awareness were considered to be the most difficult environmental and cultural barrier faced in the uptake of low-carbon housing refurbishment (Davies and Osmani, 2011). This research recommended capturing views of end-users in housing refurbishment to establish the current practice, hindrance and enablers and to explore and assess the contribution low carbon refurbishment can make in achieving an 80% CO2 reduction by 2050 (Davies and Osmani, 2011).

3.2.1 Motivations

Research by Organ, Proverbs and Squires (2013) categorised motivations to refurbish into broad themes of economic, social and environmental motivations. This research was partly psychological and describes a new motivation model for energy-efficiency refurbishment of the owner-occupied housing stock, as shown in Figure 1 (Organ et al, 2013). This model was developed from a review of literature and incorporates both internal and external factors demonstrating how they are inter-related and may be affected by external factors. The internal factors are shown in the centre and the energy efficiency motivation and action are shown in the outer layers. External factors include current incentives, penalties, social norms, housing market, property condition, cost of works and

regulation (Organ et al 2013). As the current research develops the internal and external factors for each case study dwelling will be captured and it may be possible to establish how the internal factors such as decision making, trust and expectations are affected by external factors such as policies such as The Green Deal, the individual property condition and the cost of the work.

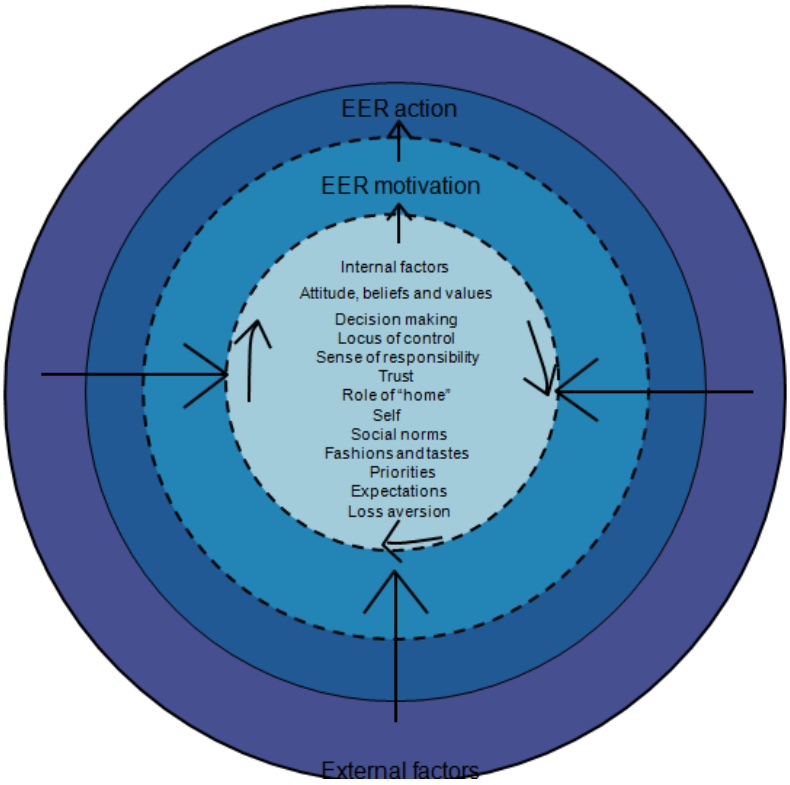


Figure 1.Motivation for owner-occupied housing refurbishment (Organ et al, 2013).

3.3 Occupant experiences of housing refurbishment

The occupant's experiences of housing refurbishment are the focus of this study. Literature relating to this has been found on thirteen key areas: decisions, planning, routines, investment, timescales, service delivery, comfort, satisfaction, success and rebound.

3.3.1 Refurbishment decisions

Research carried out by Wilson et all (2013) as part of the VERD project, which aims to understand homeowner's refurbishment decisions, found that occupant's refurbishing for repair and maintenance and saving energy have similar decision making processes. This is useful as all of the present research case studies are motivated to refurbish for either one or both of these reasons to some degree. Wilson et al (2013) also found that efficiency installers are no more influenced than

government policy than any other category. They carried out a survey of 1028 homeowners and interviewed 35 of the survey respondents between January and May 2012. At the survey stage 19% were thinking about renovations, 16% concretely planning and 15% in the middle of finalising renovations. They categorised refurbishments into: renovations, energy efficient renovations and amenity renovations. The decision to renovate was usually a lengthy one with most occupants planning to carry out the work for over a year. Decisions to go ahead were often based on positive attitudes towards renovating, social norms and being open to ideas from external sources. Home and household characteristics were not found to directly explain why people renovate. In terms of contractor selection, householders were found to prefer small local companies with good customer support. They also found via choice experiments that home-owners theoretically find the Green Deal attractive. However, work initially planned to be an 'efficiency-only' refurbishment is unlikely to be 'efficiency-only' by the time work starts. This may be due to recommendations made by contractors influencing the occupant's, or, the occupant's realising it will save time or money in the long-run to carry out additional work alongside the energy-efficiency installation. Conversely, research in the Netherlands by Konstantinou and Knaack (2011) found that decisions taken early in the design process determine the final result. The case studies used in the present research will be asked about their expectations and motivations in the pre-installation interview. This will be compared with what actually happens in the post-installation interview to see if they have changed their approach and the selected measures.

3.3.2 Information sources

Where people turn for information deters their knowledge of the available measures, the potential benefits of the measure and the potential risks of installing a measure (Nair et al, 2010a). Research by Nair et al (2010a) in Sweden focused on the owner-occupier's perception of the adoption of building fabric insulation measures. They found that the most important sources of information for householders looking to install wall insulation were interpersonal sources, construction companies, installers and energy advisors (Nair et al 2010a). The present research seeks to gain insights on where UK owner-occupiers find information from and whether this differs to findings from Sweden.

3.3.3 Occupant perception of refurbishments and cultural norms

One concept which is often considered to be a factor in the adoption of energy-efficient installations is cultural norms. As installations become frequently adopted more people may accept them as a positive addition to their home. Research in Sweden, once again by Nair et al (2010a) found that 70-90% of occupants had no intention of adopting building envelope energy efficiency measures in Swedish detached houses over the next ten years. This was based on a survey of 3059 home-owners

in Sweden. This may show that the idea is still not the cultural norm in Sweden. The research mentioned previously, by Wilson et al (2013), also highlights cultural norms as being a key factor in the decision making process in the UK. Other research by Christie et al (2011) supports this. Christie et al (2011) carried out interviews with homeowners and found that the primary reason for not adopting double glazing, or solar water heating, was not the cost but their perception of risk, socially and cognitively. Their current situation was often the safest option. Financial and functional risks were reported but one risk was being the first to adopt a technology as they may be seen as different to others. They argued that if the rate of adoption increased, this would become less of an issue and the focus needed to be on how the perception of change can be minimized to encourage adoption of energy-efficiency technologies to become the social norm. The present research will consider cultural norms in each case studys' acceptance of energy efficiency measures.

3.3.4 Household routines and the sociology of consumption

Previous research has focused on the routines of householders. Research in Australia studied daily routines, in addition to environmental concerns and future plans (Cecily et al, 2011). They interviewed sixteen Australian homeowners in 2008. They argue that the most effective way to normalise energy efficiency technologies, and to encourage further adoption, is to consider daily routine practices instead of short-term financial incentives. Their research appeared to evolve from Elizabeth Shove's previous work (Shove, 1998). Shove reported that consumption is based on a set of practices to allow people to express their identity, be part of social groups or exhibit social distinction and ensure participation in social activities amongst other things (Shove 1998). In terms of housing refurbishment, households may opt to refurbish to provide a comfortable home which their family enjoys living in and which they feel happy to invite others into.

Recent research in this area by Sexton and Lees (2013) on low-carbon technologies in new homes found that any potential disruption of a household's everyday life due to the installation of a low-carbon technology can lead to dissatisfaction with that product, and even the home as a whole. The household practices may also prevent the energy savings from being made. The data comes from interviews in the homes of nine case study housing developments. Two 60-90 minute interviews were conducted with each householder in their home.

3.3.5 Planning and communication

The complex nature of domestic refurbishment can result in distorted communication between contractors and occupants which may affect customer satisfaction and performance, or success. A study by Juan (2009) in Taiwan proposed a systematic decision support approach to solve refurbishment communication problems. This is intended to enable occupants to select contractors

based on their personal needs and this should consequently equal a greater satisfaction of the whole process. Figure 2 shows this model and illustrates how the user needs which initiate the refurbishment lead to the refurbishment needs, the steps in the middle outline the actual refurbishment process and the final step includes five factors which can be used to assess occupant satisfaction based on their experiences with contractors: tangibles, empathy, reliability, responsiveness and assurance.

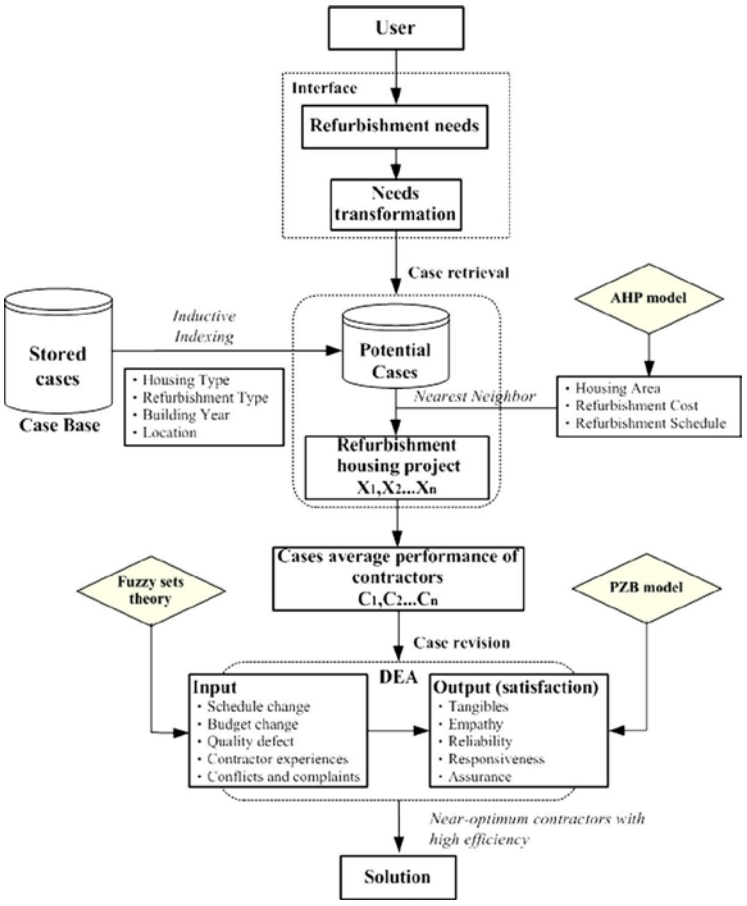


Figure 2. Evaluation model for refurbishment contractor and occupant communication [WILL BE REDRAWN]

3.3.6 Investment

Other research by Nair et al (2010b) in Sweden found that, for most Swedish homeowners, it was important to reduce their household energy use and most had undertaken no-cost measures as opposed to investment measures. This was based on a 2008 survey of 3,000 owners of detached properties. Personal attributes such as income, age, education and contextual factors such as house age, thermal discomfort, past investment and perceived energy cost influenced their preference for a particular type of energy efficiency measure.

3.3.7 Timescales for refurbishment

Tina Fawcett carried out research titled 'Exploring the time dimension of low carbon retrofit: owner-occupied housing' (Fawcett 2013). The paper considers three key questions which will be useful to bear in mind during the current research: "whether an over-time low carbon retrofit could be attractive for owner-occupiers; whether it could deliver sufficient carbon and energy savings; and what policy support would be needed?" Fawcett used householder survey and qualitative data as well as the timescales that typically apply to housing, refurbishment and owner-occupiers. The findings suggest that over-time retrofit could attract some householders in achieving a 60% carbon saving and policy design could assist this.

Fawcett has also co-authored a paper titled 'Building Expertise: Identifying policy gaps and new ideas in housing eco-renovation in the UK and France (Fawcett et al 2013). As the current research hopes to draw conclusion to advise policy-makers, Fawcett's work may be useful to consider during the recommendations stage of this research. Fawcett (2013) aimed to identify the policy gaps regarding energy-efficiency domestic refurbishment. The paper presented summaries and comparisons of existing policy (at the time of writing) and compared those with known barriers to refurbishment. Fawcett found that most policy focuses on reducing cost to householders and there is lack of attention given to other barriers such as a lack of information, motivation or trust in professionals. New policy ideas which incorporate consideration to 'over-time' refurbishment were discussed.

'Retrofitting existing housing: how far, how much?' (Jones et al 2013) found that existing funding opportunities such as the Green Deal do cater for an 'over-time' refurbishment, or 'shallow elemental measures' which can achieve reductions in CO_2 emissions by 10-30%. However, they found that the payback periods for deep refurbishments which could achieve 60-80% reductions were not currently feasible via the existing funding mechanisms. They used a combination of modelling techniques (Energy and Environmental Prediction model) and two whole-house refurbishment projects, one of which is being monitored long-term (Jones et al 2013). Previous research, which was included in the first year report, by Firth and Lomas (2009) provided the chart shown in Figure 3 which estimates the savings wall insulation, replacement boilers and double glazing can make to household CO_2 emissions ($kTCO_2$). The chart shows that solid wall insulation is estimated to save just below 15%, cavity wall insulation around 18%, efficient condensing gas boilers replacing old gas boilers just over 20% and double glazed windows replacing single glazed windows is estimated to save almost 30% in CO_2 emissions (Firth and Lomas, 2009). This chart will be used comparatively with the actual savings made in the case study dwellings following the installation of energy efficiency measures.

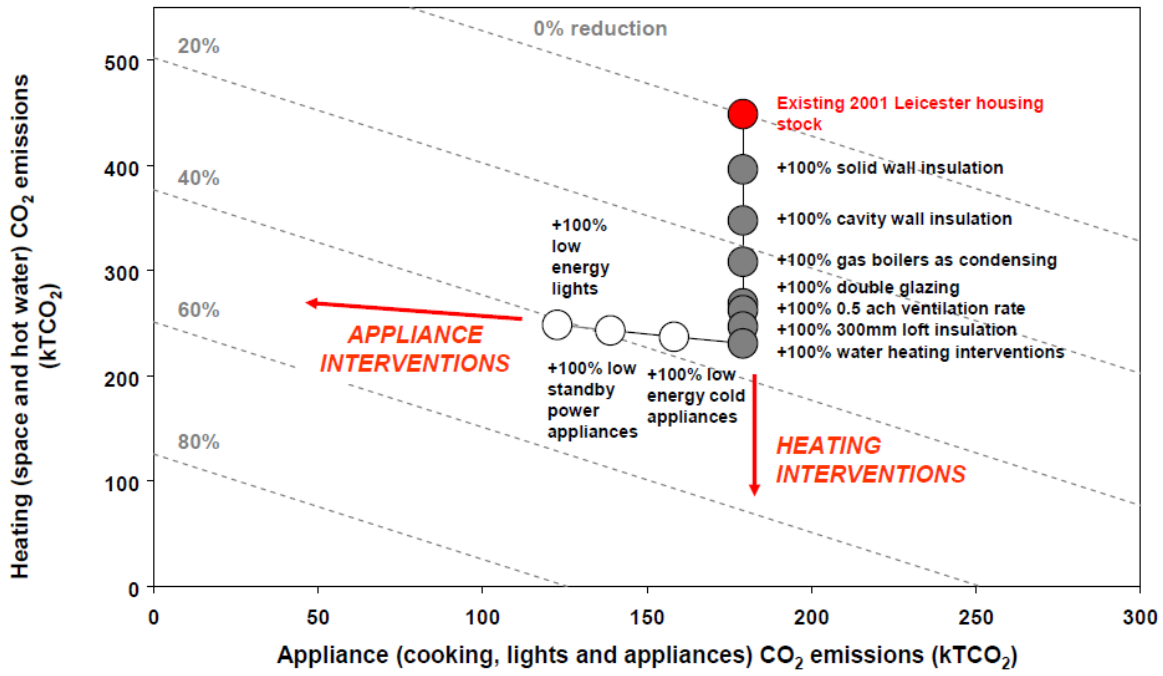


Figure 3. Potential savings from insulation, glazing and boiler improvements alongside electricity appliance savings (Firth and Lomas (2009)

3.3.8 Expectations and service delivery

In Sweden in 2000, it was reported that whilst the quality of work in construction had been highlighted it was unusual to find housing refurbishment projects which had been carried out with a clear emphasis on the service provided for tenants (Holm, 2000). Holm (2000) carried out a survey tenants living in two multi-family housing estates owned by a semi-public housing estate in Sweden. He found that there was strong link between meeting the customers' expectations and contractor reputation (Holm, 2000). He also surveyed 32 contractors and found that there were high significant correlations between workers feeling well informed and having regular contact with occupants and receiving feedback about their quality of work (Holm, 2000).

3.3.9 Comfort in the home

Other research carried out in Sweden by Zalejska-Konsson (2012) focused on the occupants experiences of living in a low-energy home in comparison to a traditional home. The study used an occupant survey to find out about perceived satisfaction and indoor comfort. Questions on temperature, air quality, acoustics and heating use were included. Surveys were sent to occupants living in the properties of three low-energy and three conventional homes. Responses were compared and the statistical difference was tested. They found that both sets of occupants could be either satisfied or less satisfied. However, their satisfaction may decrease if thermal discomfort leads

them to use supplementary heating. Issues relating to ventilation and heating occurred in both sets. Their results suggested that the low-energy buildings required less system adjustment which they believed may lead to a better investment from a life-cycle perspective. The occupants also suggested that the 'green' credentials of the low-energy homes have a positive impact on their environmental awareness and behaviour. Another key finding was that occupant feedback is an important part of building performance assessment.

A study by Mlecnik et al (2012) focused on end-user experiences in nearly-zero-carbon homes. The project analysed German, Austrian and Swiss post-occupancy results in nearly-zero-carbon homes and took a survey of occupants in those home types in the Netherlands. They determined how various comfort parameters including thermal comfort, indoor air quality and acoustics, information provision and control parameters result in positive or negative occupant appraisal. They also found that summer comfort design and information on operating heating and ventilation systems were the critical factors to address in improving occupant satisfaction.

In the UK Lomas and Kane carried out a study titled 'Summertime temperatures in UK homes: a case study of houses in Leicester' (Lomas and Kane 2012). There is increasing concern for summertime temperature in UK homes and particular uncertainty about the impact of refurbishment. They found, from a sample of 282 homes, which included 230 which 28% of the living rooms and 88% of the bedrooms were classed as severely overheated by CIBSE criteria. However, in contrast 64% of the living rooms and 71% of the bedrooms were classed as uncomfortably cool by the adaptive thermal comfort standard detailed in BSEN15251 CAT II. The data will be useful for comparison with the current research results. The current case studies are asked about their comfort levels within the interviews in addition to measurement of air temperature within each room of the property.

3.3.10 Usability of installed measures

There is increased awareness that the effectiveness of installed energy efficiency measures often depends on the users having the knowledge of how to operate it correctly. The research carried out by Sexton and Lees (2013) found that although low-carbon technologies are increasingly being installed in new homes there is a risk that this could lead to dissatisfaction with their homes because of energy bills becoming higher than expected and consequently carbon emission targets would not be met.

3.3.11 Satisfaction from energy-efficiency refurbishment

Retrofit 4 the Future (R4tF) funded by the Technology Strategy Board recently published a report titled 'Retrofit Revealed: The Retrofit for the Future projects – data analysis report' (TSB, n.d). R4tF

was an energy efficiency refurbishment project aiming to reduce carbon emissions of 100 existing homes by 80% or more whilst maintaining an adequate level of thermal comfort at an affordable rate for the occupants. The analysis report included 37 dwellings owned either by local authorities or social housing providers, mostly two-storey and a combination of archetypes. This aimed to: identify the energy and carbon performance following an energy-efficient refurbishment; explore the occupant comfort and satisfaction; and to identify common success factors, lessons and challenges from the delivery. This research methodology provides a framework for the current research.

A qualitative post-occupancy evaluation 10 London houses from the R4tF project was undertaken by UCL-Energy and the Institute for Sustainability (Chiu et al 2012). The houses were selected from 25 London projects including a mixture of house types and building ages with a variety of social and economic households. Again, the case studies R4tF sourced were from a £150,000 R4tF competition offered to social landlords to carry out refurbishments. This means that either part or all of the case studies were social housing, which distinguishes the sample from the current research. As in the current research, the households were interviewed three times to explore the occupant's' experiences of refurbishment. The study included thermal comfort assessments before and after the refurbishment and their satisfaction with the refurbished home and the overall R4tF programme. The findings of this will be valuable for comparison. However, as the current research studies owner-occupied homes the results will differ greatly. The main reasons for the importance of carrying out similar research on owner-occupied homes is that owner-occupied households are making a decision to install measures, doing their own research on available options, planning their own funding, timescales and accepting the risks which all of this entails.

The findings provided a number of insights under fourteen key lessons. These lessons are useful to consider for the present research are: Know the occupants and understand the appropriate style of engagement; include occupants (and landlords) in the planning process; help the occupants to cope with the disruption; assist occupants though changes to their daily lives; help the occupants adapt to new technologies; understand the interactions between the occupants and those technologies; understand occupants thermal preferences; provide appropriate information and communication; consider additional aspects of comfort such as lighting; allow occupants to be actively be involved in the monitoring so they feel at ease with it; consider how the process may impact the occupants perception of environmental retrofit programmes; be aware of the health impact of the work – positive and negative; occupants overall satisfaction will be affected by the benefits they receive from the work (Chiu et al 2012).

Research in Finland found that the measurement of customer satisfaction in this field is still at an early stage of development (Karna, 2004). Karna has produced a framework for measuring customer satisfaction in this area via surveys or interviews which includes factors which fit under the following sub-headings: quality assurance and handover, environment and safety at work, personnel, co-operation and site supervision and sub-contracting. The list of factors will be useful to refer to in the present research. According to Karna (2004) customers are satisfied when the perceived performance is greater than the standard and dissatisfaction occurs when performance falls short of the standard. There is also a big difference between being merely satisfied and completely satisfied.

3.3.12 Success from energy efficiency refurbishments

Research in Norway by Risholt and Berker (2013) found that homeowners who are conscious consumers or have knowledge of energy efficiency measures succeed in saving energy. They also suggested that contractors could be mediators between available measures and specific buildings. This was based on case studies of Norwegian privately owned single family houses built between 1980-1990. The energy efficiency status of 102 dwellings mapped. Conditions were analysed from visual examination reports, which could be similar to surveys in the current research. The condition and upgrade status of 91 houses were categorised. Eleven dwellings were then further investigated and had a detailed analysis of their technical condition, occupants' energy behaviour, their renovation decision processes and their experiences from renovation. They selected suburban large houses with substantial heating energy demand. They carried out semi-structured interviews with the householders in November 2011. Interviews lasted around an hour and questions covered energy use, energy efficiency, quality of living in the house, the technical condition of the house and the renovation experience. The data are all taken post-renovation and the qualitative findings are based on just one interview with the homeowners. As most Norwegian's own their home, they recognised that private homeowners are a key group to increase energy efficiency rates of dwellings.

4 METHODS

This section summarises the methods used in this research. The research is carried out by collecting data from case study households that were planning to carry out a refurbishment of either wall insulation, boiler replacements or window replacements.

4.1 Method outline

The methods adopted are outlined in Table 1.

Table 1. An outline of the methods and related tasks

Method section	Notes
Recruitment	Participants were identified via word-of-mouth, emailing local groups, posters and energy-workshops.
Interviews	Semi-structured 30-60 minutes held in the case study homes with the homeowner/s pre, during and post installation.
Building survey	Measured including notes for SAP model.
Temperature monitoring	HOBO temperature pendants in each room and outside. Collecting data at 30 minute intervals. Mar 13 – May 14
Relative humidity monitoring	HOBO U12 monitors in living rooms. Collecting data at 15 minute intervals. Mar 13 – May 14.
Fabric permeability/air tightness testing	Blower door tests pre and post-installation. Depressurisation method Type A.
Interview analysis	Thematic analysis focusing on key points of objectives.
Building modelling	SAP models using data from building survey and measured temperature and air tightness.
Measured temp. and relative humidity data analysis	Averaged per room and month using Excel.

4.2 Case study recruitment

Owner-occupied UK household case studies at the planning stage of a refurbishment were selected during the late winter of 2012/2013. The refurbishment criteria was: wall insulation: internal, external and cavity, boiler replacements and window replacements. Case studies were sourced by word-of mouth, energy saving workshops, a local architect and local community groups. Information on the case studies is provided in section 5.1.

4.3 Data collection stages

Data collection is on-going in the case studies. The data collection is divided into three main stages: pre-refurbishment, during-refurbishment and post-refurbishment as shown below and in table 2.

Table 2. An overview of the methods

PRE-REFURBISHMENT	DURING-REFURBISHMENT	POST-REFURBISHMENT	ONGOING
Interview one	Interview two	Interview three	Temperature monitoring
Building survey	Photographing the installation	Testing dwelling air tightness	Relative humidity monitoring (one year)
Temp. monitoring setup	Gas and electricity meter readings	Modifying the model with new installation additions, further temperature data and new air tightness results	Energy monitoring (via meter readings for one year)
RH monitoring setup			
Energy meter readings			
Testing dwelling air tightness			
Photographing the front and rear of the homes and installation area			
Modelling the dwellings using SAP09			

The quantitative data will be used to support the interview data. Throughout the design of the methodology, the case study sourcing and the actual data collection, the approach to analysing and presenting the required data has been carefully considered to ensure the research questions are adequately answered. During the planning stages this was crucial to ensure all data collected from the households are necessary.

4.4 Data analysis outline

The data analysis outline is shown in Table 3. Each interview (pre, during and post) are shaded progressively darker orange. The objectives that relate to each interview analysis theme are shown in the left-hand column. The interview analysis themes are in the central column. The research questions each section answers are listed in the right-hand column. The themes which the quantitative data supports are in large bold text, namely: occupant comfort, temperature, air quality, draughts and damp against objective C - energy consumption, energy costs and energy efficiency against objective D.

Table 3. Objectives, analysis themes and research questions

The themes in large bold text are supported by quantitative measurements.

Objective	Interview analysis themes	Research question
Pre-installation interview		
A) To identify the householders' expectations of the energy efficiency improvement process. This will incorporate their understanding on the installations, their estimation of time and financial costs, their existing knowledge of available measures, their expectations of the process of fitting and expected disruption. This will be later compared with the actual process.	Reason to install: Expectations Knowledge of measure Used sources of information Trusted sources of information Expected process of fitting Expected start and finish date Expected duration of fitting Expected cost Expected installers Expected number of installers.	1. What are the occupant expectations of an energy efficiency installation and what do they actually get?
During/just after installation interview		
B) To ascertain what happens during the actual delivery process of the installation. This will cover the occupant's experiences throughout the process. Particular focus will be paid to the installation of the measures, time taken and cost, disruption or any additional unexpected factors experienced.	Experiences of the fitting process Installer used Duration of fitting Start and completion date Cost Changes to daily routine during the process Comfort during the process: Safety, security, thermal, air quality, noise, mess, unexpected inconvenience. Unexpected factors	1. What are the occupant expectations of an energy efficiency installation and what do they actually get?
Pre and post interviews: to be compared		
C) To evaluate and compare the levels of thermal comfort and quality of living environment before and after the refurbishment. This will include the occupant's perceptions and quantitative measurements.	**Occupant comfort: temperature, air quality, draughts, damp,** acoustics, aesthetics, lighting.	1. What are the occupant expectations of an energy efficiency installation and what do they actually get? 2. Do the occupants perceive an internal environment improvement?
D) To quantify the energy, fuel and subsequent CO_2 and financial cost savings using measured and modelled data. This will focus on the energy consumed for space heating by comparing usage before and after the refurbishment. The air permeability of the fabric will be measured before and after the work, this will also be an input to the SAP model.	**Energy consumption** **Energy costs** **Energy efficiency** Fuel provider Heating patterns Thermostat temperature	1. What are the occupant expectations of an energy efficiency installation and what do they actually get? 3. Do the householders actually save money, energy and carbon?
E) Identify where the occupants' expectations are not met and where they are exceeded, to ensure householder satisfaction and help encourage future adoption. This will detail how the process of energy efficiency refurbishment can be improved to maximise the benefits to the occupant - both perceived and actual.	Expectations met Expectations not met Expectations exceeded Recommendations for policy makers, industry stakeholders on installer trainers made by occupants	1. What are the occupant expectations of an energy efficiency installation and what do they actually get?

5 PROGRESS MADE DURING THE SECOND YEAR

During the second year case studies were sought, data collection started and the majority of data collection carried out. Figure 4 shows the data collection timeline, this includes the data collected already and that planned for 2014.

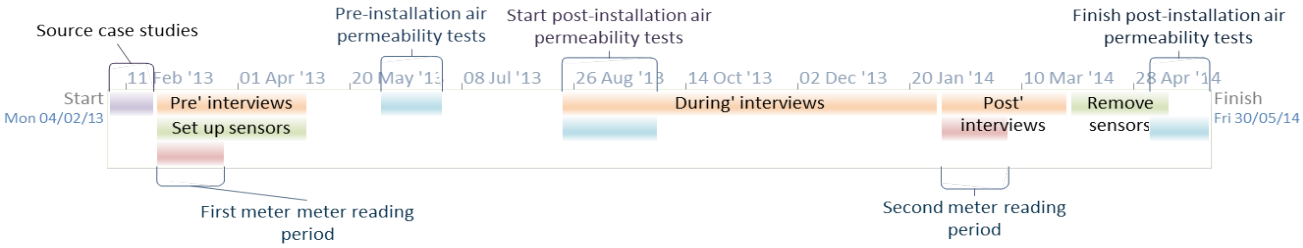


Figure 4. Data collection timeline

Table 4 adds a little more detail for each element of the timeline, colour coded as in the timeline.

Table 4. Data collection methods, dates carried out and notes

Data collection method	Carried out	Notes
Interview: Pre-installation. One hour semi-structured.	Feb – Apr 2013	Complete: Held at the start of a four week winter monitoring period.
Energy recording: Meter readings for a four week period	Feb - Mar 2013	Complete: Some households continued meter reading over the year.
Set up sensors: Air temperature: each room and outside.	Feb - Mar 2013	Complete: Once set up the sensors were left for twelve months of data collection.
Set up sensors: Relative humidity. Living room.	Feb - Mar 2013	Complete: Once set up the sensors were left for twelve months of data collection.
Pre-installation fabric permeability tests	June 2013	Complete: All depressurisation unless they had open oil flues or very dusty open fires.
During installation interviews	Aug 2013 – Jan 2014	On-going: Carried out as individual installations complete.
Post-installation fabric permeability tests	Aug 2013 – Oct 2013 and May 2014	On-going: Households which completed in the colder months will be tested in May 2014 to minimise disruption to their thermal comfort.
Post-installation interviews	Feb - Mar 2014	To do: During the winter months
Second meter reading period	Feb 2014	To do: 4 weeks during the winter. Some households have continued reading their meters throughout the year but not all.
Remove sensors	May 2014	To do: This can take place during the final air permeability test.

The pre-intervention interviews are complete and the eight during-intervention interviews are complete. Two more case studies are hoping to complete by February 2014 and two other whole-house refurbishments have started. The post-intervention interviews will be carried out February 2014. The temperature and relative humidity data collection period has been extended to one full year in each house. The sensors will be removed during the final house visit in May 2014. The energy monitoring via meter readings has also been extended to one year at intervals suitable to the individual households. The extensions were approved by the Ethical Advisory Committee in May 2013.

5.1 Case studies

Fourteen case studies including the pilot study were recruited. Six were recruited by word-of-mouth via colleagues, friends and university internal emails, three were recruited through energy-saving workshops, three were recruited via a local architect who has worked on previous whole-house refurbishments and one was recruited via a local community group. These methods were selected as they were considered to be effective, efficient and low-cost ways to recruit trustworthy homeowners at the planning stage of a refurbishment within the next year.

5.1.1 Sample

The case studies are a variety of archetypes, sizes and household makeup with a mix of planned measures, sequences of work and funding sources. Four of the case studies are installing measures with the primary goal of reducing their household energy demand, six needed to carry our repairs or replacements and the energy efficiency or increased warmth aspects are an added bonus, four primarily need to replace building elements. Table 5 presents an overview of the case studies.

Table 5. An overview of the case study participants

I	Ca	Location	House type	Year built	No. of adult	No. of infant	Floor area (m	Work planne	Why	Planned by:	Expected cost	Funding source	Expected time
1	A	Beeston	Detached house	1890	2	0		EWI x 2 w indow s	Refurb + energy	ow ner		Private	
2	B	Leicester	Semi	1930s	2	0	*74.2*	2 x triple glazed w indow s	Energy saving	ow ner	£5-10,000	Private/ ECO grant	1-2 days
3	C	Leicetser	Semi	1934	2 to 3	0	84	EWI	Energy saving	ow ners		Private/ ECO grant	
4	D	Bistall	Cottage	1921	2	1		EWI	Refurbr + energy	ow ner	3,000+	Private/ Green Deal	1 w eek
5	E	Loughborough	Detached house	1982	2	0		Boiler	Boiler is faulty	ow ner	£5,000	Private	1 w eek
6	F	Nottingham	Semi	1925	2	0	*192*	passivhou s refit	Enegy saving	ow ner + architect	£100,000	Private	3 months
7	G	Harrogate	Semi	1964	2	0	87.7	EWI and boiler	Boiler is old + house is cold	ow ner	£2,270	Private	3.5 days
8	H	Sw allington	Detached house	1830s	2	1	*111*	EWI + refit	Refurb + energy	ow ner + architect + builder	£100,000	Private	no plan
9	I	Birstall	Semi	1950s	2	1	90.8	EWI and 2 w indow s	Energy saving	ow ner	£1,400	Private/ ECO grant	1 day
10	J	Norfolk	Detached house	16-1700s	1	0		Window s	New w indow s needed	ow ner	£9,995	Private	3 days
11	K	Loughborough	Semi	1937	2	new baby	74.2	ext, boiler and EWI	Extension and reliable boiler needed for new baby	ow ner + builder + AT		Private	3 months
12	L	Leicester	Semi	1950-60s	2	new baby	82.1	Boiler	Reliable boiler and w indow needed for new baby	ow ner	£3,000	Private	1 day
13	M	Peak District	Detached Farmhouse	1830	2	2	142	IWI, boiler + refit	Energy saving +refurb	Peak district national park + architect + occupant	£170,000	Peak District Authority	2-3 months
14	N	Loughborough	Semi	1970s	1	2	61.8	Boiler and IWI	New boiler needed + energy saving	ow ner + father		Injured Players/ ECO	3 days

5.1.2 Categorising occupants

As this research seeks to gain insights from case study households it is necessary to categorise the case studies to understand how to apply the insights to future refurbishment projects. This process is ongoing and during the second year, research has been carried out to identify a robust way of categorising the case study households. As a result there are three categories of refurbishment type, five categories for the life-stage of occupants and seven potential categories for the environmental attitudes of the householders. Some data which will help this process was collected in interview one, primarily: household size, age of occupants, the reasons why people are refurbishing their home. The final interview questions have been drafted to include further questions which will help distinguish each household into categories. Table 6 shows an example of how the three different categories could be combined to place each case study household. Appendix 4 includes the initial stage of drafting of questions to include within the third interview, to help categorise people.

Table 6. Categorising case study households

Wilson (2013) / Munro & Leather (2000)	**Amenity-only renovators**	**Mixed renovators**	**Efficiency-only renovators**
Young household			G
Household with children		H, K M	D, I, L, N
Potential mover		**CONCERNED CONSUMERS**	**POSITIVE GREENS**
Empty nester/ pre-retirement		A, E, J	B, C, F
Older household			

Colour coded labels refer to the DEFRA (2008) report categories

5.1.2.1 Refurbishment type

Wilson et al (2013) categorised refurbishments based on the work they were planning to undertake. However, the categories are quite broad as the research was based on a survey of 1028 homeowners, about half of which were not planning a refurbishment at all. Due to the selection criteria for the current research all case studies will be either efficiency-only renovators or mixed-renovators according to Wilson's categories:

- **Amenity-only renovators**

  This category includes major structural changes to kitchens, bathrooms and other living spaces in the home. This may affect energy efficiency but not directly.
- **Mixed renovators**

  This category is a mix of amenity-only renovations and efficiency-only renovations.
- **Efficiency-only renovators**

  This refers to renovations involving windows, doors, heating and hot water measures or insulation. Efficiency measures.

As part of the work carried out by Wilson et al (2013) they identified five conditions which may help explain why interest and motivation to refurbish first arises. They are not intended to be specific to renovating, more as conditions which have created a tension or issue which a refurbishment could potentially resolve. The conditions: prioritising, delineating, demonstrating, embodying and adapting are outlined below and were considered during the final interview question scripting.

Condition	**Question to establish whether condition exists in the home:**
• Prioritising:	Does the household compete for space use?
• Delineating:	Do their vision for their ideal, and actual home, match?

- Demonstrating: Do they take inspiration from: others, media, stores and adverts?
- Embodying: Do they anticipate adapting their home for physical needs?
- Adapting: Is there a need to adapt the physical arrangement or materials?

5.1.2.2 Life-stage of occupants

The life-stage of occupants may have a large impact on why they are choosing to do the work. Research by Munro and Leather (2000) splits people into seven main categories. The case studies of the current research fit into four of these.

- **Young household**

  Recent movers who are likely to be active in small or major refurbishments. They may make bold investments and have undeveloped contact networks. Case G fits into this category.

- **Household with children**

  Likely to be a longer established household. They may tackle problems as they arise. May be concerned about protecting children from disruption and mess and have conflicting spending priorities. Case H, K, M and D, I, L, N fit into this category. In cases K, I, L and N, providing better comfort for young or newly born children was a motivation to do the refurbishment.

- **Potential mover**

  Working to improve saleability of property. None of the present case studies fit into this category.

- **Empty nester/pre-retirement**

  Likely to be looking to the long-terms and minimise future maintenance work. Cases A, E, J and B, C, F fit into this category. A, E and J are pre-retirement empty nesters and B, C and F are slightly younger empty nesters.

- **Older household**

  Long term occupants who may neglect even reactive maintenance work. May be cash poor, have few contacts and be unwilling to face disruption. None of the present case studies fit into this category.

- **Household dissolution/death**

  Dwelling recycled to new generation. None of the present case studies fit into this category.

5.1.2.3 Environmental attitudes of households

Throughout history environmental impact has been a by-product of human desire for factors such as comfort, enjoyment and security. Only relatively recently has environmental protection become a consideration in human decision making (Stern, 2000). The environmental attitudes of case study households will be considered to establish the impact it had on their decision to refurbish their house. During the first interview some householders made reference to wanting to save energy and some even mentioned feeling a personal responsibility to do so, therefore, this stage will be essential. Questions will be included in the final interview to place occupants into one of the following categories as defined by the Department for Energy, Food and Rural Affairs (DEFRA, 2008). A draft interview script can be found in appendix 3.

- **Positive greens**

  Very conscious about their impact on resources and take every opportunity to act.

- **Waste watchers**

  Driven by a motivation to avoid waste.

- **Concerned consumers**

  May care about issues but have less conviction than the Positive Greens.

- **Side-line supporters**

  May also care about the issues but be early in their steps to act.

- **Cautious participants**

  May be willing to act if they see others doing the same.

- **Stalled starters**

  Have not considered installing measures yet.

- **Honestly disengaged**

  Fairly unwilling to install energy saving measures, may have other priorities.

Figure 5, which is adapted from a figure included in the first year report, shows factors relating to a housing refurbishment. The central factors in the diagram relate to the occupants; occasions, attitudes and resources. Wider factors are also included such as sociodemoographic situation, life stage, attitudes towards housing and lifestyles. This clarifies how attitudes, occasions and household resources combine to influence the refurbishment.

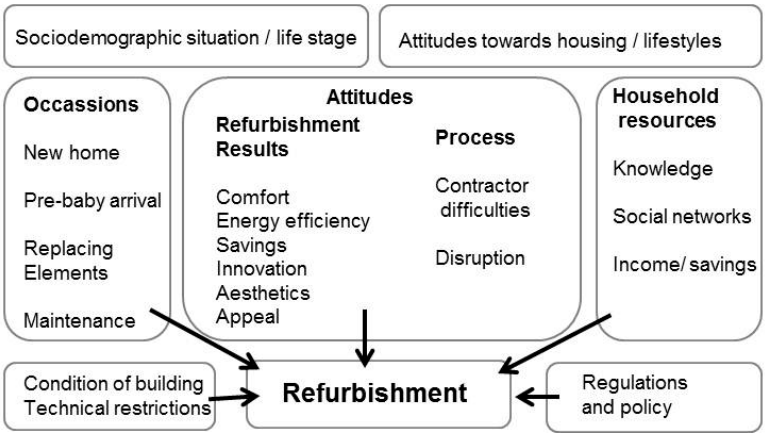


Figure 5. Occasions and attitudes for refurbishment

5.2 Qualitative data collection

The qualitative data collection provides the primary findings to this study which the quantitative data will support.

5.2.1 Piloting the interviews

The first and second interviews were pre-piloted and piloted before the actual interviews took place. The pre-pilots were carried out with other PhD researchers. The pilot studies were carried out with acquaintances of the author, in their own homes. Case A was used as a pilot study for interview one. At the time of interview they were unsure whether they would go ahead with the refurbishment within the project timescale but the findings from the pilot interview will still be useful. A household which recently had solar PV and a new boiler installed was used to pilot interview two. In both cases the occupants were asked to provide feedback at the end on the content of the interview, how comfortable they felt, the delivery of the interview, the length and whether they found it an enjoyable or interesting process and changes were made accordingly.

5.2.2 Pre-refurbishment interview

The first interview questions were designed with the research aim and objectives in mind, Objectives A, C and D in particular. The interview script and comfort assessment sheets for interview one can be found in Appendix 1.

5.2.3 During-refurbishment interview

The second interview was also designed with the research aim and objectives in mind, this time particular focus was paid to Objective B. The script for interview two can be found in Appendix 2.

5.2.4 Post-refurbishment interview

This interview will be carried out in February 2014. The draft of this script can be found in Appendix 3.

5.2.5 Data analysis

The interview data is being thematically analysed, so far this has been via a mix of manual colour coding, Microsoft Excel and NVivo 9 to establish the most effective method for the purpose of the research. A two-day NVivo training course was attended on the 24th and 25th July 2013. The interviews are recorded with a Dictaphone and notes are taken on the interview scripts. The interview data is themed according to the objective it applies to as shown in Table 3 in Section 4.3.

5.3 Quantitative data collection

The quantitative data will support the qualitative findings. The data includes building surveys, monitored temperature and relative humidity data and air-tightness tests.

5.3.1 Building survey

This includes a measured survey of each house, including floor areas, wall areas and external door and window openings in addition to construction details and lighting surveys. Photographs taken of the front and rear of the house and planned intervention locations will support this information. Any details which are uncertain will be checked with the households during the second or final interview.

5.3.2 Temperature and relative humidity monitoring

These data are being collected for one year from the date of the initial visit during the winter of 2012/2013 to the same time during 2014. The original plan was to monitor for only four weeks periods during the winter before and again during the winter after the refurbishment. However, it was since decided that collecting for a full year would improve the accuracy of the SAP09 modelling and include interesting summertime data. This change was cleared by the Ethical Advisory Committee in May 2013.

5.3.2.1 Temperature

For each case study house, a HOBO temperature pendant was installed in each room to measure and log air temperature. There was also one pendant positioned outside the house for the external temperature. These data will be used to improve the accuracy of the modelling work. The temperature data were collected at 15 minute intervals for the first four weeks and then for 30 minute intervals from there onwards. Collecting at 30 minute intervals extends the data collection period from 64 days to 130 days which provides a longer period of evaluation and fewer property visits whilst still providing adequate date.

5.3.2.2 Relative Humidity

A U10 HOBO pendant measuring and logging relative humidity at 15 minute intervals was installed in the living room of each case study. This will be used to measure if the refurbishment has any impact on relative humidity within the living spaces of each dwelling.

5.3.3 Air-tightness testing

Air tightness tests were carried out on ten of the case study houses pre-installation and three of the case studies post-installation so far. Two households opted out of this test. The depressurisation method is used on Test Type A. A risk assessment was carried out for this test and signed off in May 2013. Approval was then granted by the Ethical Advisory Committee in May 2013.

5.3.4 Gas meter readings

Gas and electricity meter readings were taken at the start and end of a four week period from the occupant's first visit to four weeks from that date. Some occupants have continued to take either weekly or monthly meter readings throughout the year.

5.3.5 SAP Modelling

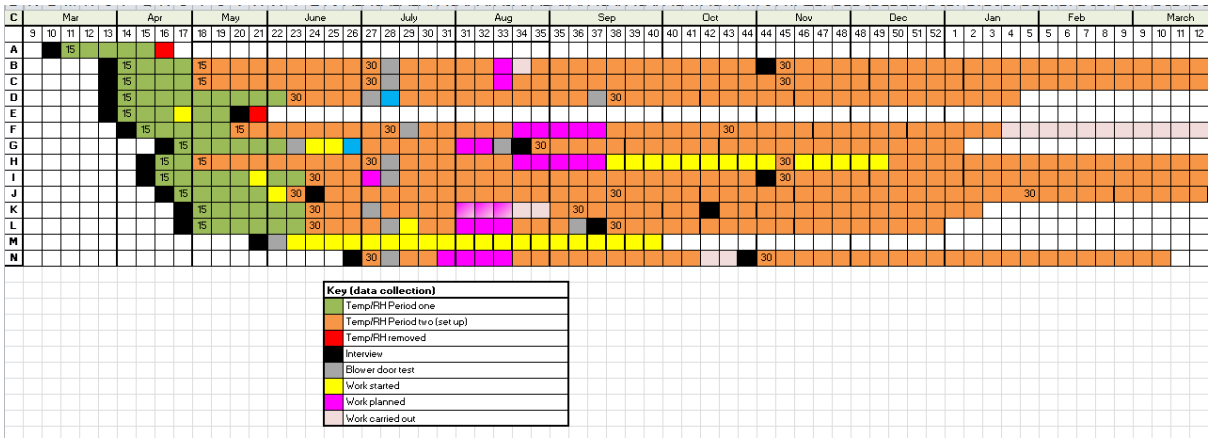
The modelling is necessary to provide a calculated estimate of the energy performance and CO_2 emissions of the dwellings before and after the refurbishment. The temperature and air tightness data collected will be used as inputs to the Standard Assessment Procedure Model 2009 (SAP09).

5.4 Data collection summary

All data collected were copied and stored anonymously into individual property files labelled A, B, C etc and backed up on an external hard drive. Both laptop and the hard drive are password protected. Paper files are stored within a locked drawer with names and consent forms stored in a separate folder with no connecting information.

Figure 6 shows a case study Gantt chart which has been produced to assist in organising the case study visits, keep a record of their refurbishment and research contact progress.

Figure 6. A case study Gantt chart



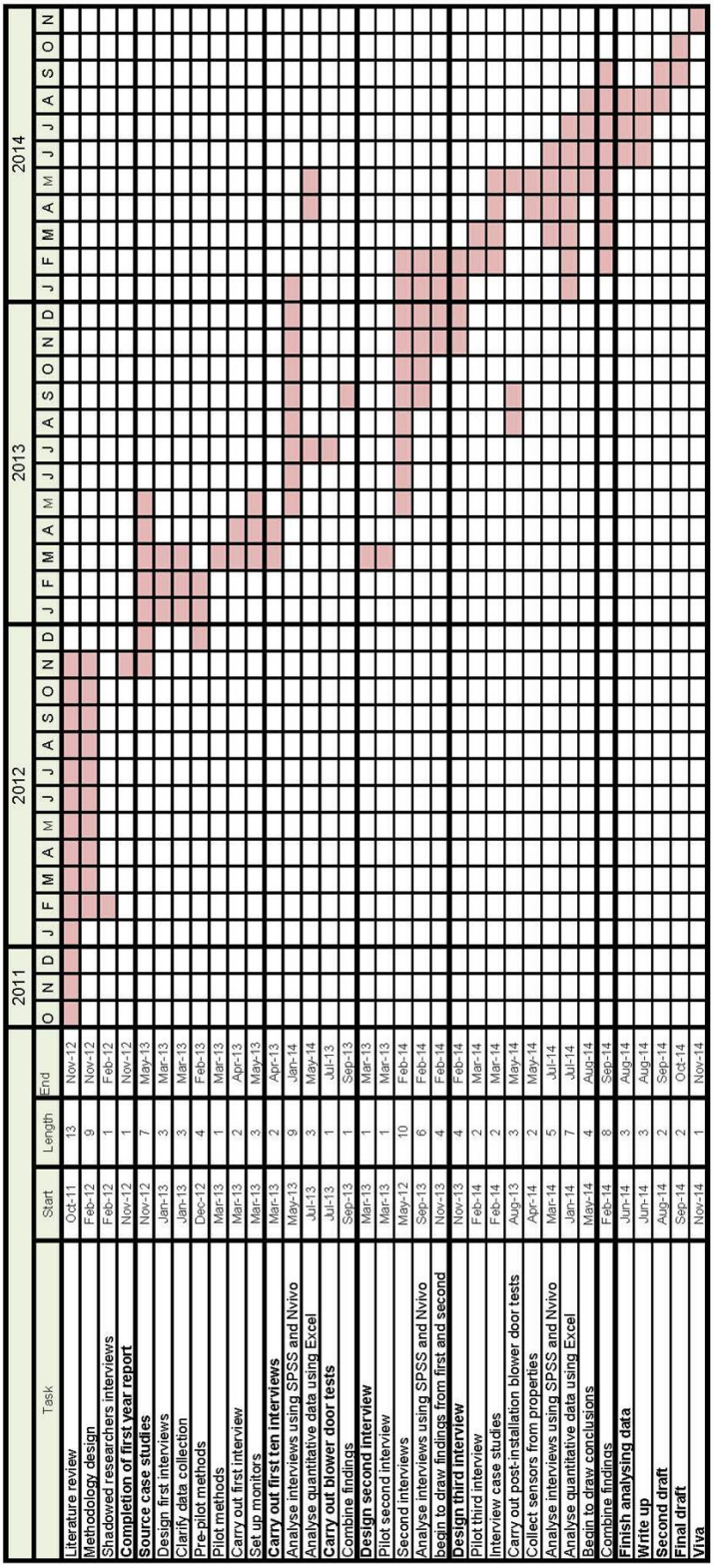
5.5 Skills training

A post-graduate skills training spread sheet for the second year can be found in Appendix 6.

6 SCHEDULED WORK

The Gantt in figure 7 shows the work that has been completed to date and planned for the next ten months.

Figure 7. A Gantt chart to show a plan of work including compleetd and planned



6.1 Scheduled data collection

This section outlines the remaining data collection.

6.1.1 During-refurbishment interviews

Eight second interviews have been carried out. Four more may be carried out within the project timescale. Two are unlikely to start work within the research time frame. The delays occupants have encountered add useful findings.

6.1.2 Post-installation interviews

The third interview script is ready to be used in February 2014.

6.1.3 Temperature and relative humidity monitoring

The temperature and relative humidity monitoring will be on-going until May 2014. The removal of the data loggers will be the final visit to the case study dwellings when the post-installation air-tightness test is carried out.

6.1.4 Gas meter readings

The households, where possible, will continue to read their meters either weekly or monthly. This will continue up until one year from their first visit date. All household will be reminded to do this for a four week period in February 2014 to ensure there are two four week periods to compare pre and post-installation.

6.1.5 Post-installation air- tightness tests

Three second blower door tests were carried out before October 2013. However for those five other case studies which completed their work in 2013 it was deemed too cold to carry out the test after they finished. This was to prevent drawing heated air out of the building and causing the occupants discomfort and/or additional heating costs.

6.2 Scheduled data analysis

This section outlines the remaining data analysis.

6.2.1 Interview data

All interview data will be analysed using thematic analysis.

6.2.2 Temperature data

The temperature data will be taken from the HOBO software, saved as a csv file and exported into table data to use within Excel. It will then be used to find averages within each month per room in each dwelling, taking into account the room volume. The temperature difference will be normalised using the methods adopted by Oreszczyn et al (2006) and Summerfield et al (2007).

6.2.3 Relative humidity data

The relative humidity data will also be used to find monthly averages per living room per dwelling. These can be collated into a spread sheet with the dates of refurbishment included. This will be useful to establish the changes in relative humidity before and after the work. The interview data will be used as a record of those properties which had issues with internal moisture before the refurbishment. The same questions will be asked again following the refurbishment.

6.2.4 Gas and electricity data

This will be entered into spread-sheets for each case study and the table data will be used to create graphs of the individual household energy consumption throughout the year. Comparisons will be drawn from the winter before the refurbishment and the winter after.

6.2.5 Air-tightness tests

This data will be entered as an input to the SAP model. The data will also be entered into an Excel spread sheet to compare each case study before and after the refurbishment.

6.2.6 SAP Modelling

The results of the model will be compared with the qualitative findings of the occupant's perception of energy efficiency and comfort. As mentioned previously, the temperature and air-tightness data will be used as inputs to the model.

6.3 Writing up

The writing of the first results chapter has started. The draft thesis titles are below. The draft thesis is in appendix 6, it should be noted that this version does need updating as it was saved in late 2013.

7 DRAFT STRUCTURE OF THESIS

This is a draft table of contents for the final thesis:

Table of Contents

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APPENDICES

Appendix 1: Interview one (pre-refurbishment) script

London-
Loughborough Centre
for doctoral research
in energy demand

Vision and leadership for a
sustainable built environment

Loughborough University

Property code:

Introduction

Hello,

Thanks for agreeing to take part in this study. I will begin by briefly explaining what I intend to do. I want to make sure you are happy with this and I can answer any questions you might have.

I hope to carry out three interviews in your home, this being the first. The second will be during your home improvement and the third following the work. In between these visits I hope to leave some sensors in your home to monitor the internal environment. These will record the air temperature and relative humidity. During today's visit and the final visit I will carry out an energy assessment of your home which will provide an idea of the impact of your improvement on the internal environment and energy performance. At the end of the interview I would like to walk around your house with you to ask you a few questions about your heating system. I will then need to record the floor areas, window and door openings and light fittings. Finally I would like to take **photographs of the outside of your house and the work being done**, if you are happy for me to do so. These will be the only images I need and should not include you or other family members.

You have a right to withdraw from this study at any point but if you withdraw once I have added your anonymous data to the study it may not be possible to remove this data. Any questions? Are you happy you understand the purpose of the study? Are you ok to carry on today?

Obtain signed consent at this point.

Collect and photograph energy bills either now or at end of interview.

Task	Done
Interview	
Measured survey	
Sensors	
Photographs front and back	
Meter readings	

London-
Loughborough Centre
for doctoral research
in energy demand

Vision and leadership for a
sustainable built environment

Loughborough University

General house information

I would like to start by asking you some details about your house and who lives here and then I will move on to the work you have planned.

1. Do you know when the house was built? (taken from EHS – in line with building regs)

Dwelling age:

A	B	C	D	E	F	G	H	I	J	K
pre 1900	1900-1929	1930-1949	1950-1966	1967-1975	1976-1982	1983-1990	1991-1995	1996-2002	2003-2006	2007 onwards

2. When did you buy the house? Did you move in straight away?
3.

Date	**Bought**	**Moved in**
Year		

Person (A, B etc)	**Relationship to interviewee**	**Age**	**length of time here**

Notes….

4. When are people usually in? probe for details…(fill in numbers)

Time / **Days**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Overnight							
Morning							
Lunchtime							
Evening							

Comments:

Energy use

I'm now going to ask you some questions about the way you heat your home.

5. Do you have central heating?							
Yes		No		Not yet		Not in working order	
Notes:							

6. If yes, what fuel does the boiler use?							
Gas		Oil		Electricity		Solid	
Notes:							

7. Is it a combination boiler which heats up water when you turn on a tap?							
Yes		No		Unsure			
Notes:							

8. If not, do you have a separate hot water tank?							
Yes		No		Unsure			

9. What do you do to control your heating?	
No time or thermostatic control of temperature	
Programmer, no room thermostat	
Room thermostat only	
Programmer and room thermostat	
Programmer and at least two room thermostats	
programmer, room thermostats and TRVs	
TRVs and bypass	
programmer, TRVs ad bypass	
Programmer TRVs and flow switch	
Programmer, TRVs and boiler energy manager	
Time and temperature zone control	

Notes:	

10. When is your heating usually on?								
Time	Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Overnight								
Morning								
Lunchtime								
Evening								
Night-time								

11. What temperature is your thermostat usually set? (^{o}C)												
15	16	17	18	19	20	21	22	23	24	25	26	27
Other:												

12. Do you or other people in your house ever change the temperature settings?			
Yes	No	Sometimes	Unsure
Comments:			

13. If yes, why?					
Too cold	Too warm	Saving fuel	To dry clothes	as the weather changes	varying thermal comfort levels
Notes:					

14. Do you use every radiator?								
Yes		No		Sometimes		unsure		

15. If no: Which rooms are not on?	Dining room	Utility	WC

Spare bedrooms:	Attic conversion:	Other:

16. Are these rooms used?	**Yes**	**No**	**Sometimes**
Notes:			

17. How do you control the radiators?							
TRVs		on/off		Other		unsure	

18. Do you find the current system easy to use?							
Yes		No		Sometimes		unsure	

Notes:

19. Do you have any other ways of heating the home? (circle all that apply)	
No	Make and model
Gas fire	
Oil room heater	
solid fuel room heater	
Electric	
Other/notes:	

20. When do you usually use the additional heater?							
Time / **Days**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Overnight							
Morning							
Lunchtime							
Evening							
Night-time							
Just when it's cold	Winter weekends	If we have guests	Special occasions	Instead of heating			
Notes:							

Moving on to discuss the work you have planned for the house…

21. Do you know what is going to be installed/fitted?		
Measure	**Yes**	**Maybe**
Insulation		
Windows		
Boiler		
Radiators		
Draught stripping		
Other:		

Insulation Type	Thickness	Material	Adhesive method	Which walls?	Area needed
Cavity wall					
External wall					
Internal wall					
Roof					
Floor					
Other					

Window Type	Thickness	Frame	Opening	Rooms	Aprox area
Double glazed		PVC	Side casement		
Triple glazed		Timber	Sliding sash		
Argon filled		Metal			

Draft stripping	Thickness	Windows	Doors	Rooms	Aprox perimeter
Rubber					
Brush					
Foam					
Other					

New boiler type	Brand	Radiators	Rooms		
Condensing					
Combination					
Gas					
Oil					
Other system					

22. How long have you been thinking about this?	
Under 1 month	
1-3 months	
3-6 months	
6-9 moths	
9-12 months	
1-2 years	
2-3 years	
3+ years	
Other	

23. Why has it taken this length of time to make the decision?					
Cost	Time	Uncertainty	Change in circumstance	Disagreements	Lack of information
Notes:					

24. Who made the final decision?
Notes:

25. When do you think the work will start?	
Within: 1 month	
1-3 months	
3-6 months	
6-9 moths	
9-12 months	
1-2 years	
Other	

26. And how long do you think it should take?	
1 hour	
2-3 hours	
½ day	
1 day	
1-3 days	
3-7 days	
7-10 days	
10-14 days	
14-21 days	
21+ days	
Other	

27. Do you feel you have enough information on the measure?					
Yes		No		Uncertain	
Notes:					

28. Was information easy to find?					
Yes		No		Uncertain	
Notes:					

29. Where did you receive most information from? (Steib – occasions and

barriers) – explain which/where from		
Tradsemen/craftsmen	Initial	Detailed
Heating installer		
family and/or relatives		
Building centre/home-improvement market		
Internet (which site)		
Leaflets, guidebooks and literature		
Chimney sweeper		
Journals/periodicals/newspapers		
Manufacturer		
Architect		
Energy advisors		
Energy advice centre		
Energy saving workshop		
Consumer advice centre		
Local authority		
Other/further info		

30. Why did you choose the installation you have chosen?	
Embellish the home	
Save heating energy	
Reduce energy costs	
create a better/more comfortable indoor environment	
Maintain the homes value	
Increase the homes value	
Install up-to-date technology	
Make a contribution to climate protection	
Become less dependent on fossil fuels	
Perform necessary maintenance	
Replace a defect or broken building component	
Respond quickly to a problem or defect	
Remedy a structural defect	
Create more living space in the house	
Utility provider	
Notes:	

31. Have you considered other options?	
Yes	
No	
What	

32. How are you feeling about the installation overall?

33. Have you carried out home improvements previously?	
No	
If yes, outline:	

Installation expectations, dates and timescales

34. Do you have the date of fitting confirmed yet?	
No	
Yes, when?	

35. Do you know what you expect the installation process to be?	
No	
Yes, sequence of works:	

36. How many installation companies are involved?						
Companies	1	2	3	4	5	
Installers						
1						
2						
3						
4						
5						
Can I ask the names of these companies?						
Notes:						

37. Why did you choose this installer?							
Recomm-ended	Has done work here before	Is a friend	Cheapest quote	Seemed most trustworthy	Certified	Lack of time to search for alternatives	Special offer
Notes:							

38. Are you anticipating any changes to your normal routine during the work?	
No	
Yes, what?	Probe for moving out…

39. What about after the work?	
No	
Yes, what?	

40. Do you need to be here during the work?	
No	
Yes, why?	(probe for motivation: security, quality and safety)

41. What will you do?
Notes:

42. Do you expect to have anything extra to do following the work?	
Not sure	
Notes:	

Anticipated costs

I'm now going to ask a few questions about your expected costs and funding for this.

43. What do you expect this work to cost in total?	
0-100	
1-250	
250-500	
500-750	
750-1000	
1-2000	
2-3000	
3-4000	
4-5000	
5-1000	
10-15000	
15-20000	
20-25000	
25-30000	
30000+	

Fixed	Variable
Notes:	

44. Do you know how this cost is broken down?

45. Any additional costs?
No
Yes, notes:

46. Has the installer been here to go through this?
No
Yes, details:

47. What was involved?
Notes:

48. Will you/have you receive/d any more quotes?
No
Yes, details:

49. Will you have any type of survey as part of the work?
No
Yes, details: (energy, structural, measured etc)

50. Do you mind me asking how you plan to fund this?				
Privately	Loan	Green Deal	Re-mortgage	Private borrowing
Notes:				

51. Do you think this measure will save you money in the long term?	
No	Yes

52. If yes any idea what these savings will be?				
No	per month	per year	over 10 yrs	over 20 yrs
Notes:				

53. How would you rate the energy performance of your home?			
Excellent	Good	Reasonable	Poor
Notes:			

54. Do you know the energy rating of your home?						
A	B	C	D	E	F	G
Notes:						

Internal environment

55. Please can you rank the following cue cards on internal conditions in order of importance to you within the home (inspired by Survey on IEQ Frontczal and Wargocki):	
Condition	**Ranking**
Air quality	
Temperature/thermal comfort	
Acoustics/acoustic comfort	
Aesthetics	

56. Do you think any of these factors are a particular issue in your home?	
Condition	
Air quality	
Temperature/thermal comfort	
Acoustics/acoustic comfort	
Aesthetics	

Perhaps now, you can help me in sketching floor plan of your house so that we can add notes as we go through the next set of questions…

57. Using this scale (flashcard) how would you say the overall home temperature is usually? (PMV scale)						
+3 hot	+2 warm	+1 neutral	0 neutral	-1 slightly cool	-2 cool	-3 cold
Mark on any particular warm or cold rooms						

58. Could you tell me which rooms are the warmest?
Notes:

59. Thinking back to the coldest spell in winter, how did you maintain comfort?						
Turn the heating up	Thermostat temp up	Extra heat source	clothing	warm drinks	hot water bottle	changing routine
Notes:						

60. How about the hottest spells of summer?					
windows open	motor fan	less clothing	cold drinks	move less	hand fan
Notes:					

61. How many layers do you typically wear indoors in the winter?
62. Are the other occupants similar?

63. How about the summer?
64. Are the other occupants similar?

65. Using this scale (flashcard) how would you say the overall air movement is in the house? (Scale: very high to very low)						
+3 vh	+2 sh	+1 h	0 neither h n l	-1 quite low	-2 l	-3 vl
Mark on any particular warm or cold rooms						

66. Could you mark on any particular cold or draught spots you know of?
Notes:

67. How do you get fresh air into the house?			
Windows	trickle vents	mechanical ventilation system	extractor fans
Notes:			

68. How often do you open the windows?	
69. Does this change in winter?	
70. And summer?	

71. Using this scale (flashcard) how would you say the overall air quality is in the house? (Scale: very bad to very excellent)						
+3 vb	+2 sb	+1 b	0 neither g n b	-1 quite g	-2 vg	-3 e
Mark on any particular spots of odour etc						

72. Do you ever have problems with condensation, damp or excess moisture?			
Condensation	Rising damp	Penetrating damp	Excess moisture
If so, which room? (mark on sketch)			

73. Does this change in winter?	
74. And summer?	

75. Using this scale (flashcard) how would you say the overall lighting is in the house? (Scale: very bright to very dim)						
+3 vl	+2 l	+1 sl	0 neither b n d	-1 sd	-2 d	-3 vd
Mark on any particular dark areas						

76. Using this scale (flashcard) how would you say the overall comfort is in the house? (Scale: very bad to excellent)						
+3 vb	+2 sb	+1 b	0 neither b n g	-1 sg	-2 g	-3 e
Mark on any particular dark areas						

77. Do you have any final comments or questions on anything we have talked about?

Energy Data

Boiler model:	

Gas and electricity costs					
Gas			Electricity		
monthly	quarterly	pre-payment	monthly	quarterly	pre-payment
Notes:					

Unit prices			
Gas		Electricity	
Notes:			

Set up sensors

	Temp pendant ID number	**RH sensor ID**	**CO2 sensor ID**
House			
Kitchen			
Living room			
Dining room			
Hallway			
WC			
Bedroom 1			
Bedroom 2			
Bedroom 3			
Bedroom 4			
Bathroom			
Hallway			

Thank you for your time today. Explain what next.

Appendix 2: Interview two (during-refurbishment) script

London-
Loughborough Centre
for doctoral research
in energy demand

Vision and leadership for a
sustainable built environment

Loughborough University

Property code:

Introduction

Hello,

Thanks for your help so far and continuing with study.

Today I will ask your experiences of the installation process.

You still have a right to withdraw from this study at any point but if you withdraw once I have added your anonymous data to the study it may not be possible to remove this data.

Do you have any questions at this stage? Are you ok to carry on today?

Tasks	Done
Interview	
Photographs of the new measure	
Meter readings	

Questions	
What	**Why**
Installation	
1. Did you go with the measure planned? (make of boiler, insulation type etc)	
2. If not, why not – what changed and why?	
Time, duration and process	
3. Did you go with the installer(s) planned? (if they were not confirmed previously – find out the company name, if it has changed find out why)	
4. Was it just this(ese) company(ies)?	
5. How many installers came?	
6. When did the installation start?	
7. When did it finish?	
8. Was this as expected?	
9. Did the installers arrive on time during the work?	
10. Were there any unexpected visits?	
11. Did anything take longer than expected?	
12. Was anything quicker than expected?	
13. Did you feel comfortable leaving the installers alone with their work?	

14. Was the process of work as you expected?	
15. Do you think this process time could be reduced?	
Comfort	
16. Was your heating pattern affected during the work?	
17. Was the work noisy?	
18. Any dust or fumes created?	
19. Did you open windows or doors more or less than usual during the work for any particular reason?	
20. Were you able to use your house as you normally would?	
21. Was the area clean following the work?	
22. Were you comfortable enough during the work?	
23. Could this have been improved in any way?	
24. Did you feel particularly uncomfortable at any point during the work?	
Information and functionality of product	
25. Do you feel you have enough information on how to operate the boiler?	
26. Do you know whether there will be any ongoing maintenance?	
27. How long do you expect the product to last?	
28. Did they provide any warranties?	

29. Does it seem (to work) ok overall?	
30. Are you pleased with the selected product?	
31. Are you happy with the finished appearance?	
32. Do you think it improves the home? How?	
33. Do you have any work to do now?	
Personal resources: cost and time	
34. How did the cost compare with what you were previously expecting?	
35. Do you think the research time you put into this has paid off?	
36. Do you think it adds value to the home? Financial or otherwise.	
Satisfaction	
37. Were you satisfied with the workmanship?	
38. Would you suggest this installer to a friend or relative?	
39. Do you think they could have done anything better?	
40. Did they seem competent overall??	
41. Did they work safely?	
42. Did they communicate their work to you effectively throughout?	

General	
43. Did anything unexpected happen?	
44. If you could provide advice on anything we have covered direct to an installer, installer trainer or the UK government, what would this be?	

Gas and electricity meter readings	
Time:	Date:
Gas	Electricity

Thank you for your time today. Explain what next.

Appendix 3: Interview three (post-refurbishment) script

Interview three draft outline Qs (those in boxes taken from first interview)

Objective	Interview analysis themes	Research question
Pre-installation interview		
A) To identify the householders' expectations of the energy efficiency improvement process. This will incorporate their understanding on the installations, their estimation of time and financial costs, their existing knowledge of available measures, their expectations of the process of fitting and expected disruption. This will be later compared with the actual process.	Reason to install: Expectations Knowledge of measure Used sources of information Trusted sources of information Expected process of fitting Expected start and finish date Expected duration of fitting Expected cost Expected installers Expected number of installers.	1. What are the occupant expectations of an energy efficiency installation and what do they actually get?
During/just after installation interview		
B) To ascertain what happens during the actual delivery process of the installation. This will cover the occupant's experiences throughout the process. Particular focus will be paid to the installation of the measures, time taken and cost, disruption or any additional unexpected factors experienced.	Experiences of the fitting process Installer used Duration of fitting Start and completion date Cost Changes to daily routine during the process Comfort during the process: Safety, security, thermal, air quality, noise, mess, unexpected inconvenience. Unexpected factors	1. What are the occupant expectations of an energy efficiency installation and what do they actually get?
Pre and post interviews: to be compared		
C) To evaluate and compare the levels of thermal comfort and quality of living environment before and after the refurbishment. This will include the occupant's perceptions and quantitative measurements.	**Occupant comfort: temperature, air quality, draughts, damp,** acoustics, aesthetics, lighting.	1. What are the occupant expectations of an energy efficiency installation and what do they actually get? 2. Do the occupants perceive an internal environment improvement?
D) To quantify the energy, fuel and subsequent CO_2 and financial cost savings using measured and modelled data. This will focus on the energy consumed for space heating by comparing usage before and after the refurbishment. The air permeability of the fabric will be measured before and after the work, this will also be an input to the SAP model.	**Energy consumption** **Energy costs** **Energy efficiency** Fuel provider Heating patterns Thermostat temperature	1. What are the occupant expectations of an energy efficiency installation and what do they actually get? 3. Do the householders actually save money, energy and carbon?
E) Identify where the occupants' expectations are not met and where they are exceeded, to ensure householder satisfaction and help encourage future adoption. This will detail how the process of energy efficiency refurbishment can be improved to maximise the benefits to the occupant - both perceived and actual.	Expectations met Expectations not met Expectations exceeded Recommendations for policy makers, industry stakeholders on installer trainers made by occupants	1. What are the occupant expectations of an energy efficiency installation and what do they actually get?

Contents

Measure and functionality

1. Why did you choose the installation you have chosen?	
Embellish the home	
Save heating energy	
Reduce energy costs	
create a better/more comfortable indoor environment	
Maintain the homes value	
Increase the homes value	
Install up-to-date technology	
Make a contribution to climate protection	
Become less dependent on fossil fuels	
Perform necessary maintenance	
Replace a defect or broken building component	
Respond quickly to a problem or defect	
Remedy a structural defect	
Create more living space in the house	
Utility provider	
Notes:	

2. Has it met your expectations?	
Yes	
No	
Notes	

1. How are you now feeling about the installation overall?

1. Do you have anything extra to do as a result of the work	
Not sure	
Notes:	

How has the measure been since it was fitted?

Is it working ok?

Are you able to operate it ok?

Are you satisfied with the result now you have lived with the measure?

Energy

1. What do you now do to control your heating?	
No timer or thermostatic control of temperature	
Programmer, no room thermostat	
Room thermostat only	
Programmer and room thermostat	
Programmer and at least two room thermostats	
programmer, room thermostats and TRVs	
TRVs and bypass	
programmer, TRVs ad bypass	
Programmer TRVs and flow switch	
Programmer, TRVs and boiler energy manager	
Time and temperature zone control	
Notes:	

2. When is your heating usually on?								
Time	**Days**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
Overnight								
Morning								
Lunchtime								
Evening								
Night-time								

1. What temperature is your thermostat usually set? (^{o}C)												
15	16	17	18	19	20	21	22	23	24	25	26	27
Other:												

1. Do you or other people in your house ever change the temperature settings?			
Yes	No	Sometimes	Unsure
Comments:			

1. If yes, why?					
Too cold	Too warm	Saving fuel	To dry clothes	as the weather changes	varying thermal comfort levels
Notes:					

2. Do you use every radiator?							
Yes		No		Sometimes		unsure	

3. If no: Which rooms are not on?	Dining room	Utility	WC

Spare bedrooms:	Attic conversion:	Other:

4. Are these rooms used?	**Yes**	**No**	**Sometimes**
Notes:			

1. How do you control the radiators?							
TRVs		on/off		Other		unsure	

1. Do you find the current system easy to use?							
Yes		No		Sometimes		unsure	
Notes:							

1. Do you have any other ways of heating the home? (circle all that apply)	
No	Make and model
Gas fire	
Oil room heater	
solid fuel room heater	
Electric	
Other/notes:	

1. **How would you now rate the energy performance of your home?**			
Excellent	Good	Reasonable	Poor
Notes:			

1. **Do you now know the energy rating of your home?**						
A	B	C	D	E	F	G
Notes:						

Does your home feel more efficient?

Would you save you now use less energy?

Have you noticed a big difference in your energy bills compared with last year?

Savings

1. **Do you now think this measure will save you money in the long term?**	
No	Yes

1. **If yes, do you now have any idea what these savings will be?**				
No	per month	per year	over 10 yrs	over 20 yrs
Notes:				

Comfort

1. **Do you think any of these factors are a particular issue in your home?**	
Condition	
Air quality	
Temperature/thermal comfort	
Acoustics/acoustic comfort	
Aesthetics	

1. **Using this scale (flashcard) how would you say the overall home temperature is usually? (PMV scale)**						
+3 hot	+2 warm	+1 neutral	0 neutral	-1 slightly cool	-2 cool	-3 cold
Mark on any particular warm or cold rooms						

1. **Could you tell me which rooms are the warmest?**
Notes:

1. **Thinking back to the coldest spell in winter, how did you maintain comfort?**						
Turn the heating up	Thermostat temp up	Extra heat source	clothing	warm drinks	hot water bottle	changing routine
Notes:						

1. **How about the hottest spells of summer?**					
windows open	motor fan	less clothing	cold drinks	move less	hand fan
Notes:					

1. **How many layers do you typically wear indoors in the winter?**
2. **Are the other occupants similar?**

3. **Using this scale (flashcard) how would you say the overall air movement is in the house? (Scale: very high to very low)**						
+3 vh	+2 sh	+1 h	0 neither h n l	-1 quite low	-2 l	-3 vl
Mark on any particular warm or cold rooms						

1. **Could you mark on any particular cold or draught spots you know of?**
Notes:

1. How do you get fresh air into the house?			
Windows	trickle vents	mechanical ventilation system	extractor fans
Notes:			

2. How often do you open the windows?	
3. Does this change in winter?	
4. And summer?	

4. Using this scale (flashcard) how would you say the overall air quality is in the house? (Scale: very bad to very excellent)						
+3 vb	+2 sb	+1 b	0 neither g n b	-1 quite g	-2 vg	-3 e
Mark on any particular spots of odour etc						

1. Do you ever have problems with condensation, damp or excess moisture?			
Condensation	Rising damp	Penetrating damp	Excess moisture
If so, which room? (mark on sketch)			

2. Does this change in winter?	
3. And summer?	

5. Using this scale (flashcard) how would you say the overall lighting is in the house? (Scale: very bright to very dim)						
+3 vl	+2 l	+1 sl	0 neither b	-1 sd	-2 d	-3 vd

			n d			
Mark on any particular dark areas						

6. Using this scale (flashcard) how would you say the overall comfort is in the house? (Scale: very bad to excellent)						
+3 vb	+2 sb	+1 b	0 neither b n g	-1 sg	-2 g	-3 e
Mark on any particular dark areas						

Have you felt much warmer?

Have there been fewer drafts?

Less damp?

Recommendations

What do you think could have gone better?

Is there anything which could have made the whole process easier for you?

Now you have lived in the property through the winter with the measure what are you most happy with?

What could be improved?

- Categorising occupants
- Satisfaction criteria from other work

- Compare Qs with objectives and interview one/two

Final

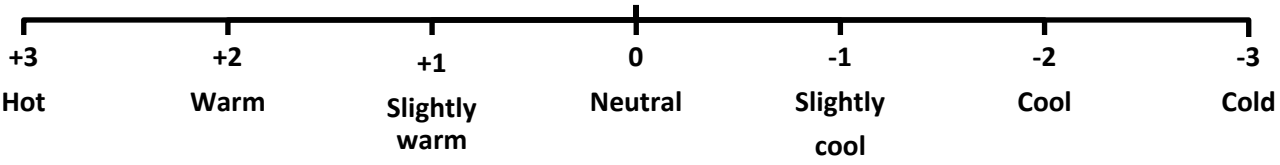
1. Do you have any final comments or questions on anything we have talked about?

Boiler model:	

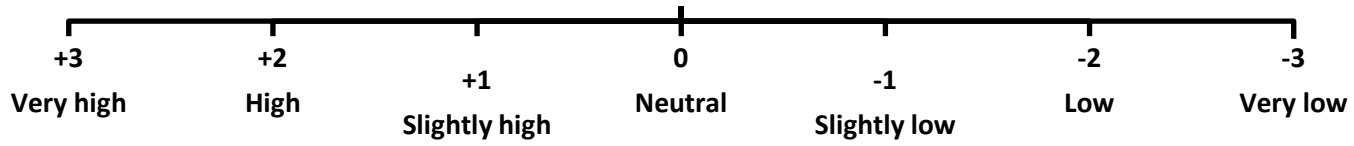
Gas and electricity costs					
Gas			Electricity		
monthly	quarterly	pre-payment	monthly	quarterly	pre-payment
Notes:					

Unit prices			
Gas		Electricity	
Notes:			

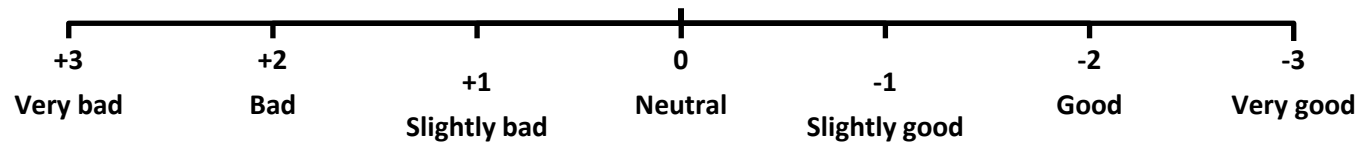
Temperature



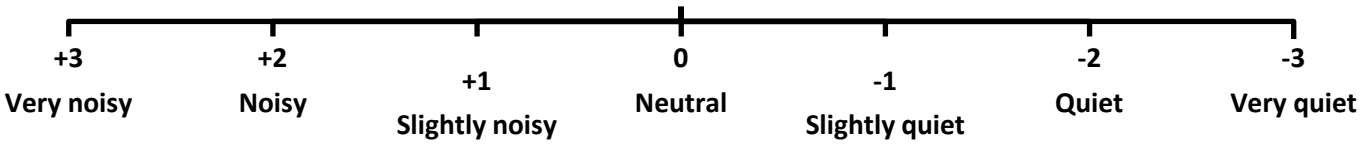
Air movement scale



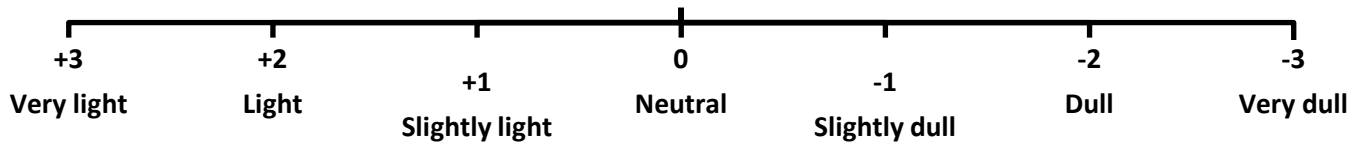
Air quality scale



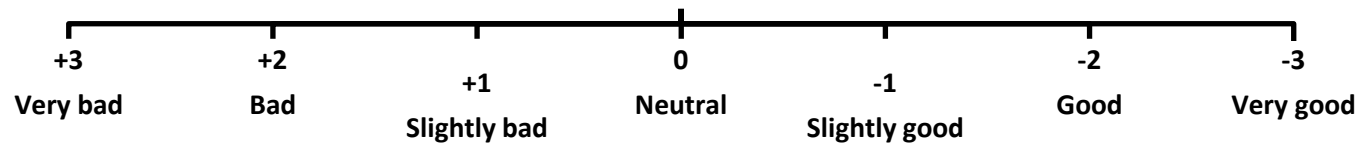
Surrounding noise levels



Overall lighting levels

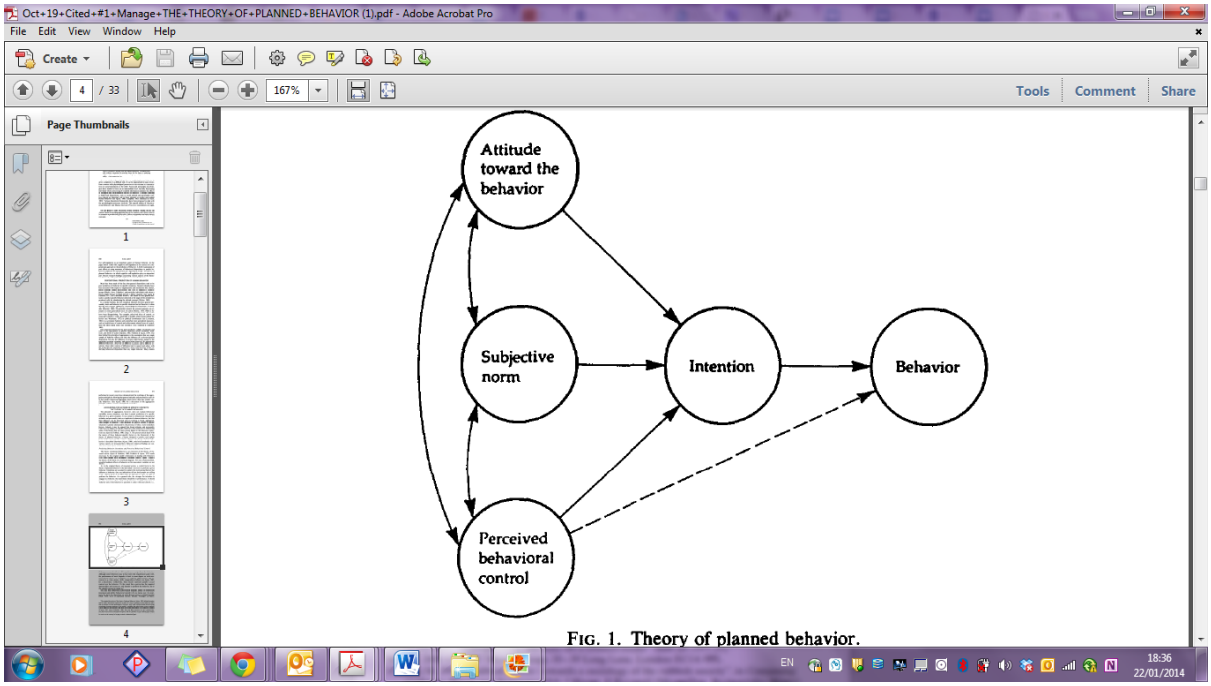


Overall comfort



Appendix 4: The first stages of forming questions to categorise occupants

Theory of planned behaviour traces attitudes , subjective norms, and perceived behavioral control to an underlying foundation of beliefs about the behaviour (ORGANIZATIONAL BEHAVIOR AND HUMAN DECISION PROCESSES 50, The Theory of Planned Behavior by ICEK AJZEN 179-211 (1991)
University of Massachusetts at Amherst)



Pro-environmental behaviours Qs

Nest-building or investing in the future? Owner-occupiers' home improvement behaviour

The theory of planned behaviour traces attitudes, subjective norms and perceived behavioural control to an underlying foundation of beliefs about the behaviour (

The theory of planned behavior traces attitudes, subjective norms, and perceived behavioral control to an underlying foundation of beliefs about the behavior. Although

Living lightly – how does climate change feature bin home improvement decisions

Nest building

\

Green consumption: life-politics, risk and contradictions

Whatever Happened to 'Housing and the Environment'?

TIM BROWN1 & MARK BHATTI2

1

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University, Leicester, UK

2

School of Applied Social Science, University of Brighton, Brighton, UK

[Paper first received 22 April 2002; in final form 22 July 2002]

Owning, making and maintaining a nice home is an important issue in most families. In this paper we have analysed 13 interviews, with families living in detached houses, concerning why and how the home

and its decoration and maintenance is important to

them. The analysis has shown that the home is a symbol

in several different ways: the house with its style, size

and location is an integral part of the power structure in

society – urban structure and class structures reflect

each other.

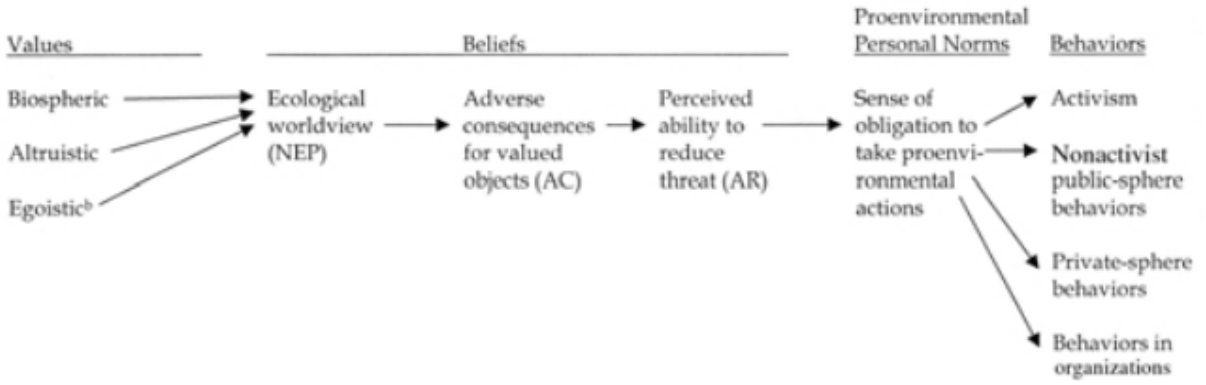


Fig. 1. A schematic representation of variables in the VBN theory of environmentalism[a]
[a]Arrows represent postulated direct effects. Direct effects may also be observed on variables more than one level downstream from a causal variable.
[b]Empirically, measures of egoistic values have been negatively correlated with indicators of environmentalism.

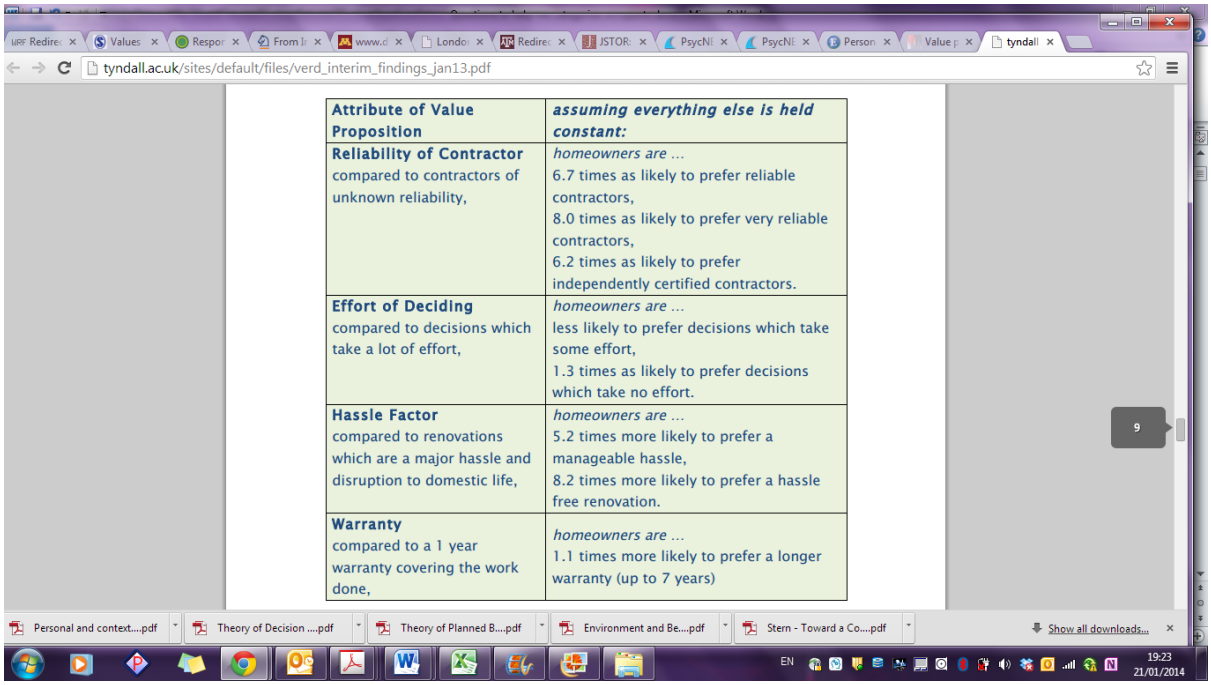
"Through human history, environmental impact has largely been a by-product of human desires for physical comfort, mobility, relief from labor, enjoyment, power, status, personal security, maintenance of tradition and family, and so forth, and of the organizations and technologies humanity has created to meet these desires. Only relatively recently has environmental protection become an important consideration in human decision making. This development has given environmentally significant behavior a second meaning. It can now be defined from the actor's standpoint as behavior that is undertaken with the intention to change (normally, to benefit) the environment. This intent-oriented definition is not the same as the impact-oriented one in two important ways: It highlights environmental intent as an independent cause of behavior, and it highlights the possibility that environmental intent may fail to result in environmental impact. For example, many people in the United States believe that avoiding the use of spray cans protects the ozone layer, even though ozone-destroying substances have been banned from spray cans for two decades. The possible discrepancy between environmental intent and environmental impact raises important research questions about the nature and determinants of people's beliefs about the environmental significance of behaviors."

Journal of Social Issues, Vol. 56, No. 3, 2000, pp. 407–424

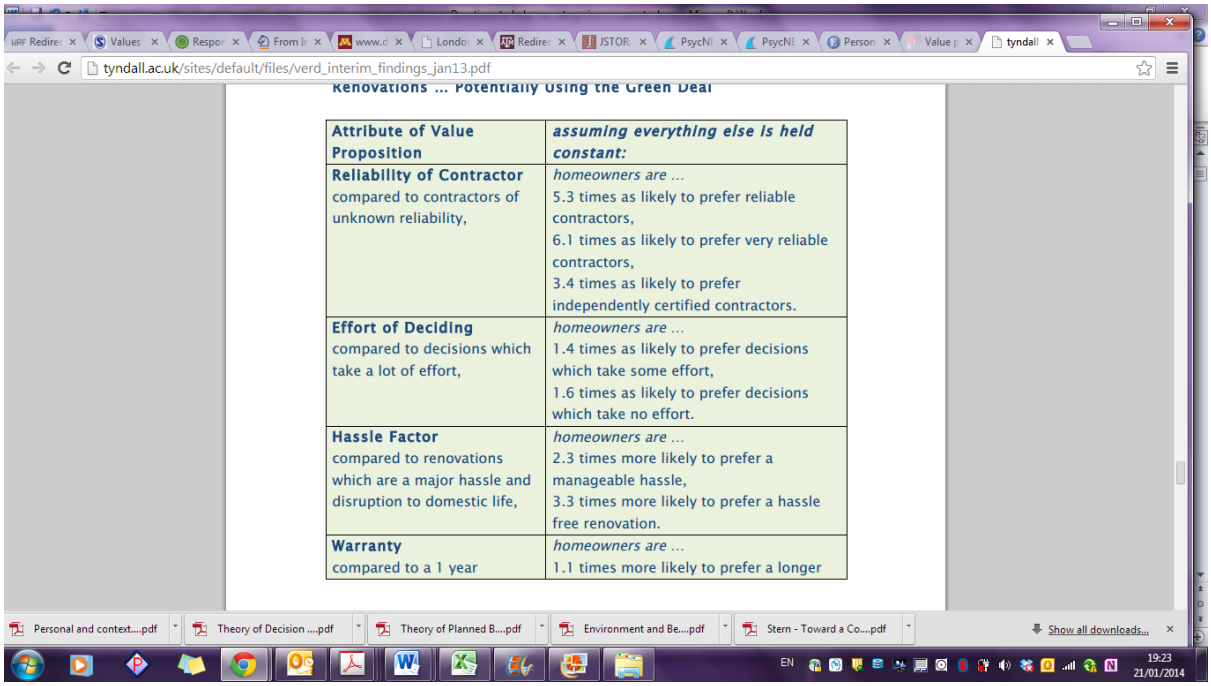
Toward a Coherent Theory of Environmentally Significant Behavior

Paul C. Stern. National Research Council

Wilson: Interim findings (http://tyndall.ac.uk/sites/default/files/verd_interim_findings_jan13.pdf)

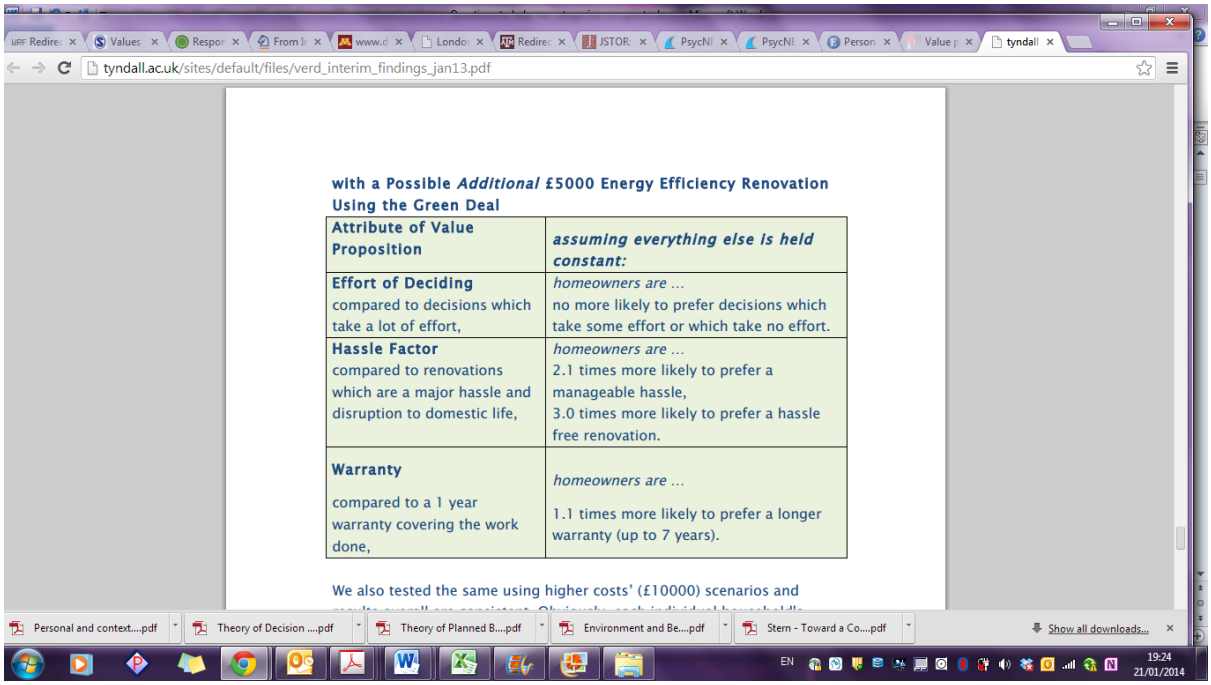


Attribute of Value Proposition	*assuming everything else is held constant:*
Reliability of Contractor compared to contractors of unknown reliability,	*homeowners are …* 6.7 times as likely to prefer reliable contractors, 8.0 times as likely to prefer very reliable contractors, 6.2 times as likely to prefer independently certified contractors.
Effort of Deciding compared to decisions which take a lot of effort,	*homeowners are …* less likely to prefer decisions which take some effort, 1.3 times as likely to prefer decisions which take no effort.
Hassle Factor compared to renovations which are a major hassle and disruption to domestic life,	*homeowners are …* 5.2 times more likely to prefer a manageable hassle, 8.2 times more likely to prefer a hassle free renovation.
Warranty compared to a 1 year warranty covering the work done,	*homeowners are …* 1.1 times more likely to prefer a longer warranty (up to 7 years)



Renovations … Potentially using the Green Deal

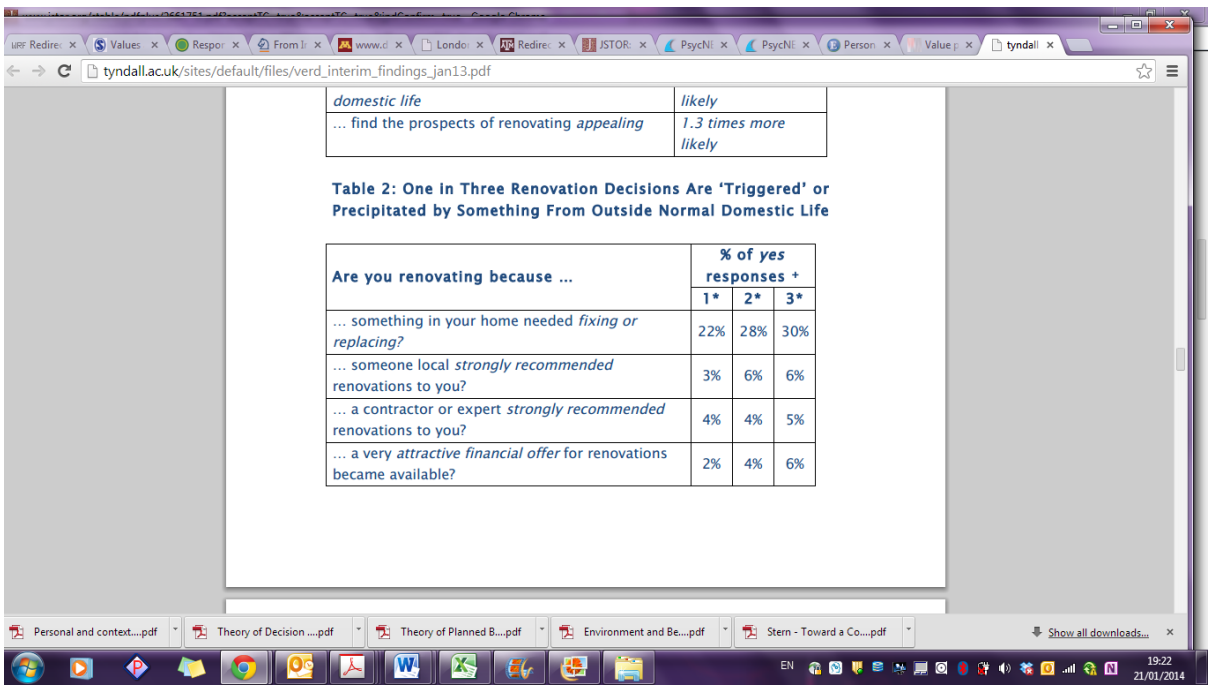
Attribute of Value Proposition	*assuming everything else is held constant:*
Reliability of Contractor compared to contractors of unknown reliability,	*homeowners are …* 5.3 times as likely to prefer reliable contractors, 6.1 times as likely to prefer very reliable contractors, 3.4 times as likely to prefer independently certified contractors.
Effort of Deciding compared to decisions which take a lot of effort,	*homeowners are …* 1.4 times as likely to prefer decisions which take some effort, 1.6 times as likely to prefer decisions which take no effort.
Hassle Factor compared to renovations which are a major hassle and disruption to domestic life,	*homeowners are …* 2.3 times more likely to prefer a manageable hassle, 3.3 times more likely to prefer a hassle free renovation.
Warranty compared to a 1 year	*homeowners are …* 1.1 times more likely to prefer a longer



with a Possible *Additional* £5000 Energy Efficiency Renovation Using the Green Deal

Attribute of Value Proposition	***assuming everything else is held constant:***
Effort of Deciding compared to decisions which take a lot of effort,	*homeowners are ...* no more likely to prefer decisions which take some effort or which take no effort.
Hassle Factor compared to renovations which are a major hassle and disruption to domestic life,	*homeowners are ...* 2.1 times more likely to prefer a manageable hassle, 3.0 times more likely to prefer a hassle free renovation.
Warranty compared to a 1 year warranty covering the work done,	*homeowners are ...* 1.1 times more likely to prefer a longer warranty (up to 7 years).

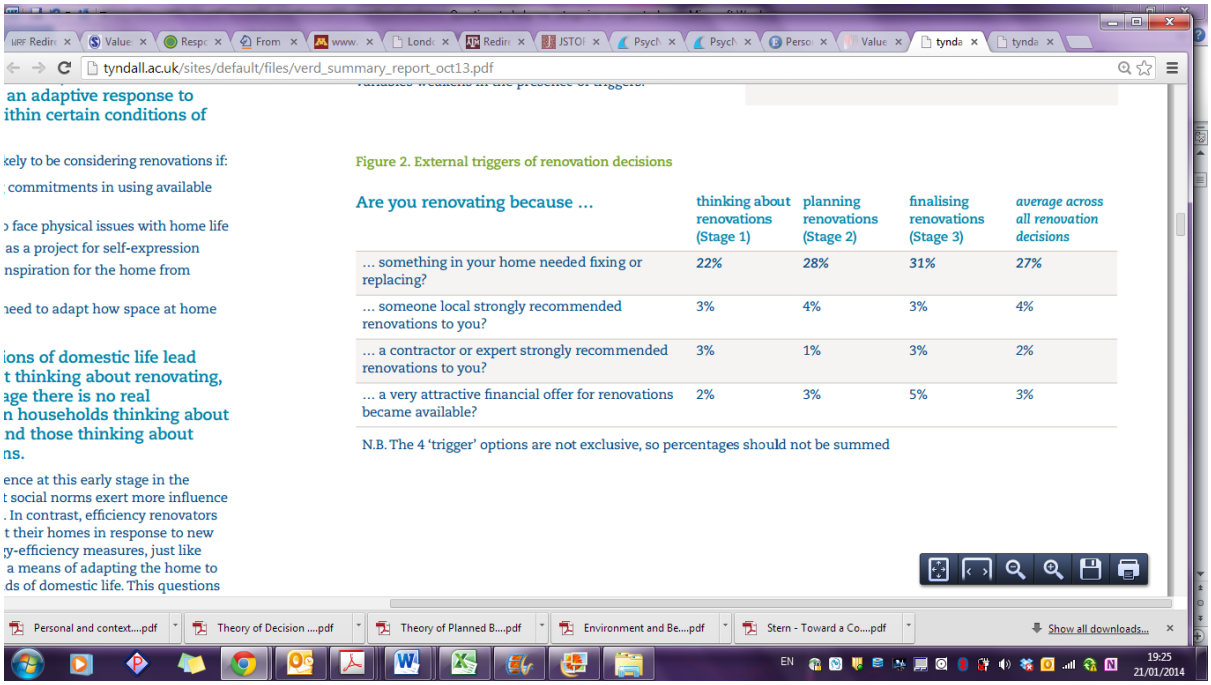
We also tested the same using higher costs' (£10000) scenarios and



domestic life	*likely*
... find the prospects of renovating *appealing*	*1.3 times more likely*

Table 2: One in Three Renovation Decisions Are 'Triggered' or Precipitated by Something From Outside Normal Domestic Life

Are you renovating because ...	**% of *yes* responses +**		
	1*	**2***	**3***
... something in your home needed *fixing or replacing?*	22%	28%	30%
... someone local *strongly recommended* renovations to you?	3%	6%	6%
... a contractor or expert *strongly recommended* renovations to you?	4%	4%	5%
... a very *attractive financial offer* for renovations became available?	2%	4%	6%



an adaptive response to
ithin certain conditions of

kely to be considering renovations if:
commitments in using available

face physical issues with home life
as a project for self-expression
nspiration for the home from

need to adapt how space at home

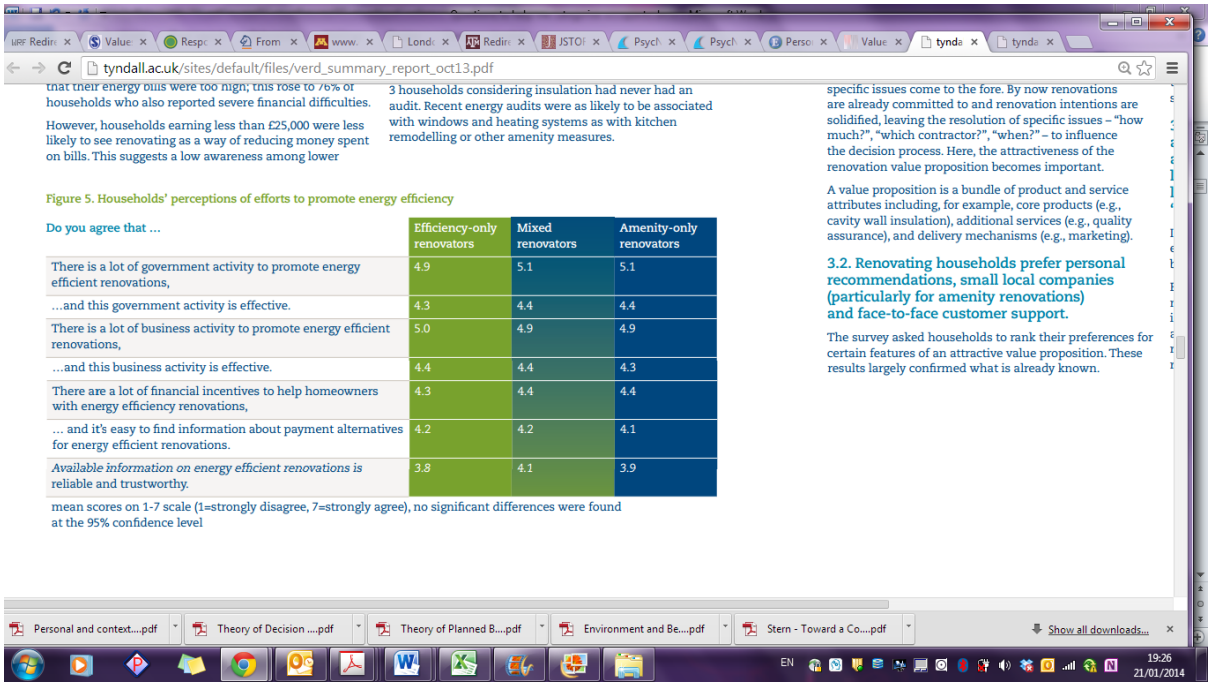
ions of domestic life lead
t thinking about renovating,
age there is no real
n households thinking about
nd those thinking about
ns.

ence at this early stage in the
t social norms exert more influence
. In contrast, efficiency renovators
t their homes in response to new
y-efficiency measures, just like
a means of adapting the home to
ds of domestic life. This questions

Figure 2. External triggers of renovation decisions

Are you renovating because …	thinking about renovations (Stage 1)	planning renovations (Stage 2)	finalising renovations (Stage 3)	*average across all renovation decisions*
… something in your home needed fixing or replacing?	22%	28%	31%	27%
… someone local strongly recommended renovations to you?	3%	4%	3%	4%
… a contractor or expert strongly recommended renovations to you?	3%	1%	3%	2%
… a very attractive financial offer for renovations became available?	2%	3%	5%	3%

N.B. The 4 'trigger' options are not exclusive, so percentages should not be summed



that their energy bills were too high; this rose to 76% of households who also reported severe financial difficulties.

However, households earning less than £25,000 were less likely to see renovating as a way of reducing money spent on bills. This suggests a low awareness among lower

3 households considering insulation had never had an audit. Recent energy audits were as likely to be associated with windows and heating systems as with kitchen remodelling or other amenity measures.

Figure 5. Households' perceptions of efforts to promote energy efficiency

Do you agree that …	Efficiency-only renovators	Mixed renovators	Amenity-only renovators
There is a lot of government activity to promote energy efficient renovations,	4.9	5.1	5.1
…and this government activity is effective.	4.3	4.4	4.4
There is a lot of business activity to promote energy efficient renovations,	5.0	4.9	4.9
…and this business activity is effective.	4.4	4.4	4.3
There are a lot of financial incentives to help homeowners with energy efficiency renovations,	4.3	4.4	4.4
… and it's easy to find information about payment alternatives for energy efficient renovations.	4.2	4.2	4.1
Available information on energy efficient renovations is reliable and trustworthy.	3.8	4.1	3.9

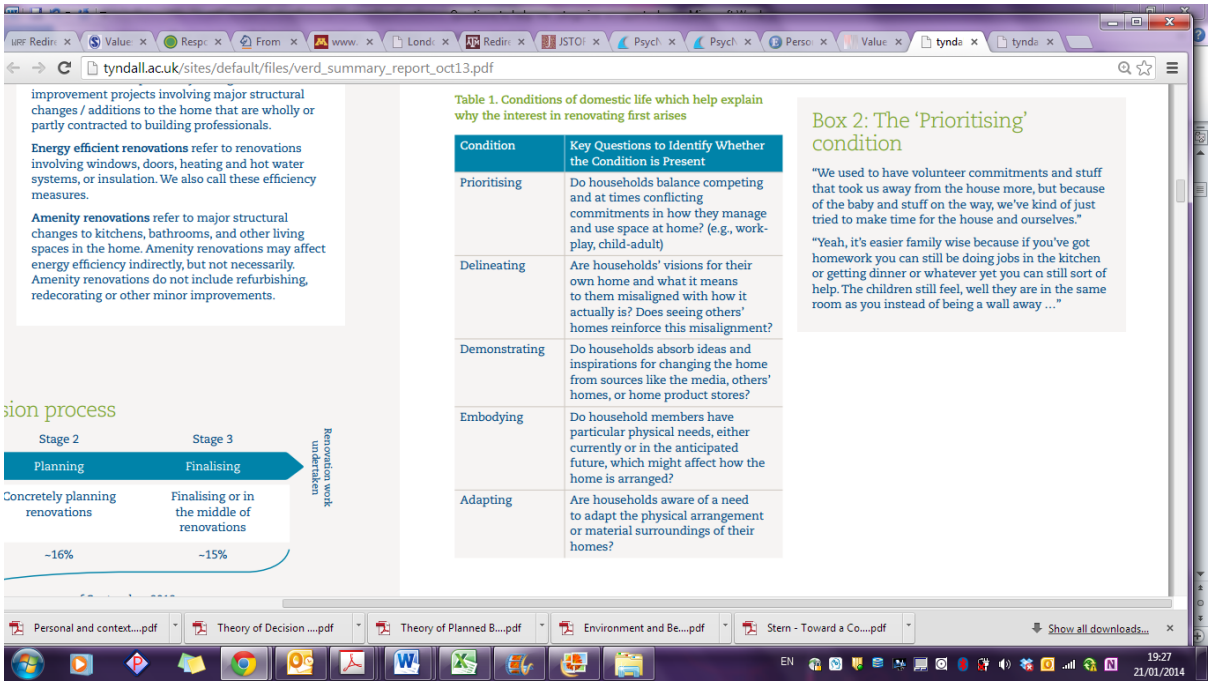
mean scores on 1-7 scale (1=strongly disagree, 7=strongly agree), no significant differences were found at the 95% confidence level

specific issues come to the fore. By now renovations are already committed to and renovation intentions are solidified, leaving the resolution of specific issues – "how much?", "which contractor?", "when?" – to influence the decision process. Here, the attractiveness of the renovation value proposition becomes important.

A value proposition is a bundle of product and service attributes including, for example, core products (e.g., cavity wall insulation), additional services (e.g., quality assurance), and delivery mechanisms (e.g., marketing).

3.2. Renovating households prefer personal recommendations, small local companies (particularly for amenity renovations) and face-to-face customer support.

The survey asked households to rank their preferences for certain features of an attractive value proposition. These results largely confirmed what is already known.



Nest-building or investing in the future?

Owner-occupiers' home improvement behaviour

Moira Munro and Philip Leather

English

This article uses qualitative data to explore in detail owners' accounts of why they choose to undertake

particular works on their houses. It argues that motivation is strongly linked to the importance

people place on their homes as a site of comfort and the locus of family life. This suggests that

'consumption'-motivated expenditure is frequently prioritised rather than 'investment' motivated

work. This helps explain why there is considerable disrepair identified in the owner-occupied stock,

despite owners' apparently good intentions and considerable ongoing expenditure on the stock. It

also suggests that policy measures predicated on evaluating owners' returns from investing in their

housing and altering such incentives are unlikely to be sufficient to solve problems of underinvestment

in owner-occupied housing. A detailed linking of motivations and constraints that affect owners across

the life-course enables a mapping of the points at which disrepair is likely to occur and become

problematic, and indicates the likely potential for and limits to policy measures designed to tackle disrepair in the owner-occupied sector.

Nest-building or investing in the future?

Owner-occupiers' home improvement behaviour

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Table 1: Lifecycle, occupancy and repair and improvement bahaviour

Household lifecycle	Length of stay/ occupancy path	Repair and improvement behaviour	Pressure points
Young household	Recent mover	Most active period. At minimum will personalise and customise; at maximum will undertake complete programme of refurbishment	Marginal owner. Foolhardy purchase/ investment choices. Undeveloped contact networks
Household with children	Longer established household	Diminishing work requirements; tackle problems as they arise	Competing spending priorities. Protecting children from disruption/mess
	Potential mover	Works to improve saleability	Potential renovation costs associated with subsequent property
Empty nester pre-retirement	Looking to the long-term	Gets house 'finished'; works that will reduce future maintenance works to meet outstanding aspirations	Decision on whether to move or stay put
Older household	Long-term occupant	Ongoing diminution of amounts of works undertaken; very little aspirational work; even responsive repair work neglected	Cash poor; losing contact networks; diminishing DIY capacity; unwilling to face disruption
Household dissolution/death	Dwelling recycled to new generation, with degree of renovation depending on condition		

English

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particular works on their houses. It argues that motivation is strongly linked to the importance people place on their homes as a site of comfort and the locus of family life. This suggests that 'consumption'-motivated expenditure is frequently prioritised rather than 'investment' motivated work. This helps explain why there is considerable disrepair identified in the owner-occupied stock,

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Conclusion

Questions to help me categorise occupants

Contents

1

DEFRA / EST

Attitudes and Behaviour Tracker

Introduction

(Household and respondent characteristics will be used from first interview)

ASK ALL

3. INTERVIEWER CODE WORKING STATUS

SINGLE CODE ONLY

Full-time paid work (30+ hours per week) Part-time paid work (8-29 hours per week) Part-time paid work (under 8 hours per week) Retired

Still at school

In full time higher education

Unemployed (seeking work)

Not in paid employment (not seeking work) Refused

All things considered, how satisfied are you with your life as a whole nowadays?

Please answer on a scale of 0-10, where 0 means extremely dissatisfied and

10 means extremely satisfied.

0 (Extremely dissatisfied) - 10 (Extremely satisfied)

Don’t know

Refused

B. Environmental and energy behaviours

21. I am now going to read out some changes that people might make to their lifestyles. For each

one tell me what answer on the screen applies to you personally at the moment. Remember there are no right or wrong answers – we’re just interested in what you personally do at the moment, not what you think you should or shouldn’t be doing.

INTERVIEWER: READ OUT BEHAVIOUR AND PROMPT AS NECESSARY:

‘Which of the options on this list best describes what you personally think about this’

Answer codes (vary by behaviour):

Standard (S):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I'm already doing this, but I probably won't manage to keep it up

I'm already doing this and intend to keep it up

I've tried doing this, but I've given up

I haven’t heard of this

Don’t know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

Regular Purchasing (RP):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've done this, but I probably won't do it again

I've done this and intend to do it again

I've tried doing this, but I've given up

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

One-Off purchasing (OO)

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've already done this

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

Statements:

RANDOMISE

1. Cutting down on the use of gas and electricity at home S
2. Buying energy efficient ('A' rated or better) appliances excluding energy saving light bulbs RP
3. Washing clothes at 40 degrees or less S (QUANT)

4. Turning down thermostats (by 1 degree or more) OO

5. Making an effort to cut down on water usage at home S (QUANT)

6. Cutting down on the use of hot water at home S (QUANT)

Q22. ASKED FOR ALL – ONLY FOR OPTIONS MARKED 'QUANT' AT Q21

22. Please tell me how frequently you personally…

REPEAT FOR: RANDOMISE

- Wash clothes at 40 degrees or less
- Make an effort to cut down on water usage at home
- Cut down on the use of hot water at home

PLUS

- Leave the heating on when you go out for a few hours (QUANT)
- Leave your TV or PC on standby for long periods of time at home (QUANT)
- Leave lights on when you are not in the room (QUANT)

ANSWER OPTIONS:

Always Very often Quite often Sometimes Occasionally Never

Don't know (SHOULD BE SEEN ON SCREEN)

Not applicable / cannot do this (SHOULD BE SEEN ON SCREEN)

INTRODUCTION TO Q23

SHOW SCREEN

Cavity walls: In most houses and parts of houses built after the 1920s, the external walls are made of two layers with a small air gap or 'cavity' between them. These are known as 'cavity walls'.

25. I am now going to read out some other changes that people might make to their lifestyles. For each one, please tell me which answer on the screen applies to you personally at the moment.

INTERVIEWER: READ OUT BEHAVIOUR AND PROMPT AS NECESSARY:

'Which of the options on this list best describes what you personally think about this'

Answer codes (vary by behaviour):

Standard (S):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I'm already doing this, but I probably won't manage to keep it up

I'm already doing this and intend to keep it up

I've tried doing this, but I've given up

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

Regular Purchasing (RP):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've done this, but I probably won't do it again

I've done this and intend to do it again

I've tried doing this, but I've given up

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY) One-Off purchasing (OO)

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've already done this

I haven’t heard of this

Don’t know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

Statements:

RANDOMISE

1. Installing cavity wall insulation (SKIP IF CODES 2,5,7 AT Q23) 1 OO /

barriers

2. Installing solid wall insulation1 OO / barriers

3. Installing loft insulation or top-up loft insulation 1 OO / barriers

(EXCLUDE IF NO LOFT –IF Q24=NO)

4. Installing double glazing1 OO / none

5. Installing draught exclusion OO / none

6. Installing solar panels for electricity at home1 OO / levers

7. Installing solar water heating at home1 OO / levers

8. Installing a wind turbine to generate electricity at home1 OO / levers

9. Installing a condensing boiler 1 OO / none

10. Installing a ground source heat pump 1OO / levers

11. Installing biomass heating1 OO / levers

12. Having thermostat controls fitted on individual radiators 1 OO / none

13. Volunteering with a conservation group (or other group helping the environment) S / barriers

NOTE: Levers and barriers – Options above lead into Q26/Q27. Not all options get these. Each

statement is marked with levers / barriers / both / none

1[EXCLUDE [IF RENTING – IF Q13=CODE 4] OR IF NOT RESPONSIBLE FOR PHYSICAL UPKEEP OF HOME IF Q15 =

NO]]

Q26 = BARRIERS Q27 = LEVERS

ASK Q26 FOR STATEMENTS 1,2,3,13 AT Q25 ONLY – IF CODES 1,2,3,4

FOR EACH STATEMENT

INTRODUCTION

I'm now going to ask you the reasons you have not done some of the things I just asked you about…

26. What would you say are the main reasons you have not done this? CODE ALL THAT APPLY

Never thought about it

Don't know if I have it or not

I cannot afford it

Takes too long to get costs back through lower energy bills

Causes too much disruption

It is too much hassle

Waiting until we do major renovations

Don't know how to go about it – or who to ask

Would not look right

Other reason (please specify)

ANSWER CODES ARE DIFFERENT FOR Q26 FOR STATEMENT 13 ONLY

Not enough time / too busy

Don't know where to find out about what I can do

Not interested

Rather do a different type of volunteering

Tried to volunteer but it was too difficult to sort out

Other (specify)

ASK Q27 FOR THOSE INSTALLED (6,7,8,10,11 AT Q25) ONLY – IF CODE

5 FOR EACH BEHAVIOUR

INTRODUCTION

I'm now going to ask you the reasons you have done some of the things I just asked you about…

- **SHOW SCREEN**
- **27. What would you say are the main reasons you have already done this? CODE ALL THAT APPLY**
- **It saves money**
- **It is easy to do/install**
- **It helps the environment**
- **It prevents waste**
- **It reduces your carbon dioxide emissions**
- **Doing a refurbishment anyway**
- **Have or can get a grant (loan) for the work**
- **It was a legal requirement**
- **Saw / knew other people had done it**
- **Makes the home a warmer / nicer place to be**
- **Other reason (specify)**
- **Able to sell surplus electricity OPTIONS 6 & 8 ONLY**
- **Able to generate my own heat and/or power OPTIONS 6, 7 & 8 ONLY**
- **It is a reliable energy supply OPTIONS 6 & 8 ONLY**

IF ANSWER CODE 5 FOR LOFT INSULATION AT Q25. SHOW SCREEN

28. B7. How thick is the insulation in your loft?

Don't know thickness 1

50mm (2") thick 2

100mm (4") thick 3

150mm (6") thick 4

200mm (8") thick 5

250mm (10") thick 6

270mm (11") thick or

more

IF LOFT THICKNESS UNKNOWN OR LESS THAN 270MM (ANSWER CODE 1-6 AT Q28)

SHOW SCREEN

29. When did you install loft insulation or last top up your loft insulation?

1 year ago

2 years ago

3-5 years ago

6-10 years ago

11-15 years ago

16-20 years ago

more than 20 years ago

Don't know

ASK ALL

SHOW SCREEN

30. I am now going to read out some other changes that people might make to their lifestyles. For

each one, please tell me which answer on the screen applies to you personally at the moment.

INTERVIEWER: READ OUT BEHAVIOUR AND PROMPT AS NECESSARY:

'Which of the options on this list best describes what you personally think

about this'

Answer codes (vary by behaviour):

Standard (S):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I'm already doing this, but I probably won't manage to keep it up

I'm already doing this, though I'd like to do it more

I'm already doing this and intend to keep it up

I've tried doing this, but I've given up

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

Regular Purchasing (RP):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've done this, but I probably won't do it again

I've done this before, though not as much as I'd like

I've done this and intend to do it again

I've tried doing this, but I've given up

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

One-Off purchasing (OO)

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've already done this

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

RANDOMISE STATEMENTS

1. Recycling items rather than throwing them away S (QUANT)
2. Wasting less food S
3. Buying fresh food that has been grown when it is in season in the country where it was produced
4. Checking whether the packaging of an item can be recycled, before you buy it RP
5. Deciding not to buy something because it has too much packaging RP (QUANT)

'INTERVIEWER: IF ASKED 'This isn't just about buying food but all types of products'

6. Reusing items like empty bottles, tubs, jars, envelopes or paper RP

(QUANT)

7. Taking your own shopping bag when shopping RP (QUANT)

8. Buying plants that especially encourage wildlife in the garden RP

9. Growing your own fruit and vegetables RP

10. Taking fewer flights S

11. Installing a water butt to collect rainwater OO

12. Buying fish from sustainable sources (such as certified by the Marine

Stewardship Council) RP

13. Buying wood and wood products from certified sustainable sources

(such as certified by the Forest Stewardship Council) RP

14. Composting your household's food and/or garden waste S (QUANT)

15. Only boiling the kettle with as much water as you need S (QUANT)

1[EXCLUDE [IF RENTING – IF Q13=CODE 4] OR IF NOT RESPONSIBLE FOR PHYSICAL UPKEEP OF HOME IF Q15 =

NO]]

ASKED FOR ALL – ONLY FOR OPTIONS MARKED 'QUANT' AT Q30

SHOW SCREEN

31. Please tell me how frequently you…

REPEAT FOR:

1. Recycle items rather than throw them away

2. Decide not to buy something because it has too much packaging

3. Reuse items like empty bottles, tubs, jars, envelopes or paper

4. Take your own shopping bag when shopping

5. Compost your household's food and/or garden waste – ONLY FOR THOSE WITH GARDEN (IF YES AT Q19)

6. Only boil the kettle with as much water as you need

ANSWER OPTIONS:

Always Very often Quite often Sometimes Occasionally Never

Don't know (SHOULD BE SEEN ON SCREEN)

Not applicable / cannot do this (SHOULD BE SEEN ON SCREEN)

C. Food behaviours

INTRODUCTION SHOW SCREEN

There are many different types of uneaten food that people throw away. These might include the types of things on this list:

Inedible food waste (e.g. peelings, bones) Fruit, vegetables or salad

Processed meat & fish (e.g. sandwich meats) Bread and cakes

Food left on the plate after the meal

Food you cooked or prepared too much of but didn't serve up

Raw or home-cooked meat & fish Ready meals or convenience foods Cheese and yoghurt

ASK ALL

SHOW SCREEN

32. How much uneaten food, overall, would you say you generally end up throwing away?

SINGLE CODE ONLY

Quite a lot

A reasonable amount

Some

A small amount Hardly any None

Don’t know (SPONTANEOUS ONLY)

ASK ALL

SHOW SCREEN

33. Thinking about when you have to throw uneaten food away, to what extent, if at all does it bother you personally?

SINGLE CODE ONLY

A great deal

A fair amount

A little

Not very much

Not at all

Don’t know (SPONTANEOUS ONLY)

ASK ALL

SHOW SCREEN

34. Thinking about the different types of food waste on the list I just showed you, how much effort do you and your household go to in order to minimise the amount of uneaten food you throw away?

SINGLE CODE ONLY

A great deal

A fair amount

A little

Not very much

None at all

Don’t know (SPONTANEOUS ONLY)

ASK ALL

SHOW SCREEN

35. How much do you agree or disagree with the following statement? STATEMENTS

Food production contributes to climate change

ANSWER CODES Strongly agree Tend to agree

Neither agree nor disagree

Tend to disagree Strongly disagree Don't Know

ASK ALL

SHOW SCREEN

36. Please read the statement below and tell me which of the options best applies to you.

If I had a better understanding of the environmental impacts of how food is produced…

I would still buy the food I usually buy

I would be willing to make changes to the food I buy to reduce my impact on the environment

I already make changes to the food I buy to reduce my impact on the environment

I already make changes to the food I buy to reduce my impact on the environment and

I'd like to do more

Don't Know

D. Recycling behaviours

ASK ALL

SHOW SCREEN

37. As far as you know, which of these can you put outside for a council recycling or composting collection?

CODE ALL THAT APPLY

Paper/Newspapers/magazines Glass bottles/jars/glass Tins/Cans/Foil

Cardboard Clothes Shoes

Plastic bottles/plastic packaging

Food waste

Garden waste

Other items (Specify) None of these

Don’t know

IF 1-10 AT Q37 (ONLY PRESENT THOSE OPTIONS SELECTED AT Q37) SHOW SCREEN

38. Which of these do you normally put outside for recycling or composting collection?

CODE ALL THAT APPLY

Paper/Newspapers/magazines Glass bottles/jars/glass Tins/Cans/Foil

Cardboard Clothes Shoes

Plastic bottles/plastic packaging

Food waste

Garden waste

Other items (Specify) None of these

Don’t know

ASK ALL

39. Is there a bottle bank or recycling bank in your area where you can take things like bottles,

cans or paper to recycle?

Yes

No

Don’t know

IF YES AT Q39

40. Do you [or your household] ever use these facilities?

Yes

No

Don’t know

IF YES AT Q40

DO NOT SHOW SCREEN

41. What things do you take to recycle?

DO NOT PROMPT. CODE ALL THAT APPLY. PROBE FULLY: What else? Anything else?

Paper/Newspapers/magazines Glass bottles/jars/glass Tins/Cans/Foil

Cardboard Clothes Shoes

Plastic bottles/plastic packaging

Other items (Specify) None of these

Don’t know

E. Energy in the home

ASK ALL

42. Approximately, how many light bulbs do you have in your home? WRITE IN NUMBER BELOW.

INTERVIEWER - IF NECESSARY: You do not need to count the number of bulbs. Please give your best estimate.

Don’t know

ASK ALL

SHOW SCREEN WITH IMAGE OF ENERGY SAVING LIGHT BULB

These are energy saving light bulbs.

43. Approximately, how many of the light bulbs in your house, if any, are energy saving light bulbs?

Don’t know

ASK IF ALL BULBS ARE NOT ENERGY SAVING (Q43 IS LESS THAN Q44)

DO NOT SHOW SCREEN

44. .What are the main reasons stopping you fitting/fitting more energy saving light bulbs in your home?

DO NOT PROMPT - CODE ALL THAT APPLY

PROBE FOR SPECIFIC REASONS, e.g. REASONS FOR NOT LIKING

THEM RATHER THAN 'I don't like them'.

Don't like the way they look

Do not fit my light fittings

Not as bright as ordinary bulbs/quality of light is poor

Will replace as other bulbs blow

Too expensive

Takes too long to turn on

Can't use with a dimmer switch Don't believe they save you money Not thought about it

Other reason (no need to specify)

Don't know

ASK ALL READ OUT

45. Which of the following types of heating does your home have? SINGLE CODE.

Central heating

Warm air heating system (heating grates bringing heat from a communal building source)

Electric storage heating

None of these

Don't know

ASK ALL

SHOW SCREEN

46. Thinking about your heating system at home, which of these statements best describes how you set the temperature during the winter?

CODE ALL THAT APPLY

INTERVIEWER: SETTING THE TEMPERATURE CAN INCLUDE SETTING A CENTRAL THERMOSTAT OR THERMOSTATIC

CONTROLS ON INDIVIDUAL RADIATORS (IT DEPENDS ON HOW THE RESPONDENT CONTROLS THE TEMPERATURE IN

THEIR HOME)

I change it whenever it gets too hot or too cold, I don't like to wear a lot of

layers indoors

I change it whenever it gets too hot or too cold, I'll often wear a jumper

indoors

I don't change the setting often, but it can be too warm

I don't change the setting often, but it can be too cold

I don't change the setting often, it's a comfortable temperature

I don't tend to use the central heating

Don't know

ASK ALL

DO NOT READ OUT

47. What proportion of the windows in your home are double-glazed? SINGLE CODE ONLY

None 1

Some (25%) 2

About half (50%) 3

Most (75%) 4

All (100%) 5

Don't know (DO NOT READ) 6

ASK Q48

GO TO Q49

ASK ALL EXCLUDING RENTERS [IF Q13=CODE 4] AND THOSE NOT RESPONSIBLE FOR PHYSICAL UPKEEP OF HOME [IF

Q15 = NO]

READ OUT

48. Which of the following windows are you interested in getting/replacing? CODE ALL MENTIONS

Replacing single glazing with double glazing

Getting new double glazing for a new extension/renovation e.g. extension or loft extension

Replacing old double glazing with new improved double glazing

Don't know

None of these

ASK ALL READ OUT

49. What proportion of your single glazed opening windows and doors are draught-proofed?

None

Some (25%) About half (50%) Most (75%)

All (100%)

Don't know

ASK ALL EXCLUDING RENTERS [IF Q13=CODE 4] AND THOSE NOT RESPONSIBLE FOR PHYSICAL UPKEEP OF HOME [IF

Q15 = NO]

SHOW SCREEN

50. Have you bought any of the following household appliances in the last year?

CODE ONE FOR EACH OWNED

SHOW SCREEN WITH ENERGY SAVING RECOMMENDED LOGO

ASK FOR ONE APPLIANCE BOUGHT IN LAST 12 MONTHS (SCRIPT TO SELECT ONE AT RANDOM)

51. When you were looking for the (APPLIANCE), did you look for the Energy

Saving Recommended logo on it? SINGLE CODE ONLY

ASK FOR ONE APPLIANCE BOUGHT IN LAST 12 MONTHS (SCRIPT TO SELECT ONE AT RANDOM – SAME AS Q51)

52. And did the (APPLIANCE) you actually bought have the Energy Saving

Recommended logo on it? CODE ONE ONLY

Within the past year

	Logo			Bought		
	Yes	No	DK	Yes	No	DK
Washing machine	1	1	2	3	1	2	3
Tumble dryer	2	1	2	3	1	2	3
Washer-dryer	3	1	2	3	1	2	3
Dishwasher	4	1	2	3	1	2	3
Fridge-freezer	5	1	2	3	1	2	3
Fridge	6	1	2	3	1	2	3
Freezer	7	1	2	3	1	2	3

G Travel

ASK ALL READ OUT

53. How many cars or vans are there in your household currently? SINGLE CODE

1	1
2	2
3 or more	3

ASK Q54

None 4 SKIP TO Q59

ASK ALL READ OUT

54. Do you drive?

Yes 1 ASK Q55

No 2 SKIP TO Q59

ASK ALL WHO DRIVE (IF YES AT Q54) SHOW SCREEN

55. Approximately how many miles a year do you personally drive? SINGLE CODE

Less than 5000 miles

5000 – 7999 miles

8000 – 10,999 miles

11,000 – 15,999 miles

16,000 – 20,000 miles More than 20,000 miles Don't know

ASK ALL WHO DRIVE (IF YES AT Q54) SHOW SCREEN

56. Thinking of the car you drive the majority of the time, what size engine does it have?

Less than 1 litre

1.0 – 1.4 litres

1.5 – 2.0 litres

2.1 – 3.0 litres

More than 3.0 litres

Don't know

23

ASK ALL WHO DRIVE (IF YES AT Q54) SHOW SCREEN

57. And what sort of fuel does it run on? SINGLE CODE ONLY

Petrol Diesel LPG

Hybrid petrol/electric

Electric

Other

Don't know

ASK ALL WHO DRIVE (IF YES AT Q54)

58. I am now going to read out some changes that people might make. For each one, please tell me

which answer on the screen applies to you personally at the moment.

INTERVIEWER: READ OUT BEHAVIOUR AND PROMPT AS NECESSARY:

'Which of the options on this list best describes what you personally think about this'

Answer codes (vary by behaviour):

Standard (S):

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I'm already doing this, but I probably won't manage to keep it up

I'm already doing this and intend to keep it up

I've tried doing this, but I've given up

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

One-Off purchasing (OO)

I don't really want to do this

I haven't really thought about doing this

I've thought about doing this, but probably won't do it

I'm thinking about doing this

I've already done this

I haven't heard of this

Don't know (SPONTANEOUS ONLY)

Not applicable (SPONTANEOUS ONLY)

STATEMENTS RANDOMISE

1. Switching to public transport instead of driving for regular journeys S
2. Switching to walking or cycling instead of driving for short, regular journeys S
3. Driving in a fuel efficient way S
4. Switching to an electric / hybrid / LPG car OO
5. Buying or using a more fuel efficient / smaller / diesel car OO

INTRODUCTION READ OUT

Next I'd like to ask you about air travel. I'm just interested in air travel for leisure, holidays

and visiting friends or family, not air travel for work or business purposes.

ASK ALL

59. Have you taken any flights in the last 12 months for leisure, holidays or visiting friends or

family?

Yes

No

Don't know

IF YES AT Q59

60. How many flights within the UK did you take in the last 12 months? Please count the outward and return flight and any transfers as one flight.

Numeric range (0 to 99)

Don't know

IF YES AT Q59

61. How many flights to other European countries did you take in the last 12 months? Please count the outward and return flight and any transfers as one flight.

Numeric range (0 to 99)

Don't know

IF YES AT Q59

62. How many flights to countries outside Europe did you take in the last 12 months? Please count the outward and return flight and any transfers as one flight.

Numeric range (0 to 99)

Don’t know

H. Environmental and energy attitudes

QUESTIONS Q63 – Q74 TO BE COMPLETED AS SELF-COMPLETION SECTION IN CAPI

ASK ALL

SHOW SCREEN

63. How much if anything would you say you know about the following terms? SINGLE CODE ONLY

STATEMENTS

Climate change (to always appear first in the list) Global warming

Carbon footprint

CO2 (carbon dioxide) emissions

Biodiversity

ANSWER CODES A lot

A fair amount

Just a little

Nothing – have only heard of the name

Nothing – have never heard of it

Don’t know

ASK ALL

SHOW SCREEN

64. Which of these best describes how you feel about your current lifestyle and the environment?

I'm happy with what I do at the moment

I'd like to do a bit more to help the environment I'd like to do a lot more to help the environment

Don't know

ASK ALL

SHOW SCREEN

65. And which of these would you say best describes your current lifestyle? SINGLE CODE ONLY

I don't really do anything that is environmentally-friendly

I do one or two things that are environmentally-friendly

I do quite a few things that are environmentally-friendly

I'm environmentally-friendly in most things I do I'm environmentally-friendly in everything I do

Don't know

ASK ALL

SHOW SCREEN

66. How much do you agree or disagree with these statements?

RESPONSE CODES Strongly agree

Tend to agree

Neither agree nor disagree

Tend to disagree Strongly disagree Don't Know

STATEMENTS RANDOMISE

1. I don't really give much thought to saving energy in my home
2. People have a duty to recycle
3. I don't pay much attention to the amount of water I use at home
4. The so-called 'environmental crisis' facing humanity has been greatly exaggerated
5. I find it hard to change my habits to be more environmentally-friendly

6. We are close to the limit of the number of people the earth can support

7. It would embarrass me if my friends thought my lifestyle was purposefully environmentally friendly

8. It's not worth Britain trying to combat climate change, because other countries will just cancel out what we do

9. The Earth has very limited room and resources

10. The effects of climate change are too far in the future to really worry me

11. It's not worth me doing things to help the environment if others don't do the same

12. If things continue on their current course, we will soon experience a major environmental disaster

13. It's only worth doing environmentally-friendly things if they save you money

14. For the sake of the environment, car users should pay higher taxes

15. I would only travel by bus if I had no other choice

16. People who fly should bear the cost of the environmental damage that air travel causes

17. Being green is an alternative lifestyle it's not for the majority

ASK ALL

SHOW SCREEN

67. And how much do you agree or disagree with these statements:

RESPONSE CODES Strongly agree

Tend to agree

Neither agree nor disagree

Tend to disagree

Strongly disagree

Don't Know

STATEMENTS RANDOMISE

1. The Government is doing a lot to tackle climate change

2. Any changes I make to help the environment need to fit in with my lifestyle

3. I need more information on what I could do to be more environmentally friendly

4. I sometimes feel guilty about doing things that harm the environment

5. I would be prepared to pay more for environmentally-friendly products

6. I do worry about the changes to the countryside in the UK and the loss of native animals and plants

7. 'Waste not want not' sums up my general approach to life

8. I often talk to friends and family about the things they can do to help the environment

9. I try to persuade people I know to be more environmentally friendly

10. I've suggested improvements at my workplace/the place where I study to make it more environmentally friendly

11. Climate change is beyond control – it's too late to do anything about it

12. The environment is a low priority compared to other things in my life

13. If government did more to tackle climate change, I'd do more too

14. I don't believe my everyday behaviour and lifestyle contribute to climate change

15. I make an effort to buy things from local retailers and suppliers

ASK ALL

SHOW SCREEN

68. Here are some things other people have said. For each one, please say how much you agree or disagree with the statement:

RESPONSE CODES Strongly agree

Tend to agree

Neither agree nor disagree

Tend to disagree Strongly disagree Don't Know

STATEMENTS RANDOMISE

1. I do worry about the loss of species of animals and plants in the world

2. It's important to me that I can be proud of my local environment

3. We should all try and save water regardless of whether it rains or is sunny

4. There are many natural places that I may never visit, but I'm glad they exist

5. If business did more to tackle climate change, I would too

6. It really disappoints me when I see big offices and public buildings with their lights on when

the building is empty

7. It really bothers me when I see people wasting energy or food

ASK ALL

SHOW SCREEN

69. And thinking now about your overall attitudes towards energy usage and climate change, which of these statements best reflects how you currently feel?

SINGLE CODE ONLY

I don't believe there are climate change problems caused by energy use and I'm not willing or able to change my behaviour with regards to energy use.

Whether there are climate change issues or not, I am not willing or able to change my behaviour with regards to energy use

Climate change is caused by energy use and I'm beginning to think that I should do something

Climate change is caused by energy use and I'm doing a few small things to help reduce my energy use and emissions

Climate change is caused by energy use and I'm doing quite a number of things to help reduce my energy use and emissions

Climate change is caused by energy use and I'm doing lots of things to help reduce my energy use and emissions

Don't know (NOT ON CARD)

ASK ALL

SHOW SCREEN

70. How important is it for you to have public gardens, parks, commons or other green spaces

nearby?

SINGLE CODE ONLY

Very important Fairly important Not very important

Not important at all

Don't Know

ASK ALL

SHOW SCREEN

71. And how often do you visit public gardens, parks, commons or other green spaces?

SINGLE CODE ONLY

6-7 days a week

3-5 days a week

1-2 days a week

Once a fortnight

Once a month

Several times a year

Once a year

Less often

Never

Don't Know

ASK ALL

SHOW SCREEN

72. What are the three most important reasons for you spending time in public gardens, parks, commons or other green spaces?

CODE ALL THAT APPLY – UP TO THREE

Tranquillity Scenery Open space Fresh air

Plants and wildlife Leisure opportunities Way of life

Villages / historic buildings

Nothing Don't Know Other (specify)

ASK ALL

SHOW SCREEN

73. How would you judge the current situation in each of the following? SINGLE CODE ONLY

RESPONSE CODES

Very good

Good

Neither good nor bad

Bad

Very Bad

Don’t know

STATEMENTS RANDOMISE

The economic situation in the UK The economic situation in the World

The financial situation in your household

76. Before I ask you the last few questions – I'd like to check one more thing

Could I ask what room temperature your heating is set to now? [answer in centigrade] [RANGE BETWEEN

0 AND 50]

INTERVIEWER – IF RESPONDENT DOESN'T KNOW PLEASE ASK THEM

TO GO AND CHECK.

WRITE IN NUMBER BELOW.

INTERVIEWER: Enter 50 if they cannot answer – i.e. have no way of controlling the temperature in the home / thermostat does not have a temperature scale

Don't know

Refused

I. Household and respondent characteristics

INTRODUCTION

Finally, I'd just like to ask you a few more questions about your circumstances.

ASK ALL

SHOW SCREEN

77. Are you a member of, or do you make regular donations to, any of the organisations on this list?

CODE ALL THAT APPLY

National Trust/The National Trust for Scotland Royal Society for the Protection of Birds (RSPB) WI (Women's Institute)

Civic Trust Wildlife Trusts WWF

The Woodland Trust

Christian Aid

Stop Climate Chaos

Oxfam

British Trust for Conservation Volunteers (BTCV) Greenpeace

Ramblers Association

Friends of the Earth

Council to Protect Rural England

None of these

Another organisation concerned with the environment (specify)

ASK ALL READ OUT

78. In the last 12 months, have you volunteered with, given time to or taken part in any groups?

Yes

No

Don't know

Refused

ASK ALL WHO HAVE VOLUNTEERED (YES AT Q78) SHOW SCREEN

79. Which of the following types of group have you volunteered with, given time to, or taken part in?

CODE ALL THAT APPLY

Schools

Youth / Children's Activities (outside school)

Environment/Conservation

Adult education

Sports/Exercise – in team, coaching or organising

Religion

Politics

Health, Disability, Counselling and support services, Advice on welfare

Safety / First Aid

Animal protection

Justice and Human Rights

Local Community or Neighbourhood Groups

Hobbies/Recreation/Arts groups

Trade Union Activity

Other

ASK ALL

80. Do you read any daily newspapers at least 3 times a week? INTERVIEWER: This would include any regional or local daily paper

Yes

No

Don't know

ASK ALL WHO READ DAILY NEWSPAPER (YES AT Q80) SHOWN SCREEN

81. Which one of the following daily newspapers do you read most often? SINGLE CODE ONLY

Daily Express Daily Mail Daily Mirror Daily Star

Daily Telegraph Financial Times The Guardian The Independent The Sun

The Times Metro London Lite

The London Paper Regional/local daily paper Other daily newspaper None of these

ASK ALL

82. Do you read any Sunday newspapers at least twice a month?

Yes

No

Don't know

ASK ALL WHO READ SUNDAY NEWSPAPER (YES AT Q82) SHOWN SCREEN

83. And which of these Sunday newspapers do you read most often? SINGLE CODE ONLY

News of the World Mail on Sunday Sunday Express Sunday Mirror Daily Star Sunday The People Sunday

Times

The Observer Sunday Telegraph Independent on Sunday

Regional/local Sunday newspaper

Other Sunday newspaper

None of these

ASK ALL

SHOW SCREEN

84. To which of these groups do you consider you belong? SINGLE CODE ONLY

a. White - British b. White – Irish

c. White – other white background

d. Mixed – White and Black Caribbean e. Mixed – White and Black African

f. Mixed – White and Asian

g. Mixed – any other Mixed background h. Asian or Asian British – Indian

i. Asian or Asian British – Pakistani

j. Asian or Asian British – Bangladeshi

k. Asian or Asian British – other Asian background l. Black or Black British – Caribbean

m. Black or Black British – African

n. Black or Black British – other Black background o. Chinese

p. Other (specify)

q. Don't know

r. Refused

ASK ALL

SHOW SCREEN

85. I am now going to ask you about your household income. I only need to know an approximate amount, to see if this influences people's views and experiences.

Please can you tell me your overall HOUSEHOLD income from all sources in the last year? This

includes earnings from employment or self-employment, income from benefits and pensions, and income from other sources such as interest and savings.

Please look at the screen and tell me which option represents your TOTAL HOUSEHOLD INCOME in the

last year from all sources BEFORE tax and other deductions.

	Annual	Weekly	Monthly
1	Under £2,500	Under £50	Under £200
2	£2,500 - £4,999	£50 - £99	£200 - £399
3	£5,000 - £9,999	£100 - £199	£400 - £829
4	£10,000 - £14,999	£200 - £289	£830 - £1,249
5	£15,000 - £19,999	£290 - £389	£1,250 - £1,649
6	£20,000 - £24,999	£390 - £489	£1,650 - £2,099
7	£25,000 - £29,999	£490 - £579	£2,100 - £2,499
8	£30,000 - £34,999	£580 - £679	£2,500 - £2,899
9	£35,000 - £39,999	£680 - £769	£2,900 - £3,349
10	£40,000 - £44,999	£770 - £869	£3,350 - £3,749
11	£45,000 - £49,999	£870 - £969	£3,750 - £4,149
12	£50,000 -£59,999	£970 - £1,149	£4,150 - £4,999
13	£60,000 - £74,999	£1,150 - £1,449	£5,000 - £6249
14	£75,000 - £99,999	£1,450 - £1,919	£6,250 - £8,299
15	£100,000 or more	£1,920 or more	£8,300 or more
16	Don’t know (HIDDEN CODE)		
17	Refused (HIDDEN CODE)		

ASK ALL

SHOW SCREEN

86. Which, if any, of these state benefits are you currently receiving in your own right?

ADD IF NECESSARY: That is where you are the named recipient

CODE ALL THAT APPLY

Unemployment related benefits, or National Insurance Credits

Income support (not as an unemployed person) Sickness or disability benefits (not including tax

credits) State Pension

Family related benefits (excluding Child Benefit and tax credits) Child benefit

Cold weather payment

Housing, or Council tax benefits

Tax credits Other (specify) None of these Don't know Refused

ASK ALL READ OUT

87. Do you have any qualifications...? CODE ALL THAT APPLY

From school college or university

Connected with work (e.g. on the job training, apprenticeship) From Government schemes/programmes

Don't Know

No qualifications

ASK ALL WITH QUALIFICATIONS (Q87=YES) SHOW SCREEN

88. From this list, please tell me the highest academic qualification that you have obtained?

PROMPT AS NECESSARY. SINGLE CODE ONLY

PRIORITY CODE: IF TWO OR MORE QUALIFICATIONS HELD, CODE THE ANSWER WHICH IS HIGHER UP THE LIST.

Higher degree, e.g. MSc, MA, MBA, PGCE, PhD

First degree, e.g. BSc, BA, BEd, MA at first degree level

GCE 'A'-level / SCE Higher Grades (A-C)

GCSE grade A-C / GCE 'O'-level passes / CSE grade 1 / SCE O Grades (A- C) / SCE Standard Grades

(1-3) / School Certificate / Matriculation

GCSE grade D-G / CSE grade 2-5 / SCE O Grades (D-E) / SCE Standard

Grades (4-7) / SCOTVEC National Certificate Modules Other academic qualifications (PLEASE DESCRIBE)

None of these

Refused

ASK ALL WITH QUALIFICATIONS (Q87=YES) SHOW SCREEN

89. And please tell me the highest qualification on this list you have obtained? PROMPT AS NECESSARY.

SINGLE CODE ONLY

PRIORITY CODE: IF TWO OR MORE QUALIFICATIONS HELD, CODE THE ANSWER WHICH IS HIGHER UP THE LIST.

Level 1 NVQ/SVQ / Foundation GNVQ/GSVQ Level 2 NVQ/SVQ / Intermediate GNVQ/GSVQ Level 3 NVQ/SVQ /

Advanced GNVQ/GSVQ

Level 4 NVQ/SVQ Level 5 NVQ/SVQ

NVQ/SVQ - not sure what level

BEC (General) / BTEC (General) / City & Guilds Craft or Ordinary level / RSA Diploma

ONC/OND / BEC (Higher) / TEC (Higher) / BTEC (Higher) / RSA Advanced

Diploma

Other vocational or pre-vocational qualification (PLEASE DESCRIBE) No, none of these

Refused

ASK ALL

SOCIAL GRADING QUESTIONS

90. Who would you say is the chief income earner in this household?

IF RELATED: IF TWO EQUAL INCOMES TAKE THE ELDER PERSON

IF LIVING AS MARRIED TREAT AS MARRIED AND THEREFORE RELATED

IF UNRELATED: TAKE THE RESPONDENT AS CHIEF INCOME EARNER

Appendix 5: The Postgraduate Research Student Skills Sharing Record for the second year

Postgraduate Research Student Skills Training Record

Academic Year:	ID no:
PhD Year Two - 2012 to 2013	B028214
Name of Student:	**Full / Part time:**
Catherine Simpson	full time
Name of Supervisor(s):	**Dept:**
Victoria Haines and David Allinson	Civil and Building Engineering

Department Based Training. This includes external training approved by the Department and Vitae GRAD schools.

Activity. (Autofit row Height if necessary)	Skills Addressed (use skills matrix code)	Time Claimed (days)	Date Completed
Attended Qualitative analysis course by Victoria Haines	1A,1B,1E, 2C, 2D, 2E, 3A, 3C, 4C	1.5	01/06/13
SAP tutorial with David Allinson - plus several other mini tutorials	2C, 2D, 2E, 3A, 4C	0.5	16/07/13
Nvivo course by Patsy Clarke (Design School)	1A,1B,1E, 2C, 2D, 2E, 3A, 3C, 4C	1.0	15/07/13
Interview presentations for new lecturer	1A,1B, 1C,1D	0.5	18/07/13
Presented at department seminar (attended 3)	1A, 3A, 4B, 4C, 5A, 5B, 5D, 5E	0.5	20/03/13
Presented work to Kevin Lomas and Dennis Loveday	1A, 3A, 4B, 4C, 5A, 5B, 5D, 5E	0.5	21/03/13
Conversations with David Allinson, Richard Buswell, Tom Kane and Richard Jack about temperature data collection and gas monitoring	1A, 1D, 1E, 2A, 2B, 2E, 3C, 4C, 5A, 5C, 5D	0.5	01/03/13
Air-tightness testing training: Reading, pre-pilot and safety awareness with Richard Jack and pilot and safety authorising with David Allinson	1D, 1E, 2A, 2B, 2C, 2E, 3A, 3C, 4C, 5A, 5B, 5C	1.0	01/06/13
Ethics approval and risk assessment process	1B, 2E, 4A, 5A, 5B, 5C	0.5	31/01/13
Updating ethics approval and risk assessment	1B, 2E, 4A, 5A, 5B, 5C	0.5	24/05/13

Planning, carrying out and analysing research interviews	1B, 1C, 2A, 2C, 2E, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 5D, 5E	1.0	ongoing
Continuous literature review	1A, 1D, 1E, 2A, 2B, 2C, 2D, 2E, 4A, 5A, 5B, %C, 5E	1.0	ongoing
Supervisor meetings with Victoria Haines and David Allinson including planning, agenda creation, note taking and record keeping	1A, 1B, 1C, 1D, 1E, 2A, 2B, 2C, 2D, 2E,3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 5D, 5E	1	ongoing
Organisation of data collecting equipment	1C, 1E, 2E, 3C, 4C, 5A, 5B, 5C	0.5	01/03/13

Other Activities. To be validated by supervisor. Refer any queries to Heather Dalgleish in the Graduate School. H.Y.Dalgleish@lboro.ac.uk

Activity and Evidence of Skill Development:	Skills Addressed (see skills matrix code)	Time Claimed (days)	Date Completed
Bill Bordass masterclass, UCL	1A, 1D, 2B, 3A, 3C	0.5	12/06/13
The co-creation of a short-film to communicate the importance of ventilation in buildings during the LoLo summer event	1C, 3C, 4A, 4C, 5A, 5B, 5C, 5D, 5E	1.0	28/06/13
Co-hosting a LoLo stall at The Green Man Festival 2013. This includes the co-organisation and running of a thermal image photo-booth to communicate the beneits of thermal insulation.	1C, 3C, 4A, 4C, 5A, 5B, 5C, 5D, 5E	1.0	20/08/13
Side qualitative research project interviewing occupants living fuel poverty in London. This included carrying out seven interviews and assiting with a further eight. Transcribing those interviews carried out and the focus group. Splitting the transricption into quotes per questions asked. A focus group was also recorded and transcribed. The results of this will be presented at the RGS Annual conference on 29th August.	4A, 4B, 4C, 5A, 5D, 5C, 5D, 5E	1.0	29/08/13

Training Summary	Days
Department Based Training	10.5
Graduate School Courses (data from staff development website "view your activities"	
Other Activities	3.5
Total Training Days	**14.0**

Signature of Student:	Date:
Signature of Supervisor:	Date:
Signature of Chair of Progression panel:	Date:

Appendix 6: The draft thesis

Energy efficiency refurbishment in UK owner-occupied dwellings: The occupant's perspective

The aim of this project is to identify whether energy efficient refurbishments are successful from the householders' perspective.

This will be explored through the following objectives:

a) To identify the householders' expectations of the energy efficiency improvement process. This will incorporate their understanding on the installations, their estimation of time and financial costs, their existing knowledge of available measures, their expectations of the process of fitting and expected disruption. This will be later compared with the actual process.

b) To ascertain what happens during the actual delivery process of the installation. This will cover the occupant's experiences throughout the process. Particular focus will be paid to the installation of the measures, time taken and cost, disruption or any additional unexpected factors experienced.

c) To evaluate and compare the levels of thermal comfort and quality of living environment before and after the refurbishment. This will include the occupant's perceptions and quantitative measurements.

d) To quantify the energy, fuel and subsequent CO_2 and financial cost savings using measured and modelled data. This will focus on the energy consumed for space heating by comparing usage before and after the refurbishment. The air permeability of the fabric will be measured before and after the work, this will also be an input to the SAP model.

e) Identify where the occupants' expectations are not met and where they are exceeded, to ensure householder satisfaction and help encourage future adoption. This will detail how the process of energy efficiency refurbishment can be improved to maximise the benefits to the occupant - both perceived and actual.

The methodology aims to address the following research questions:

a) What are the occupant expectations of an energy efficiency installation and what do they actually get?

b) Do the occupants perceive an internal environment improvement?

c) Do the householders actually save money, energy and carbon?

Table of Contents

This report presents the progress over the first year of a three year exploration into the occupant's perspective of energy efficiency installations to owner-occupied homes in the UK. There is a current urgency to reduce the energy demand of dwellings using a transdisciplinary approach (Lomas.a, 2010). The domestic sector is responsible for 30% of annual emissions in the UK (Harris, Annut, & Macleay, 2011). At a household level this is estimated at an average of 5,827kgCO_2 per household per year (Firth, Lomas, & Wright, nd). In 2012, space and water heating account for almost 80% of these emissions (EEDO, 2012) as shown in figure 1.

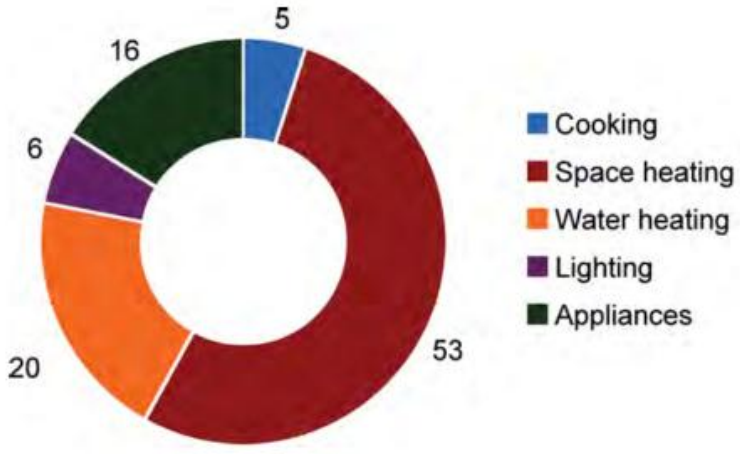


Figure 1. Carbon emissions by source – housing (Government, Low Carbon Construction, 2010)

The UK government is committed to achieving an 80% reduction in CO_2 emissions by 2050; from 1990 levels as set out in the Climate Change Act (2008) (Parliament, 2008). CO_2 emissions within the domestic sector are caused by the burning of fossil fuels to heat and power our homes (Chiras 2006). It is one of the main greenhouse gasses. The 'greenhouse effect' is responsible for maintaining temperatures near the Earth's surface which make life possible. In this process, the carbon dioxide molecules in the air, absorb infrared radiation which would usually be emitted from the Earth's surface, causing a warming of the lower atmosphere, (Roberts 2010). However, there is now a large concern that the unrelenting burning of fossil fuels alongside other human activities, is increasing the concentration of carbon dioxide and other 'greenhouse gases' leading to increased warming, (Shorrock & Utley 2008). Carbon dioxide is the most important contributor because such large quantities are emitted.

There has been recent discussion over the future carbon dioxide emission targets as the Kyoto protocol, which is the international agreement which sets binding targets for 37 developed countries for reducing greenhouse gas emissions is due to expire late 2012 (UNFCCC, 2012). However, carbon dioxide emissions are just one factor to be considered in burning fossil fuels. Other consequences include resource depletion and energy security with potential political disputes, environmental concerns from the extraction techniques and transportation of fuel, gas pipeline security and maintenance. Overall, it makes good sense to minimise our reliance of fossil fuels.

The heat produced within a dwelling to maintain a comfortable living temperature is lost through ventilation and by transmission through the building fabric (Anderson & CIBSE, 2006). Over the next fifty years around one half of building's energy use may be dissipated through ventilation and air infiltration (Liddament, 1996). Energy efficiency improvements should result in a reduction of these losses. It is hoped that a minimum of two thirds or 68% of the carbon reduction will be achieved through professionally installed insulation measures, which should provide long-term reductions (DECCb, 2012). It has been estimated that to meet an 80% reduction in CO_2 emissions by 2050 we would need to achieve almost 'zero carbon[1]' standards through the addition of energy efficiency measures to 25million UK dwellings (Davis & Oreszczyn, 2011). Research by Lomas (2010) suggests a cut in emissions of 11.5%-13.8% by 2020 with further reductions by 2050 may be feasible. This is using local and national strategies involving a combination of technical and social measures

[1] Zero carbon in this case is defined as no carbon dioxide emitted through the combustion of fuels or otherwise to meet a dwellings space and water heating requirements. This has however been a controversial definition as it does not take account of embodied carbon dioxide or the carbon footprint of a heat source.

addressing the building stock improvements in addition to attitudes and behaviours (Lomas.a, 2010). Lomas recognised that CO_2 savings are not always made due to a variety of reasons including poorly installed insulation or interventions resulting in changes of behaviour patterns and increased heating demand (Lomas.a, 2010). Therefore, the predicted savings from energy efficiency measures are a real challenge to accurately model and calculate.

The Green Deal, governed by the Energy Act (2011), may address the financial concerns of occupants whilst also promoting available measures and potential savings (DECCg, 2012). This will eliminate the need to pay upfront for energy efficiency improvement measures by providing a sum of money which will be repaid through savings made on the energy bill. The 'Golden Rule' within the scheme is used to establish whether a measure is financially viable: "The expected financial savings resulting from installing measures must be equal to or greater that the cost of repayment over the term of the Green Deal Plan" (DECCf, 2011). The assessment will be based on a strengthened version of the Standard Assessment Procedure (SAP) which has been reviewed by the Department for Energy and Climate Change (DECC). DECC are also developing an advice process to account for occupant energy behaviour within the home (DECCf, 2011). They advise that customer protection has been carefully considered within the scheme (DECCc, n.d) and has been built into every stage of the journey outlined on the 'end-to-end process map' (DECCe, 2012). The process map is clear presentation of Green Deal stakeholders are their points of interaction with the occupant.

UK dwelling occupants need to have an awareness of energy efficiency and this scheme before they choose to commit to the installation process of an energy saving measure. However, recent research in Sweden found that 70-90% of homeowners had no intention of adopting measures over the next ten years (Nair, Gustavsson, & Mahapatra, 2010). In Germany research has found that despite high awareness of energy efficiency and rising energy prices plus government incentives, home owners rarely take the opportunity to cut down their personal energy use and carbon emissions (StieB & Dunkelberg, 2012). There is no market push for energy efficiency, consumers may be concerned about climate change and generally understand the causal role of fossil fuels but often believe they have either already done everything they can or that one person cannot make a difference (Boardman.b, 2004).

Perceived barriers to the uptake of energy efficiency technologies exist such as hassle and disruption, uncertainties of relatively new technologies, concerns for the building fabric; in terms of aesthetics or moisture paths, finance or time constraints or even just a lack of awareness of the available measures and their potential benefits (Mallaband, Haines, & Mitchell, 2012). These perceived barriers may result from expectations which depend on past experiences, corporate reputation,

formal recommendations, informal recommendations, personal needs, promotion and price (Robledo, 2001). In Sweden (2000) it was found that a lack of housing refurbishment projects have been undertaken with a clear emphasis on the service provided for occupants (Holm, 2000). As social networks have been found to be essential in the diffusion of energy-efficiency innovations in UK households (McMichael & Shipworth, 2012) the experiences of the early adopters are crucial to promote further uptake of measures.

As engagement through schemes has been acknowledged as a pathway to reducing energy consuming behaviour (Lomas.a, 2010) local authorities have trialled various approaches in engaging social housing occupants during previous energy efficiency schemes. Many confirmed that the most effective approach was to take them through the process enabling them to make decisions where possible, communicate the reasons why they were adopting measures, their potential benefits and empower them to make behavioural changes (Watts, 2012) (Beagley, 2012) (Sharpe, 2012) (Nolan, 2012) (Marsh, Davies, & Laughlin, 2012). Bush, from Metropolitan Housing Partnership felt that a more fun approach was needed to engage people (Bush, 2012). Recent research and conference presentations such as these focussed on social housing as this sector was targeted within the previous and current government schemes detailed in the literature review. However, in 2010, there were 22.4million dwellings in the UK, 66%, or 14.8million, of which were owner occupied. The rest split evenly between the private rented sector (17%) and the social rented sector (17%) (CLG.1, 2012). The overall average energy efficiency rating for the whole stock, calculated using SAP09 was 55, an increase from 45 in 1996. SAP ratings in the social sector in 2010 were around eight points higher than in owner occupied and privately rented homes (CLG.1, 2012). Owner occupiers are also likely to consume more energy as they are often higher earners than many social housing tenants.

The launch of the Green Deal may not increase the demand for energy efficiency refurbishments in UK owner-occupied homes. One reason may be that occupants are satisfied with the physical condition, thermal performance and aesthetics of their home (Gupta & Chandiwala, 2010). UK owner-occupiers are likely to have already installed central heating and double-glazed windows and may assume they have done all they can to save energy and prevent heat loss. They may also be over-heating their homes, running inefficient old heating systems and be generally unaware of potential fabric improvements. Recent fuel price increases may concern some of the sector. However, they are generally harder to reach, in terms of energy efficiency programmes and research alike.

Research has also found that occupants can develop negative attitudes towards an installation experience due to technological faults or internal disputes leading to problems with contractors

workmanship (Crosbie & Baker, 2010). Faults and disputes are unexpected complications. Householders are often willing to tolerate surprising levels of disruption, but unexpected delays or complications can cause considerable stress (Vadodaria, Loveday, Haines, Mitchell, Mallaband, & Bayer, 2010). Occupants may also not expect to adapt their behaviour or learn how to use a new system. Leaman and Bordass (2001) who have carried out extensive research into post occupancy evaluation suggest that the greatest enemy of occupant satisfaction is a building and its systems which have become too complex for its managers (Leaman & Bordass, 2001), although this refers to facilities managers of non-domestic buildings it may still apply to dwellings with new system technologies.

An in depth study of a small sample of case study homes with an energy efficiency refurbishment should provide rich data on the occupants overall experiences and whether this meets or exceeds their expectations. The results should be useful to policy makers and energy efficiency installers to improve occupant satisfaction and future adoption.

1.2 Aims and objectives

The aim of this project is to identify the key factors influencing the success of energy efficient installations to UK owner occupied homes from the householders' perspective.

This will be explored through the following objectives:

a) To identify the householders' expectations of the energy efficiency improvement process. This will incorporate their understanding on the installations, their estimation of time and financial costs, their existing knowledge of available measures, their expectations of the process of fitting and expected disruption. This will be later compared with the actual process.

b) To ascertain what happens during the actual delivery process of the installation. This will cover the occupant's experiences throughout the process. Particular focus will be paid to the installation of the measures, time taken and cost, disruption or any additional unexpected factors experienced.

c) To evaluate and compare the levels of thermal comfort and quality of living environment before and after the refurbishment. This will include the occupant's perceptions and quantitative measurements of temperature, relative humidity and building fabric air tightness. The quantitative measurements are also additions to the Standard Assessment Procedure model.

d) To quantify the energy, fuel and subsequent CO_2 and financial cost savings using measured data in addition to the modelled data. This will focus on the energy consumed for space heating by comparing usage before and after the refurbishment using meter readings.

e) Identify where the occupants' expectations are not met and where they are exceeded, to ensure householder satisfaction and help encourage future adoption. This will detail how the process of energy efficiency refurbishment can be improved to maximise the benefits to the occupant - both perceived and actual.

2 CHAPTER TWO: LITERATURE REVIEW

Introduction

2.1 The UK housing stock

2.1.1 Stats from BRE energy Factfile and EHS

2.1.2 Evolution of energy efficiency standards in the UK and beyond

2.1.3 Current UK policy

Streamlining the Green Deal:

https://www.gov.uk/government/news/streamlining-and-improving-the-green-deal

2.2 Energy efficiency refurbishment

2.2.1 Potential measures

Energy efficiency measures fitted during the refurbishment process can reduce the heat loss through the building fabric, improve the efficiency of the heating system or increase occupant heating control. The measures likely to be installed within the case study homes are fabric insulation, glazing, draught proofing and boilers. Insulation may be added within cavity walls, lofts, on the inside or outside of solid walls and possibly under-floors also. Glazing may be upgraded from single to double, or double to triple. Draught proofing may be added around windows, doors and other openings. Old boilers may be replaced for A/B rated boilers and this may include radiator and pipe replacement also.

2.2.2 The installation process

2.2.3 Economics

2.2.3.1 Measure costs

The cost of measures covers the purchase cost and the cost of installation. Additional costs may be incurred to repair or decorate, termed 'make-good' following the installation. Previous research found that CESP did not include making good costs (E.ON, 2010) but these costs should be included within the Green Deal (DECCf, 2011). The occupant's experience of a professional energy efficiency refurbishment covers five main stages; 'research', 'pre-installation', 'installation', 'post-installation' and 'ongoing' as identified within the ECOFYS report (Holdaway, Samuel, Greenleaf, Briden, & Gardiner, 2009). Table 1 presents the five stages of measure implementation including the potential occupants tasks for the installation of cavity wall insulation, loft insulation, internal and external solid wall insulation, draught proofing and A/B rated boilers. The tasks are relatively similar for each measure. Occupant's research includes the identification of potential options, selection of measures, check funding and appraisal. The pre-installation stage includes their appointing of a contractor and the preparation for work. The installation stage includes the contractor installing the measure – this section is generally under-researched. The post-installation stage includes the removal of waste from the area and any redecoration needed. Ongoing includes aspects such as annual gas servicing of boilers or regular maintenance.

Table 1. The process of installation of likely measures employed by early adopters adapted from ECOFYS report of costs and hidden measures (Holdaway, Samuel, Greenleaf, Briden, & Gardiner, 2009)

Professionally installed measures	Occupant's research	Pre-installation	Installation	Post-installation	Ongoing
Cavity wall insulation	• Identify options • Selection of specific measures • Supplier choice • Check funding • Appraisal/CBA	• Appointment of contractor • Preparation of external space (incl access for equipment)	• Contractor installs insulation	• Remove waste materials • Minor external redecoration (eg filling holes and repainting) • Post installation repair(eg cracked rendering)	
Loft insulation	• Identify options • Selection of specific measures • Contractor choice • Check grant availability • Appraisal/CBA	• Survey • Appointment of contractor • Prepare/clear loft space	• Loft insulation added	• Dispose of waste materials/packaging from the insulation • Re-lay/add walk boards	
Glazing	• Identify options • Selection of specific measures	• Survey • Appointment of contractor • Preparation of space near window • Removal of obstructions	• Glazing added/upgraded	• Minor external redecoration (eg filling holes and repainting)	

Internal solid wall insulation (SWI)	• Identify options • Selection of specific measures • Supplier choice • Check grant availability • Appraisal/CBA	• Survey • Appointment of contractor • Removal of obstructions • Preparation of walls	• Cut and install drylining • Install SWI • Installation Of electricians (wiring, etc)	• Remove waste • Clear up • Plaster dry time • Redecorating • Recommission of systems affected (eg radiators)	• Redecorate post-shrinkage
External solid wall insulation (SWI)	• Identify options • Selection of specific measures • Supplier choice • Check grant availability • Appraisal/CBA	• Secure planning permission where relevant • Survey • Appointment of contractor • Preparation of external space • Preparation of walls	• Install SWI	• Remove waste materials • Clear up space • External redecoration	• Maintenance
Draught proofing	• Identify options • Selection of specific measure • Compare material prices • Appraisal/CBA	• Procurement of materials	• Install draught proofing	• Clear up space • Minor redecoration	
A/B rated boilers	• Identify options • Selection of specific measure	• contractor • Preparation on external/internal space (for access)	• Install boiler	• Clear up space Making good around fitting	• Annual service (for gas)

Each of the measures in table 1 may entail hidden costs. Table 2 uses estimated cost data from the Energy Saving Trust in addition to the hidden cost data provided in the ECOFYS report to provide estimates for the cost of each measure listed in table 1. The hidden costs cover occupants time and financial expenditure. The value of householder time was calculated on the basis of Department for Transports value for non-work time at resource cost of £3.68/hr (Holdaway, Samuel, Greenleaf, Briden, & Gardiner, 2009). Glazing has been excluded as this presently relies on quotations from individual installers. Cavity wall, loft insulation and draught proofing are the current low-cost measures at £100 to £350. However, these quotations did include current discounts provided by CERT which are unlikely to be presented during the Green Deal. The hidden financial costs of cavity wall insulation are due to phone call costs of contacting installers during the research process. The hidden time costs included are 2 to 16 hours of research time, 1.7 to 11 hours pre-installation during the survey, appointing of contractor and preparation of external space. During the installation 1 to 4 hours is allocated to manage the contractors and post-installation 1 hour is allowed for minor decoration. The total time of 4.5 to 28, is presented in table 3 and this was converted to £30 to £170 as overall hidden costs in terms of money and time. Loft insulation, and draught proofing hidden costs are similar to cavity wall insulation.

Table 2. Installation measure costs, estimates (ESTa, 2012) and hidden costs (Holdaway, Samuel, Greenleaf, Briden, & Gardiner, 2009)

	Approx. installation cost (£)	Potential hidden financial costs (£)	Potential hidden time costs (hours)	Overall potential hidden costs (£ + time)
Cavity wall insulation	100 to 250	0 to 5	4.5 to 28	30 to 170
Loft insulation (0 to 270mm)	100 to 350	0 to 5	5.5 to 37	30 to 220
Internal solid wall insulation (SWI)	5500 to 8500	9980 to 18280	77 to 180	10420 to 19320
External wall insulation	9400 to 13000	4610 to 8370	20.5 to 49	4730 to 8650
Draught-proofing	200	10 to 25	4.5 to 13	50 to 100
Boiler replacement	2300	0 to 5	2 to 4	10 to 30

Internal and external wall insulation shown in figure 2 are clearly the most expensive measures at £5,500 to £8,500 and £9,400 to £13,000 retrospectively. The hidden costs for these measures are also much larger at £9,980 to £18,280 and £4,610 to £8,370 retrospectively. These hidden costs were broken down into the research and installation stages. Research stage: £0-£10 or 8 – 16 hours. At pre-installation stage: £59 to £428.20 or 13 to 28 hours for the survey, storage of room contents, protective covers or finding alternative accommodation to vacate for the installation period. At installation stage: £9,200 to £11,200 or 0 to 8 hours for temporary accommodation, loss of internal floor area, removing and replacing skirting boards, removal of damp and mould, removal and refitting of radiators, sockets, lights and switches, removal and refit or an airbrick flush with finish, forming a neat junction around bay windows, removal and refitting of gas pipework, painting, and boxing in alongside managing contractors. These costs are all potential. Post installation: £1446.6 to £6647.2 or 56 to 128 hours. This accounted for re-cutting a carpet, recomissioning electrics and water pipes, refitting wall furniture, redecoration, post-shrinkage (drying) decoration, replacement of kitchens or bathrooms, redecoration time, unpack items from storage and a further potential redecoration. Similar types of issues were included for external wall insulation but for fixings such as window cill extenders, mould addressing, alarm box, satellite dish removal/refit, extending of boiler flues, adjustment to door canopies etc. These aspects will differ from house to house and will be difficult to accurately estimate.

The estimates of hidden costs are valuable to this research project as these financial and time costs incurred by the occupant may have a large impact on their overall satisfaction with the process. During the research accurate costings of these factors will be collected. EST also provides potential

energy savings, payback periods and annual CO_2 savings which can be used as a reference (ESTa, 2012).

Savings made on energy bills as a result of these measures will vary. In the research of Ball and Roberts (2012) 65% of occupants reported that gas bills were easier to pay since the retrofit and 60% for electricity (Ball & Roberts, 2012), conversely the Warm Front findings suggest that many occupants did not experience savings on fuel bills (Gilbertson, Stevens, Stiell, & Thorogood, 2006), this may have been due to occupants previously under-heating their home. As another reference, the unit price for gas in 2011 was 0.03(£/kWh) and electricity 0.12(£/kWh). The average annual gas bill for Nottingham in 2011 was £737 and for electricity, £466 (DECCa, 2011). The carbon dioxide emitted is calculated by multiplying the units of energy consumed by energy conversion factors specified by the Energy Saving Trust (ESTb, 2011).

2.2.3.2 Payback periods

2.3 The occupant's perspective

In recent years there has been a shift in the whole construction industry following two key reports which emphasised the need for a greater customer focus in construction (Latham, Egan). Customer satisfaction has been a focus of all services in recent decades. Construction has become a service industry across Europe and now adopts measurement tools from the field of service management. Research in Finland found that the measurement of customer satisfaction in this field is still at an early stage of development (Karna, Sorvala and Junnonen 2009).

2.3.1 The role of social networks

As social networks have been found to be essential in the diffusion of energy-efficiency innovations in UK households (McMichael & Shipworth, 2012) the experiences of the early adopters are crucial to promote further uptake of measures. Previous research found that referrals made by weak and strong relationship ties have an impact of consumer choices but strong ties are perceived to be more influential and likely to be used during the research stage of purchasing goods (Brown and Reingen 1987).

2.3.2 Customer demand

In a study which took the housebuilder's perspective on the feasibility of zero carbon homes in England by 2016 (Osmani, M and O'Reailly, A. 2009) customer demand was seen to be an essential element in the widespread development of zero carbon homes. Another study by Osmani, alongside

Davies, on the architects perspectives of low carbon housing refurbishment (LCHR), found that variable levels of householder awareness were considered to be the most difficult environmental and cultural barrier faced by architects in the uptake of LCHR (Davies and Osmani, 2011). One the further research recommendations made was to to capture the views of end-users in housing refurbishment to establish the current LCHR practice, hindrance and enablers and to explore and assess the contribution LCRH can make in achieving an 80% CO2 reduction by 2050.

2.3.3 An occupant as an end-user

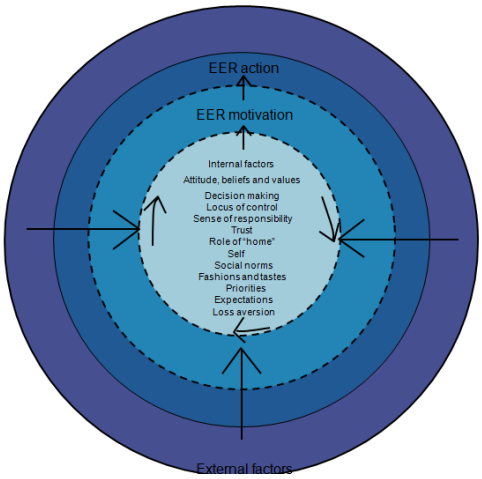
Dwelling occupant's are considered to be end-user's in this research. Some previous research in the field has referred to occupant's in this way. 'End-user experiences in nearly zero-energy houses' by Mlecnik et al (2012) was a study which analysed post-occupancy evaluation results in Germany, Austria and Switzerland and then carried out a survey of occupants in almost zero-energy houses in the Netherlands. The study assessed occupant's positive and negative end-user appraisal in connection with comfort parameters, information provision and control parameters. The research recognised that high end-user satisfaction is required for the overall acceptance of such dwellings in society.

2.4 Occupant motivations and barriers

Motivations and barriers influence expectations.

2.4.1 Motivations to add energy efficiency installations to a home

Research by Organ, Proverbs and Squires (2013) categorised motivations to refurbish into broad themes of economic, social and environmental motivations. This research was partly psychological and describes a new motivation model for energy-efficiency refurbishment of the owner-occupied housing stock, as shown in figure 1 (Oragn et al 2013). This model was developed from a review of literature and incorporates both internal and external factors demonstrating how they are inter-related and may be affected by external factors. The internal factors are shown in the centre and the energy efficiency motivation and action are shown in the outer layers. External factors include current incentives, penalties, social norms, housing market, property condition, cost of works, regulation etc (Oragn et al 2013). The research found that the external factors change more often than internal factors but affect internal factors, motivation and action.



Motivations in Germany have been found to be aesthetic or functional concerns, aiming to embellish the home, carry out necessary maintenance work or increase the value of their home. Some occupants were motivated by saving energy and reducing heating and operating costs (StieB & Dunkelberg, 2012). Improvement of the indoor environment was also found to be a key driver in addition to becoming less dependent on fossil fuels and contributing to climate protection

2.4.2 Barriers in adding energy efficiency installations to a home

Despite high awareness of energy efficiency and rising energy prices plus government incentives, home owners rarely take the opportunity to cut down their personal energy use and carbon emissions (StieB & Dunkelberg, 2012). Recent research in Sweden found that 70-90% of homeowners had no intention of adopting measures over the next ten years (Nair, Gustavsson, & Mahapatra, 2010). There is no market push for energy efficiency, consumers may be concerned about climate change and generally understand the causal role of fossil fuels but often believe they have either already done everything they can or that one person cannot make a difference (Boardman.b, 2004).

Perceived barriers to the uptake of energy efficiency technologies exist such as hassle and disruption, uncertainties of relatively new technologies, concerns for the building fabric; in terms of aesthetics or moisture paths, finance or time constraints or even just a lack of awareness of the available measures and their potential benefits (Mallaband, Haines, & Mitchell, 2012). These perceived barriers may result from expectations which depend on past experiences, corporate reputation, formal recommendations, informal recommendations, personal needs, promotion and price

(Robledo, 2001). In Sweden (2000) it was found that a lack of housing refurbishment projects have been undertaken with a clear emphasis on the service provided for occupants (Holm, 2000). Research has also found that occupants can develop negative attitudes towards an installation experience due to technological faults or internal disputes leading to problems with contractors workmanship (Crosbie & Baker, 2010). Faults and disputes are unexpected complications. Householders are often willing to tolerate surprising levels of disruption, but unexpected delays or complications can cause considerable stress (Vadodaria, Loveday, Haines, Mitchell, Mallaband, & Bayer, 2010).

2.4.3 Suitable conditions of life to refurbish a home

Conditions of life - VERD

2.4.4 Service delivery

In Sweden in 2000 it was reported that whilst the quality of work in construction had been highlighted it was unusual to find housing refurbishment projects which had been carried out with a clear emphasis on the service provided for tenants (Holm, 2000). Holm (2000) carried out a survey to tenants of two multi-family housing estates owned by a semi-public housing estate in Sweden. They found that there was strong link between meeting the customers' expectations and contractor reputation (Holm, 2000). They also surveyed 32 contractors and found that there were high significant correlations between workers feeling well informed and having regular contact with occupants and receiving feedback about their quality of work (Holm, 2000).

2.5 Experiences

2.5.1 Satisfaction

2.5.2 Delight

2.5.3 Hassle

2.6 Expectations

The perception of service delivery can be shaped by expectations. An expectation of a refurbishment is a belief of the process and an understanding of the potential benefits. Chahal (2012) is currently carrying out research into the tenant perceptions of housing retrofit. She provides useful insights into expectations, perceived barriers, satisfaction of support received, choice of measures and whether or not occupants felt they have saved money but little on the occupants experience of the actual process of implementation. Findings included from a 2010 survey of 251 UK social households showed that only 6.7% of respondents accepted energy efficiency measures to reduce fuel bills and

only 3.6% of residents decided to accept energy efficiency measures based on concerns on the environment/climate change (Chahal, Swan, & Brown, 2012). She reported that only a small number of landlords suggest there is demand from the tenants for sustainable retrofit measures. 86 residents found the main barrier to be possible upheaval. Post-occupancy there was no findings presented on the occupant's actual experiences of upheaval. However, 34% of occupants were either 'not happy' or 'very unhappy' with the level of support received, whilst the social housing sector may differ from the owner-occupied sector this is a large percentage of people dissatisfied. 24.7% were found to be unaware of whether they had made financial savings, this research did recognise that 25% of consumers do find bills hard to understand. 12.7% of occupants felt they may not be able to use a new technology however 45.7% found their new boiler very easy to use although there was 2% experiencing problems (Chahal, Swan, & Brown, 2012). Chahal (2012) did acknowledge that this research did not measure whether they were actually using their boilers correctly. The research did not record the occupants heating patterns, internal environment conditions and whether financial and energy savings were actually made either.

Chahal's (2012) research did indicate that expectations of energy efficiency measures are not always accurate but their post-occupancy perceptions will impact future expectations. Robledo (2001) offered a model for managing expectations, as shown in figure 3. This model identified that past experience and informal recommendations are integral to expectations. It includes five additional factors which contribute to expectations; corporate reputation, formal recommendations, personal needs, promotion and price. These can be seen within the central triangle of figure 3 'sources of expectation'. Each of these is relevant to what may contribute to occupant's expectations of housing refurbishment.

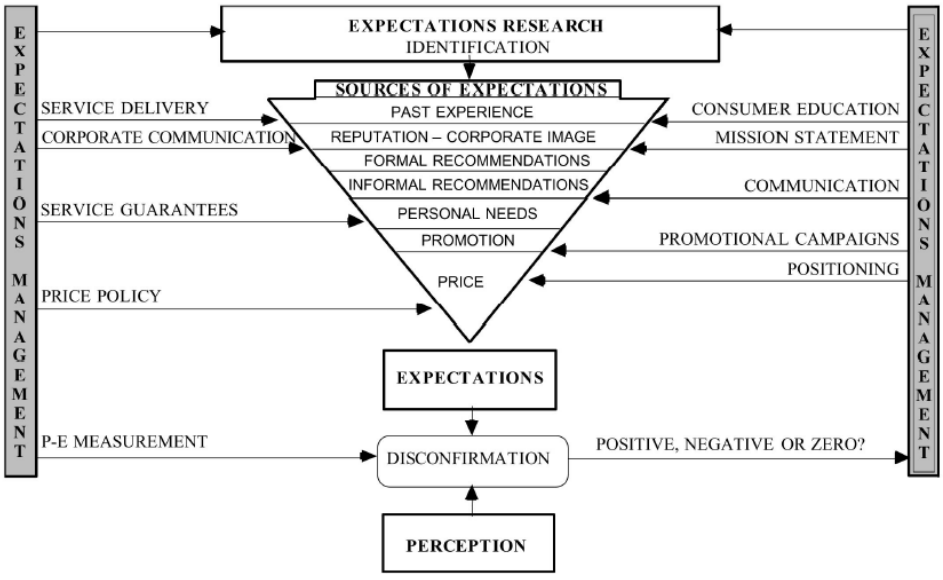


Figure 2. Expectations (Robledo, 2001)

Other manufacturing industries such as computer systems and communication rely on user feedback. The construction industry does not. Perhaps this is because houses, boilers or installations are usually be one-off purchases. However, some occupants are now attracted to the latest technologies for energy supply (Gupta & Chandiwala, 2010). Research by Gould and Lewis (1985) on designing the usability in computer systems recommended three principles of system design: early and continued focus on the users, empirical measurement of usage and repeated modification and testing (Gould & Lewis, 1985). There is a repeated theme for discussing post-occupancy evaluation potential in refurbishments and research has shown it would be beneficial, (Leaman & Bordass, 2001), but it is still not compulsory. 'Soft Landings' are used in non-domestic buildings as post-occupancy evaluation but domestic energy feedback is primarily studied by academics at present.

Crosbie and Barker (2010) carried out a study to establish 'why people react to particular energy-efficiency interventions in the ways they do?' (Crosbie & Baker, 2010). They carried out a qualitative study of 50 in-depth interviews with inhabitants who participated in one of four domestic energy-efficiency interventions. Overall they found that most of the occupants found their experience to be positive; overall, their expectations were met. Many found their homes to be of a superior design, aesthetically pleasing, of increased thermal comfort with lower heating costs than alternative homes available to them. However, some occupants did develop negative attitudes towards the experience due to technological faults or internal disputes leading to problems with contractor's workmanship. This type of issue will be explored within the current research.

In Sweden it has been found that there is a lack of housing refurbishment projects which have been undertaken with a clear emphasis on the service provided for occupants (Holm, 2000). It was found by Holm that there is a strong link between meeting the customer's expectations and contractor reputation. He also found that there is a strong belief among the workers that quality of work is essential but they would be less content with quality checking of their work by others (Holm, 2000). Whilst this work is based in Sweden and reported in 2000, it may still have relevant findings.

Customers evaluate service quality by comparing their perceptions of the service with their expectations (Robledo, 2001). The transition from expectations to delivery can be investigated using feedback techniques (Gupta & Chandiwala, 2010). Gupta and Chaniwala (2010) collected data on the occupant perceptions of comfort, satisfaction, behaviour and expectations to inform the briefing and solutions in terms of design, materials, construction, installation and commissioning practices for the energy efficiency improvements to their homes. They believed occupants who become an integral part of the low-carbon interventions assisted in minimising unintended consequences such as

increased energy use or comfort creep (Gupta & Chandiwala, 2010), or the rebound effect. Subsequently it was hoped that this process would improve occupant's perceived value of low-carbon housing refurbishment.

Gupta and Chaniwala's (2010) research extended a typical building performance evaluation to combine technical and social aspects, as with the present research. They presented the majority of data collection methods within compact tables combining post-construction fabric testing, energy assessment and benchmarking, in-use measurement and monitoring of the physical environment, in-use measurement and occupant feedback surveys (Gupta & Chandiwala, 2010). Some elements of each of these categories will be used in the present research.

A main challenge identified by StieB and Dunkelberg (2009) is to reach those unaware of the potential benefits, who tend to overestimate the performance of their homes and therefore underrate the possible energy savings. They found that despite high awareness of energy efficiency and rising energy prices plus government incentives, home owners rarely take the opportunity to cut down their personal energy use and carbon emissions (StieB & Dunkelberg, 2012). Consultation with an energy advisor was found to result in more energy-efficient measure investment.

Motivations and barriers may influence expectations. Motivations in Germany have been found to be aesthetic or functional concerns, aiming to embellish the home, carry out necessary maintenance work or increase the value of their home. Some occupants were motivated by saving energy and reducing heating and operating costs (StieB & Dunkelberg, 2012). Improvement of the indoor environment was also found to be a key driver in addition to becoming less dependent on fossil fuels and contributing to climate protection. Some people wanted to install the latest technology (StieB & Dunkelberg, 2012). UK research by Mallaband et al (2012) focused on the key barriers to the uptake of energy efficiency installations has listed householders values & preferences, cost, professionals, time, property features, life stage, attitudes to older houses, perceived difficulty, regulations, availability of parts/products, disruption , lack of consensus, personal capacity and available information as factors preventing the uptake of energy saving measures (Mallaband, Haines, & Mitchell, 2012). Similar factors were reported in other research concerned with the uptake of energy efficiency measures (Killip, 2011) and (Guy & Shove, 2000).

2.7 Living environment evaluation

Healthy internal building environments require a balance of conditions including temperature and moisture control through heating and ventilation. People typically spend 90% of their time indoors so the quality of internal environment is important for human comfort and well-being.

2.7.1 Occupant comfort

The occupant benefits of having a home which is more economical to heat are often overlooked. They may include being generally healthier and happier, feeling much warmer, more secure and comfortable and reduced noise from outside (Aspden, Ball, Roberts, & Whitley, 2012) (Gilbertson, Stevens, Stiell, & Thorogood, 2006) (E.ON, 2010). People have also reported perceived improvements to physical and mental health in addition to emotional well-being (Gilbertson, Stevens, Stiell, & Thorogood, 2006). Further consequences of enhanced social interaction, privacy and family relationships, increased use of domestic space, better use of kitchens and improved nutrition and a general comfort and atmosphere within the home (Gilbertson, Stevens, Stiell, & Thorogood, 2006). The improved warmth and comfort had broader consequences and resulted in enhanced emotional security and higher feelings of contentment (Gilbertson, Stevens, Stiell, & Thorogood, 2006). Within a similar study in New Zealand, the participants reported improved health, reduced wheezing, fewer days off school and work in addition to a trend in fewer visits to the general practitioners and fewer hospital admissions for respiratory conditions, this also correlated with increased temperatures and reduced relative humidity (Howden-Chapman, et al.).

2.7.2 Thermal comfort

Thermal comfort is defined as an expression of the mind which expresses satisfaction of the thermal environment (Fanger, 1986). The thermal sensation of a human being is mostly related to the thermal balance of his or her body as a whole (ISO, 2005). The balance is influenced by physical activity/metabolic rate, and clothing insulation, as well as the environmental parameters: air temperature, mean radiant temperature, mean radiant temperature, relative humidity and air velocity (ISO, 2005), (Humphreys, Nicol, & CIBSE, 2006). When these factors are known the thermal comfort of a person can be predicted by the PMV index (Predicted Mean Vote), using a seven point scale from hot (+3) to cold (-3) (Fanger, 1986) (ISO, 2005). This scale can be incorporated into a thermal comfort diary (Gupta & Chandiwala, 2010).

2.7.3 Noise

2.7.4 Light

2.7.5 Security

2.7.6 Overall comfort

2.7.7 Space heating

The impact of energy efficiency refurbishment on the space heating fuel consumption in English dwellings was studied in 1372 households across five major UK urban areas over two winters by Hong et al (2006). Temperature data was collected for a two to four week period from the main bedrooms and living room. Property and utility consumption data was also collected. Data was normalised to account for variation in the indoor-outdoor temperature difference and dwelling floor area. Although the data collection period was short and could not account for a future rebound effect the findings showed cavity and loft insulation could reduce the space heating consumption by 10% in centrally heated properties and 17% in non-centrally heated properties (Hong, Oreszczyn, & Ridley, 2006).

Central heating has led to temperature variation throughout the home, and insulation has increased temperatures generally which may have changed the way occupants use their spaces but there is no trend towards higher temperatures for occupied rooms as oppose to vacant rooms (Wright, 2008). It was found by Summerfield et al (2010) that, in 2005 the average household had a minimum space heating demand of 0.8kW, when the external temperature is 16^{o}C. This rises to approximately 3.8kW if the outdoor temperature decreases to 5^{o}C (Summerfield, Lowe, & Oreszczyn, 2010).

Occupants may not understand their central heating system controls or know the healthiest temperature to set their heating at (Shipworth, Firth, Gentry, Wright, Shipworth, & Lomas, 2010). Shipworth et al recommended new controls developed which appeal to householders and are intuitive to use. Other research has found that occupants find the new controls much easier following refurbishment and only two households (8%) reported difficulties in using the new heating system (Aspden, Ball, Roberts, & Whitley, 2012).

2.7.8 Indoor temperatures

3 shows the CIBSE-recommended indoor dwelling temperatures:

Table 3. The CIBSE recommended indoor temperatures for the summer and winter periods, (Humphreys, Nicol, & CIBSE, 2006)

Room	Winter	Summer
	Temp/^{o}C	Temp/^{o}C
Bathrooms	20-22	23-25
Bedrooms	17-19	23-25
Hall/stairs/landing	19-24	21-25
Kitchen	17-19	21-23
Living rooms	22-23	23-25
Toilets	19-21	21-23

Kane et al (2011) carried out a study of indoor temperatures across 292 homes in Leicester and calculated the mean temperature for the whole sample and for individual house types also. The whole sample mean was 18.4^{o}C. The graph in figure 4 demonstrates this temperature averages for dwelling archetypes. The types, with averages are: detached dwellings (17.6 ^{o}C), semi-detached (18.5 ^{o}C), end terrace (18.2 ^{o}C), mid-terrace (17.9 ^{o}C) and flats (19.6 ^{o}C) (Kane, Firth, Allinson, Irvine, & Lomas, 2011). This data provides a useful guide for average pre-refurbishment temperatures within UK homes.

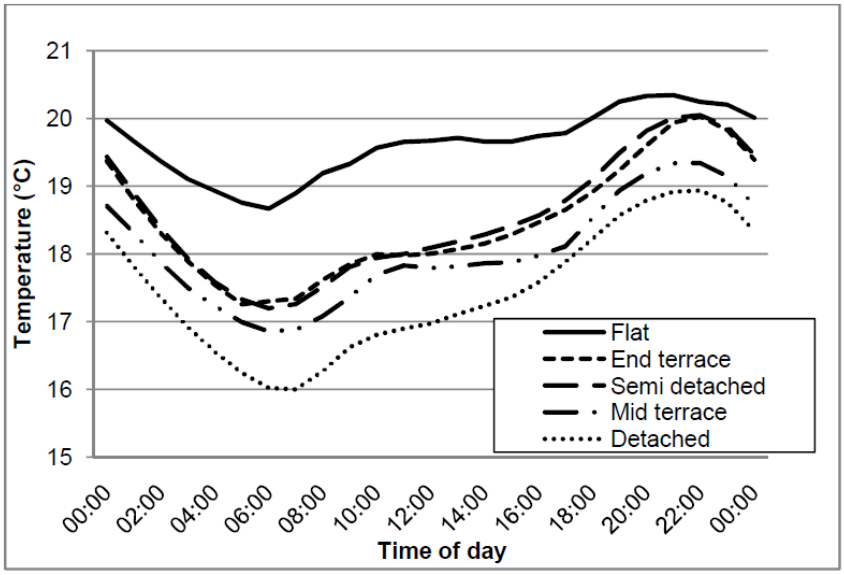


Figure 3. A graph to demonstrate a variety of indoor temperatures across house types (Kane, Firth, Allinson, Irvine, & Lomas, 2011)

2.7.8.1 Relative humidity and mould

The occurrence of any severity of mould growth appears to be greater in dwellings with lower SAP ratings (Ridley, Pretlove, Ucci, Mumovic, Davies, & Oreszczyn, 2005). The occurrence of mould is also

greater in dwellings with 'unfit' ventilation. This may suggest that excessively airtight dwellings with poor ventilation might be more subject to mould growth (Ridley, Pretlove, Ucci, Mumovic, Davies, & Oreszczyn, 2005). It is unlikely the refurbished case studies in this project will result in being 'excessively air-tight' but it is beneficial to be aware of potential issues. Any adjustments made to the insulation, heating and ventilation is likely to have some impact on existing moisture defects and the occupants perception of this will be recorded in addition to physical measurement of the relative humidity levels. Figure 5 shows mould growth occurrence within property SAP ratings.

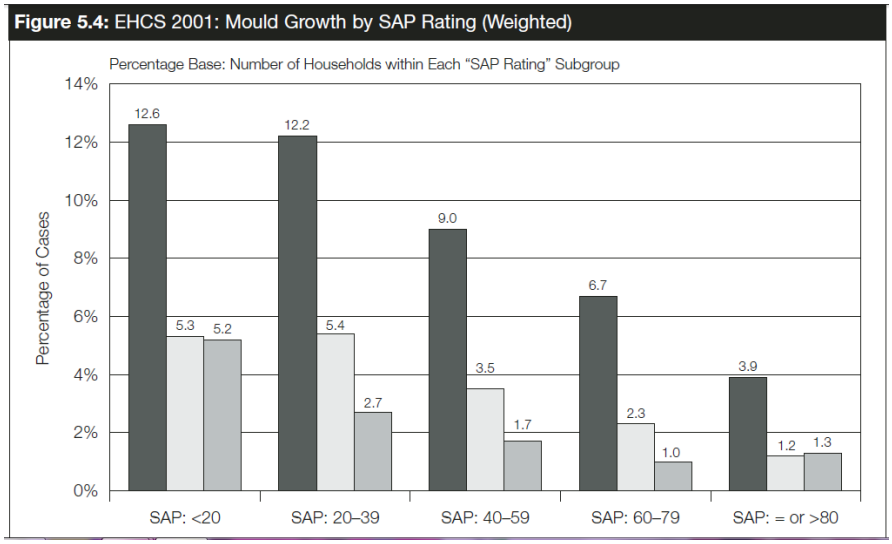


Figure 4. A graph to show SAP ratings and mould growth cases (Ridley, Pretlove, Ucci, Mumovic, Davies, & Oreszczyn, 2005)

In a study on social housing refurbishment 50% of occupants noticed a 'big improvement' in damp and mould (Ball & Roberts, 2012). Similar findings came from research in New Zealand, after the addition of energy efficiency measures, relative humidity decreased by an average of 2.3% (Howden-Chapman, et al.) Five households in the study by Ball and Roberts (2012) did report some problems to have deteriorated; damp in one house, mould in two houses and draughts for one household also. Other moisture related issues from this research included water running down the walls in the bathroom and steamed up windows in the kitchen during cooking and a non-insulated cold bathroom which still allows the pipes to freeze during the winter months (Ball & Roberts, 2012).

2.7.9 Ventilation

Ventilation determines the indoor air quality in addition to being a heat loss path (Coley & Greeves, 2004). Ventilation is the controlled supply of air into the building and infiltration is the passage of air through the building fabric. In most UK homes ventilation is provided by window opening and trickle vents. Extractor fans also remove indoor pollutants and excess moisture emitted through cooking, washing and occupant activities. Air infiltration through the building fabric permeability and through small gaps around windows and doors allows the passage of air and this is likely to be reduced considerably with the addition of insulation. Reductions in fabric permeability have been shown to reduce the presence of outdoor source pollutant gasses within the homes but increase the indoor concentration where mechanical extraction is not

present (Shrubsole, et al., 2012). Whilst deep retrofit projects may employ a mechanical ventilation heat recovery (MVHR) system to provide adequate ventilation to counteract for the low permeability of the fabric, the refurbishments in this study are unlikely to adopt that level of insulation due to cost limitations but an awareness of these issues is necessary

2.8 Categorising occupants

2.8.1 Environmental attitudes

2.8.2 Income

2.8.3 Measures

3 METHODOLOGY

The methodology aims to address the following research questions:

a) What are the occupant expectations of an energy efficiency installation and what do they actually get?
b) Do the occupants perceive an internal environment improvement?
c) Do the householders actually save money, energy and carbon?

The research proposed will be undertaken using a mixed methods case study approach. The case studies will be a small sample of UK owner-occupied homes that undergo an energy efficiency improvement. Visits will be made to the houses before, during and after the energy efficiency improvement takes place. The methods of data collection throughout these visits includes interviews, diaries, observation, building surveys, temperature and relative humidity measurement, gas and/or electricity monitoring and energy performance modelling. As the research incorporates evidence-based research in addition to deconstructing a process that influences outcomes, it combines positivist and post-positivist approaches (Sharp, McDonald, Sim, Knamiller, Sefton, & Wong, 2011). A research agenda that considers and learns from real-world conditions is necessary in order to move towards a lower-carbon future which provides comfortable indoor conditions (Shove, Chappells, Lutzenhiser, & Hackett, 2010).

Mixed methods research combines elements of qualitative and quantitative approaches for the purpose of gaining a deeper understanding and validation (Johnson, Onwuegbuzie, & Turner, 2007). This can allow for a combination of method viewpoints, data collection and analysis**.** The combination of these two types of data can result in a “terrible mess” (Greener, 2011). This is because different methods often lead to the production of different kinds of knowledge and having

more data does not always result in better research. Therefore care has been taken to ensure this research design minimises conflicting information.

3.7 Case studies

A sample of ten of households will allow a detailed study of each to be carried out in the timescale of the PhD. These will be sourced through local advertising in the form of notes on public boards, magazine and newspaper articles, newsletter emails and word-of-mouth amongst colleagues in addition to emails and conversations with LoLo stakeholders and other members of industry.

3.8 Semi-structured interviews

These will be used to establish the occupant's expectations and experiences of the installation. Three interviews will take place with each household, one before an energy efficiency improvement, one during the process and following the refurbishment also. The interviews held before and after the refurbishment will be take place during the heating season. The interview data outline is covered in table 4.

Table 4. Interview data outline

Occupant data	Number of occupants and ages Household make-up (single, married, family etc) Income group and occupation
House	Number of years in property Age of property Any known defects Known issues relating to energy consumption
Occupancy	Daily/weekly routines Visitors? Use of space
Heating behaviour	Current temperature set point – thermostat temperature or average preference Anticipated temperature set point Actual post-refurbishment temperature set point Current hours of use – typical or timed Anticipated hours of use Actual post-refurbishment hours of use
Planned refurbishment	Proposed installation Choice of measure? Choice of installer/supplier Source of information Anticipated benefits
Financial costs	Current energy expenditure Anticipated energy expenditure post refurbishment Actual energy expenditure post refurbishment Anticipated spending on measures Actual spending on measures Unexpected spending on measures

Time costs	Anticipated time spent with refurbishment related tasks Actual time spent with refurbishment related tasks Unexpected time spent
Financial savings	Anticipated savings on additional items – such as fewer trips out to keep warm, less hot drinks, less medication for cold-related ailments, fewer hot water bottles etc. Actual post-refurbishment savings on additional items. Noted spends on things possibly wouldn't purchase before. Such as using any savings made for other activities and items.

3.9 Building surveys

Table 7 details the information which will be collected during the two building surveys.

Table 5. Building survey details

Element	Building Survey Details
General	Location. Urban or rural? Exposed?
	Dwelling type
	The property age and style
	Number and name of rooms
	Extension/conservatory?
	Orientation and shading
	Garden? Front/back, small/medium/large?
	Outbuildings? Use?
Walls	• Construction (materials – cavity/solid) • Insulation, type • Thickness (mm) • External render (materials & depth) • Internal plaster type – where possible • Internal decoration – paper, exposed brick, tiles • Overall area (m^2) • Any obvious defects – damp, cracks or cosmetic?
Windows	• Total number in each room • Overall area (m^2) • Type (casement, sliding sash etc) • Frame (timber, PVC, aluminium) • Openable area (m^2) • Glazing (single, double or triple) • Any defects to frames or glazing? (cracks to frame, rot, eroded sealant) • Heavy curtains or window shutters?
Floor	• Building footprint • Overall area • Construction (solid concrete or joists and floor boards) • Insulated? (may need to rely on property age and occupants knowledge) • Floor covering (carpets, tiles, laminate, exposed boards etc) • Any obvious faults?
Roof	• Type (pitch and orientation) • Covering (tiles etc) • Cold roof: Insulation? Depth? • Insulated roof? Depth? Habitual room? Velux windows? • Obvious faults?
Internal floors	• Depth (where possible. i.e staircases with open ballustrades) • Insulation – if known
Heating system	• Central heating? Boiler – gas or electric? Efficiency rating? Gas safety record? • Thermostat type? • If CH – radiators – number, type and size, TRVs? • Alternative primary supply? (open fire, log burner, aga etc) • Secondary heat source? (electric heaters, gas heaters etc) • Any faults noted?

Additional notes	• Energy saving devices already employed – light bulbs, radiator panels, power-down switches, tap aerators, shower heads, cistern savers etc) • Any unusual features? • Conservation area or listed?
Thermographic image	• External of each elevation

3.10 Temperature and relative humidity data collection

4 Table 8 details the temperature and relative humidity sensors and their proposed locations within the dwellings. These will provide accurate internal environment data over four weeks before and after the refurbishment.

5 Table 6. Temperature and relative humidity data collection details

	Temperature (on radiators)	**Relative humidity and temperature**
	Hoboware sensor/data logger  **Figure 5 (Kane, Firth, Allinson, Irvine, & Lomas, 2011)**	Hoboware sensor/data logger  **Figure 6. Hoboware sensor/data logger**
General notes		
	Placed on radiators and hung behind out of sight – where possible.	*Placed away from windows, doors or obvious draughts as close to 1.5m as possible. Away from places where pets and children may reach – if possible.*
Outside		
	One sensor placed in the garden or just outside the property in a discrete location. Sited away from car exhausts, boiler flues, direct sunlight or any other obvious heat source.	
Downstairs		
Living room	Record: sensor number & location Take photo	Record: sensor number & location Take photo
Kitchen	Record: sensor number & location Take photo	Record: sensor number & location Take photo *(Away from direct sources of moisture – above a kettle, close to cooker or sink)*
Dining room	Record: sensor number & location Take photo	Record: sensor number & location Take photo
Hallway	Record: sensor number & location Take photo	Record: sensor number & location Take photo *(If there are no ledges, fixed with blue-tac.)*
WC?	Record: sensor number & location Take photo	Record: sensor number & location Take photo *(Away from direct sources of moisture – the sink or toilet)*
Upstairs		
Bedroom 1	Record: sensor number & location Take photo	Record: sensor number & location Take photo
Bedroom 2	Record: sensor number & location Take photo	Record: sensor number & location Take photo
Bedroom 3	Record: sensor number & location Take photo	Record: sensor number & location Take photo
Bathroom	Record: sensor number & location Take photo	Record: sensor number & location Take photo *(Away from direct sources of moisture – the sink or toilet)*

The temperature sensors used by Kane et al were the same Hobo data loggers set for use with this research. They were calibrated by Tempcon Ltd and were found to be accurate to +/-0.4^{o}C (Kane, Firth, Allinson, Irvine, & Lomas, 2011).

3.11 Gas and electricity meter readings

3.12 Air permeability testing

3.13 Modelling

The quantitative data collected will be used as inputs to the Standard Assessment Procedure 2009 (SAP09) for each case study. SAP is the government's tool for assessing the energy performance of dwellings. The SAP rating alone is based on energy associated with space heating, water heating, ventilation and lighting, less cost savings from energy generation technologies (SAP 2009). Floor area is entered so the rating is independent of dwelling size. It is expressed on a scale of 1 to 100. The higher the number the lower the running costs. It is a parametric model with inputs covering the aspects of the building survey included in table:

- Physical characteristics of the building fabric, including natural ventilation
- Characteristics of heating and ventilation technologies, such as type and efficiency
- Energy generated by technologies linked to the dwelling
- Simple estimation of solar gains

SAP09 makes assumptions for heating patterns and internal temperatures but these can be overridden with manual entry using the heating behaviour data collected. A copy of SAP09 is included in appendix 1.

3.14 Ethics and health and safety

As the research involves visiting occupants in their own homes ethics and health and safety have been carefully considered and will meet the University guidelines.

4 CASE STUDIES

4.1 Introduction

2.4.1 The role of social networks

As social networks have been found to be essential in the diffusion of energy-efficiency innovations in UK households (McMichael & Shipworth, 2012) the experiences of the early adopters are crucial to promote further uptake of measures. Previous research found that referrals made by weak and strong relationship ties have an impact of consumer choices but strong ties are perceived to be more influential and likely to be used during the research stage of purchasing goods (Brown and Reingen 1987).

KEEP THIS FOR LATER AS SOCIAL NETWORKS ARE NOT THE FOCUS OF MY WORK. POSSIBLY WHEN DESRIBING SAMPLE.

4.2 Overview

4.3 House types

4.3.1 Age

4.3.2 Style

4.3.3 Floor area

4.3.4 Volume

4.3.5 Wall area

4.3.6 Glazed area

4.4 Construction materials

4.4.1 Thermal properties

4.4.2 Air permeability

4.5 Modelled energy efficiency

4.5.1 Pre-refurbishment

4.5.2 Post-refurbishment

4.6 Actual energy consumption

4.6.1 Pre-refurbishment

4.6.2 Post-refurbishment

4.7 Refurbishment measures

4.8 Fabric approaches

4.8.1 Insulation

4.8.2 Glazing

4.9 Energy supply

4.9.1 Boilers

5 DISCUSSION OF FINDINGS: PRE-REFURBISHMENT

5.1 Introduction

5.2 Interview data: Expectations

5.2.1 Installation

5.2.2 Process of work

5.2.3 Cost

5.2.4 Time

5.2.5 Disruption

5.2.6 Benefits

5.2.7 Comfort

5.2.8 Contractors

5.3 Building data

5.3.1 Energy consumption

5.3.2 Building fabric Permeability measurements

5.3.3 Temperature measurements

5.3.4 Relative humidity measurements

5.3.5 SAP models

5.4 Chapter discussion

5.5 Chapter summary

6 DISCUSSION OF FINDINGS: DURING-REFURBISHMENT

6.1 Introduction

6.2 Interview data: Experiences

6.2.1 Installation

6.2.2 Process of work

6.2.3 Cost

6.2.4 Time

6.2.5 Disruption

6.2.6 Benefits

6.2.7 Comfort

6.2.8 Contractors

6.3 Building data

6.3.1 Energy consumption

6.3.2 Temperature measurements

6.3.3 Relative humidity measurements

6.4 Chapter discussion

6.5 Chapter summary

7 DISCUSSION OF FINDINGS: POST-REFURBISHMENT

7.1 Introduction

7.2 Interview data: Satisfaction

7.2.1 Installation

7.2.2 Process of work

7.2.3 Cost

7.2.4 Time

7.2.5 Disruption

7.2.6 Benefits

7.2.7 Comfort

7.2.8 Contractors

7.3 Building data

7.3.1 Energy consumption

7.3.2 Building fabric Permeability measurements

NHBC Lessons from Germanys passivhaus experience_NF47_PO53_web.pdf

Compare the way we measure buildings with Germany

7.3.3 Temperature measurements

7.3.4 Relative humidity measurements

7.3.5 SAP models

NHBC Lessons from Germanys passivhaus experience_NF47_PO53_web.pdf

Compare the way we measure buildings with Germany

7.4 Chapter discussion

7.5 Chapter summary

8 SUMMARY OF FINDINGS

8.1 Introduction

8.2 Comparisons: pre, during and post-refurbishment

8.2.1 Process of work: expectations, experiences and satisfaction

8.2.2 Cost of work: expectations, experiences and satisfaction

8.2.3 Energy efficiency: expectations, experiences and satisfaction

8.2.4 Unexpected benefits

8.2.5 Unexpected costs

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

9.2 Further research

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