Abstract

The turnover of the UK housing stock is such that CO_2 emissions reduction targets will require extensive refurbishment of existing homes. Both within the literature and in practice, there is limited understanding of the interaction between housing energy efficiency refurbishment and occupant behaviour. The authors implemented interview-based qualitative research into energy-related behaviours before and after an energy efficiency refurbishment project on social housing in the north east of England. Half of the sample also received an information intervention. Template analysis identified seven key patterns affecting energy behaviour: access to knowledge and skills; nature of technical intervention; habit; external circumstances; quality of technical intervention; convenience of technology; and thermal comfort. These findings were discussed in relation to Social Practice Theory and competence, material and image as components of practice. The research provides an insight into the interaction between occupants and retrofit technologies in the context of a social housing retrofit. It is recommended that policy makers and implementers of retrofit programmes ensure that competence, material and image considerations are integral to retrofit programmes for energy use practice to change and more optimal CO_2 emissions reduction achieved.

Highlights

- Qualitative analysis of impact of energy efficiency retrofit in social housing
- No evidence of influence of information intervention on energy related behaviour
- Complex relationship between technical intervention and energy related behaviour
- Seven key patterns identified, of relevance to future retrofit programmes

Key words

Energy efficiency, retrofit, social housing, template analysis

1. Introduction

As part of national and global efforts to reduce carbon dioxide (CO_2) emissions, the UK Government has developed a range of energy efficiency policies aimed at the domestic sector. For example, the Low Carbon Transition Plan [1] outlines targets for the domestic sector including a 29% reduction in greenhouse gas emissions for the domestic sector by 2020 (2008 baseline) and smart meters (meters capable of remote monitoring of energy for the supplier) in all homes by 2020. The Energy Act 2011 [2] created the legislative framework for the Green Deal, an energy efficiency support scheme launched in 2013. The Green Deal scheme is a financing mechanism from energy efficiency improvements, which enables the occupier to pay for the improvements through savings in their energy bills. It is mainly aimed at supporting retrofits by private owner-occupiers.

Extensive refurbishment of existing homes is central to achieving a reduction in CO_2 emissions because the UK's turnover of housing stock is relatively slow compared to most developed countries and approximately 87% of the current housing stock will still be standing in 2050 [3]. There is great potential for the proposed national retrofit programme to reduce carbon emissions from homes, contribute to economic growth and provide other benefits such as the reduction of fuel poverty. The Energy Saving Trust [4] has estimated that about 24 million homes, that either exist now or are built before 2016, will still exist in 2050. Therefore, on average 600,000 homes per year, or about 12,000 homes per week will need to be refurbished with energy saving and low carbon technologies in the next four decades, to meet the 80% emissions target.

As third sector organisations, approximately 1900 Social Landlords across the UK have a key role to play in the programme of housing refurbishment, as they are responsible for 3.8 million homes [1]. Gentoo Group is one of the largest Social Landlords in the UK. In order to establish the most effective retrofit measures to both increase energy efficiency and reduce CO_2 emissions for its housing stock, Gentoo Group undertook a project named 'Retrofit Reality' which began in 2008. As part of the project, research was undertaken to address the question: *How does an energy efficiency retrofit project impact on energy use practice?*

This research is a contribution to the understanding of energy consumption using methods from social sciences. The research team was multi-disciplinary and included Gentoo Group as a practitioner; both of these factors are unusual for research in the energy sector [5]. There is a recognised need for depth of investigation into routines, statuses, beliefs and knowledge which interact with energy consumption [5, 6].

This research aimed to investigate factors which impact on energy use practice, whilst the physical infrastructure underwent retrofit. The objectives of the research were:

- To identify, through comparisons of pre- and post-retrofit interviews, interactions between self reported energy use practice and physical infrastructure
- To identify, through implementation of a written information intervention to 50% of the sample, the impact of advice with retrofit on energy use practice

An understanding of occupant energy use practice can assist in the design and performance measurement of retrofit programmes. The findings of this research are therefore timely and contribute to a greater understanding of barriers and enablers to retrofit energy saving effectiveness.

Section 2 provides a summary of some literature on energy use practice. In section 3 the method of this study is described. Section 4 explains the results of the interviews, and the conclusions from the study are provided in section 5.

2. Literature review

Population growth, increasing demand for new housing and an ever-increasing standard of living means that domestic energy use, and the associated level of domestic carbon emissions, is higher than ever, and is continuing to rise [7, 8, 9]. Previous research has shown that the amount of energy used in homes is partly dependent on the behaviour of the occupant(s) [10.11, 12, 13] and that domestic energy consumption can vary widely, even 'between similar households in nominally identical houses' [14]. This makes any prediction of energy efficiency retrofit performance with regards energy saving complex, further complicated by issues of comfort 'take-back' [15] and 'rebound' [16, 17].

Energy consumption is a subject of research in the field of *practice theory*. Energy use is a form of consumption as the consequence of a range of different social practices as Warde [18, p131] points out: "*Consumption occurs as items are appropriated in the course of engaging in particular practices*". Accordingly, much consumption is 'inconspicuous', and energy consumption in particular is 'invisible' [19]. Shove [20] described social practice as an integration of three elements:

- Material (objects, things, also infrastructure)
- Image (symbolic meanings, conventions ideas and interpretations)
- Competence (procedure, skills)

Hand et al. [21] have illustrated these elements in the context of the practice of daily showering. In this case, 'image' is the concept that getting clean and fresh daily is socially acceptable; 'material' would be the plumbing infrastructure, water heating and showering equipment; and 'competence' the skills and knowledge to make that equipment work, and to fit the practice around other daily practices.

Shove and Southerton [22] used practice theory as a framework to examine the adoption of the freezer in British households.# This example is framed in terms of the way in which freezers have fitted into the changing organisation of domestic life, particularly the increasing participation of women in the workforce and associated sales narratives. #Moreover, the authors emphasise that the freezer partly creates the conditions that it alleviates –by helping to solve the problem of limited domestic time under conditions of increased working hours, it in part perpetuates that condition by enabling it to continue. #Gram-Hanssen [23] analysed

standby consumption of appliances in ten households in Denmark, and found, using a practice theory framework, that families adjusted technology and routines after receiving information which challenged their perception of social norms and provided relevant knowledge. #From the same project Gram-Hanssen [24] considered practice theory, to understand difference in heating energy consumption for five families in identical properties.

Midden et al. [25] noted that technology and behaviour are closely interwoven in many respects, and they described four main roles that technology plays: as *intermediary*, where the technology is a conduit between the behaviour an individual carries out to reach a goal; as *amplifie*r, where the technology amplifies, enhances or extends the individuals goal attainment; as *determinant*, where the technology creates context or environment surrounding the individual, thus influencing or shaping behaviour through the technology's existence, and; as *promoter* of environmentally significant behaviour, where technology is specifically designed to promote behavioural choices leading to the conservation of natural resources.

The emphasis which practice theory gives to material makes this a useful construct to use in interpreting this research, given the objective to analyse the impact of a change in material (the infrastructure of the home) on energy use practice. Midden et al's consideration of the role of technology shall also be used in interpreting the results.

In analysing the energy research of three leading journals over a fifteen year period, Sovacool [5] identified that human-centred methods such as interviews were a less common method of analysis. He proposed that these human-centred methods are needed to provide the depth of understanding of routines, statuses, beliefs and other factors which influence energy consumption. Stern [6] proposed that convenience was a major factor in the effectiveness of weatherization promotion schemes, and that determinants of energy consuming behaviours are "many, complex and context dependent". Araujo [26] called for depth in research on practices, perceptions, knowledge and finance in relation to the energy transitions research field. This research attempts to address these issues of depth, of human-centred methods and of context dependency.

The research team wished to investigate whether a retrofit intervention would lead to greater impact if combined with an information intervention. Previous research on information interventions indicate that they can lead to changes in energy use behaviour [27]. This includes evaluation of prompts [28], individualised social marketing approaches in which information is tailored to the needs, wants and perceived barriers of individual segments of consumers [29, 30], commitment strategies [31], eliciting implementation intentions in which people indicate how they plan to reduce their use [32], and modelling and providing information about the behaviour of others [33, 24]. Assessments of smart meters (i.e. that show consumption clearly) found their impact was linked to the ways the monitors are domesticated into the social practices of the household [34].

The success of CO_2 emission reduction policies and strategies rely on feedback from practical and 'real world' research projects to build the knowledge base. Drawing on experience from a recent large-scale retrofit project: 'Retrofit Reality' by Gentoo Group, we present results regarding the energy use practice self-reported by the tenants involved in the project.

3. Project method

The primary focus of the research is to investigate factors which impact on energy use practices. The research intent is to investigate these factors within a practice theory framework, in order to better understand how tenants (in social housing) carry out daily activities which result in energy use. A qualitative approach was chosen; specifically semi-structured face-to-face interviews. Qualitative methods are specifically designed to clarify the meanings of social situations and focus on the way different people experience, interpret and structure their lives [35, 36]. A qualitative approach therefore enables the researcher to capture a range tenant experiences, constructed and described by the tenant.

The interview structure was developed by compiling a range of questions based on 'Environmental Knowledge', 'Environmental Attitudes', 'Environmental Behaviour', 'Appliances', 'Tenant Satisfaction with their home', 'Energy and Water Consumption' and 'Health and Wellbeing'. Interviews lasted around 60 minutes and were held in the participant's home. Interviews were digitally recorded and transcribed verbatim. The transcript analysis method is described in section 3.3. All interviews were conducted by the same interviewer. One adult member of the household was interviewed. Occasionally other people (household, or non-household members) were present during the interview. Some of these other people involved themselves in the interview by delivering responses or discussing issues with the interviewee or interviewer, but data was only recorded from the individual interviewee (tenant).

The 'Retrofit Reality' project included 139 properties. All 139 properties received a technical intervention, which was an energy efficiency retrofit, during the period November 2008 to March 2009. 44 of these properties were selected for the purposes of conducting a semi-structured interview. The properties were selected in order to ensure the properties were identical with regards floor area and method of construction, with stratified random sampling within that pool of similar properties to ensure a range of occupancy types (with regards the age of occupants and household size). The households were situated on two adjoining streets in High Ford, Sunderland in the North East of England, approximately 9 miles south east of Newcastle upon Tyne City Centre and 2 miles east of Sunderland City Centre.

Of the 44 properties, 35 households were available and interviewed during the pre-retrofit interview period of November-December 2008. These households received their retrofit after the interviews had been conducted.

Of the 35 households which received a pre-retrofit interview, 26 were available and interviewed during the post-retrofit interview period approximately 12 months after the pre-

retrofit interview, November – December 2009. These 26 households therefore comprise the sample for this research.

Of the 26 households, 13 received an information intervention in July – August 2009. Whilst the 26 households in the final sample were not self selected, the method of choosing the households which would receive the information intervention was partly random and partly self selected, since at the pre-retrofit interview there was an option at the end of the interview for the respondent to request this information.

Further details on the technical intervention and information intervention are provided in section 3.1 and 3.2.

All 26 participants interviewed for this research gave signed permission to Gentoo Group to participate in the study. There was no financial incentive provided by the researcher or Gentoo Group to participants. Written guidance on the nature of the study was provided and participants were informed of the provision for confidentiality and anonymity. At interview, these arrangements were verbally repeated and permission obtained to digitally record the interview.

3.1. Technical intervention

The technical intervention was designed by Gentoo Group with the assistance of an external consultant, and the intervention was undertaken along side refurbishment of kitchens. Table 1 lists the technologies which were in 139 'Retrofit Reality' properties, before the technical intervention and after the technical intervention. All 26 tenants interviewed received the same package of technical intervention.

Table 1: Technologies in properties before and after the technical intervention

Pre Retrofit	**Post-Retrofit**
Single glazing	Double glazing
Single glazed wood door	Double glazed PVC doors
Bath (some properties with electric shower)	Bath and mains-fed shower
Back boiler system with hot water tank	A-rated combi-boilers with new heating system, including thermostat and radiator valves
Gas fire in living room	Electric fire in living room
No draughtproofing provided by landlord	Draughtproofing

3.2. Information intervention

For the purposes of this research, information interventions were considered interventions by means of written or verbal communication which provide information on energy use or associated information (e.g. climate change, environment).

An information booklet was produced, to provide tenants with written guidance on energy saving within the context of the new retrofit technologies installed. It was designed by the research team, based on similar information disseminated by other Social Landlords and cross checked with information from the Energy Saving Trust [37]. At the time of issue of the written advice, the interviewer described the information outlined in the booklet in order to also deliver the information intervention in a verbal manner.

This information intervention was deployed in July and August 2009 to 13 households (50% of the sample). The timing of the intervention was designed to enable tenants to adjust to the information intervention before the follow up interview.

3.3. Data analysis method

There is a range of literature that documents the underlying assumptions and procedures associated with analysing qualitative data. The method chosen was template analysis, which is related to grounded theory [38] but is more flexible and less prescriptive than grounded theory, and is not tied to a realist methodology [39,40].

The term 'template analysis' does not refer to a prescribed method, it describes a varied but related group of techniques for thematically organising and analysing textual data. Essentially in template analysis the researcher produces a list of codes ('template') representing themes identified in the textual data. Some of these can be defined *a priori*, but they will be modified and added to as the researcher reads and interprets the texts. The template is organised in a way which represents the relationships between themes, as defined by the researcher, most commonly involving a hierarchical structure [41].

MAXQDA text analysis software was used to build the basic template and manage all data, and to allow the coding and retrieval of text segments indexed to specific themes. MAXQDA has been used in a wide range of disciplines, such as Sociology, Political Science, Psychology, Public Health, Anthropology, Education, Marketing, Economics and Urban Planning [42, 43, 44, 45].

3.4. Researcher reflexivity and positionality

Positionality is the practice of a researcher defining their own position in relation to the study, with the implication that this position may influence aspects of the study, such as the types of information collected, or the way in which it is interpreted [46]. Therefore, a pre-conceived framework of the research problem will influence the choice of questions for the interviews. Questions were based on existing literature and developed in consultation with Gentoo Group

and University staff to attempt to reduce this potential bias. It was realised in the research design, that the researcher was not a neutral observer [47] and that a power relationship could be construed between the researcher and tenant [48]. This research recognised tenants as experts and authorities in their own experiences, and attempted to remove any hierarchical relationship by using neutral terminology during the interview. In addition, the interviewer was introduced to interviewees as independent of the landlord (Gentoo).

4. Results

This section provides a summary of results, and a discussion of each of the key templates identified from analysis of the interview coding. The templates are described, and examples of energy use practice from interviews, are used to aid the discussion. The structured questions used during the interview, and categories of response, are contained in Appendix 1.

4.1. Template analysis

Table 2 identifies the key templates which were identified through interview, and table 3 summarises the frequency with which the templates occurred across the interview topics.

Table 2: Results of template analysis.

INTERVIEW TOPICS	KEY TEMPLATE IDENTIFIED
Reported motivations for energy saving	
Tenants report that their primary motivation to save energy is to save money, but are also motivated to save energy to help minimise environmental impacts.	
General gas and electricity consumption	
All tenants acted to conserve gas and electricity and there was no significant impact on actions as a result of the technical intervention or information intervention.	
The majority of tenants reported no change in energy use practice as a result of the technical intervention or information intervention.	
More tenants reported changes in energy use practice in the group that was exposed to the information intervention.	
Programming central heating controls	
The introduction of the heating controls technology from the technical intervention led to a change in the practice of tenants to actively programme their central heating controls.	Technical intervention
A number of tenants did not change actions to actively programme their central heating controls, due to the following reasons: 1) Tenants did not understand how to programme the central heating controls;	Access to knowledge and skills
2) Tenants manually switched the hot water and/or central heating on or off at the combi-boiler controls, because they wanted control of energy use for hot water and/or central heating, to avoid energy use at timed intervals when they did not wish to use it, or when it was not required;	
3) Tenants manually switched (as above), due to a habit formed through previous use of back boiler.	Habit

INTERVIEW TOPICS	KEY TEMPLATE IDENTIFIED
Use of thermostatic control	
The introduction of the heating controls technology from the technical intervention led to a change in the practice of a majority of tenants to use the thermostatic controls, to change temperatures to suit their needs.	Technical intervention
A majority of tenants kept thermostat settings at 20˚C or below.	
Tenants who used thermostat settings above 20˚C, used thermostat settings at the slightly higher settings of 21-22˚C.	
Tenants changed action to use technology, because they were motivated to save energy and had knowledge and skill of how to do this.	Access to knowledge and skills
Two tenants from the group that were not exposed to information intervention were unaware of the thermostatic settings that they use and these cases may indicate the importance of training or guidance on thermostat controls.	Access to knowledge and skills
Some tenants perceived a potential issue with the location of the thermostat due to the fluctuation of temperature at its location (hallway), not always reflecting the temperature conditions of the remaining rooms of homes.	Quality of technical intervention
Use of radiator controls	
The majority of tenants changed action to use radiator controls, following the introduction of the technology during the technical intervention	Technical intervention
Tenants who did not change reported this was because of being unaware of them, not understanding how to use them or for what reason, and/or leaving them on installation settings.	Access to knowledge and skills
Fire use for space heating	
The replacement of the gas fire with an electric fire (in conjunction with central heating) technology from the technical intervention led to a change in energy use practice in more than half of tenants.	Technical intervention
The communication of information was a factor which encouraged the change, in addition to the introduced central heating as an alternative means of space heating.	Access to knowledge and skills
Tenants who did not change their use of the fire reported this was due to being unaware or unclear on the most efficient way to use space heating.	Access to knowledge and skills
A number of tenants stated a preference for using a fire for space heating instead of the central heating.	Habit
Some tenants regretted having the electric fire installed and would like to have their gas fire back.	Habit
Tenants did not change fire use because of perceptions and routines developed prior to the interventions which were continued afterwards.	Habit

INTERVIEW TOPICS	KEY TEMPLATE IDENTIFIED
Some tenants initially used the electric fire but then stopped using it because it was ineffective and costly compared to the gas fire.	Technical intervention
Hot water use (bathing)	
The installation of the mains fed shower technology as part of the technical intervention led to a change in bathing practice in almost half of the tenants.	Technical intervention
Some tenants perceived the shower to save more energy than having a bath and thus changed bathing practice due to motivations to saving energy.	Access to knowledge and skills
Tenants used hot water more frequently, increasing the number of showers and in some cases baths after the technical intervention due to the convenience of the combi-boiler rather than the back boiler.	Convenience of technology
Some tenants took showers instead of baths because of the increased convenience and time saving compared to using the bath.	Convenience of technology
Some tenants were unclear on which type of bathing consumed the most energy.	Access to knowledge and skills
Some tenants took baths as this provided a warmer more comfortable experience than showers and are willing to use more energy for this experience.	Thermal comfort
Some tenants continued having baths because they liked having baths.	Habit
Continued bath use instead of the shower may be linked to routines created when the house was cold, before the technical intervention, however some tenants did say bathrooms were still cold.	Habit
Control of drafts	
The installation of the external doors and double glazed windows technology as part of the technical intervention led to a change in the practice of control of drafts.	Technical intervention
The installation of double glazed windows and doors led to the experience of reduced drafts and resulting improved thermal comfort and some tenants no longer felt the need to control drafts.	Thermal comfort
Just under half of tenants continued to experience drafts, and therefore continued to practice control of drafts. Continued drafts were likely to be due to inadequate attention to air tightness in the retrofit process	Quality of technical intervention
The significant difference in draft controlling practice between the two sample groups exposed or not exposed to the information intervention was reported by tenants as due to continued experience of drafts.	Quality of technical intervention

INTERVIEW TOPICS	KEY TEMPLATE IDENTIFIED
Close curtains	
Tenants reported, post technical intervention, a slight change in practice of closing curtains to reduce heat loss.	Technical intervention
Changes in the practice of closing curtains may also be linked to external circumstances, such as not having curtains up temporarily during and post retrofit.	External circumstances
Put on warm clothing	
Tenants reported a change in practice post technical intervention, with nearly quarter of all tenant wearing warmer clothing occasionally rather than frequently.	Technical intervention
Tenants with young children reported that they wear warmer clothing when children are not in the house and avoid using the heating. When children are in the house tenants use central heating and/or fires for the warmth of children and cease to use extra clothing for themselves.	Technical intervention
Use energy saving light bulbs	
Changes in practice were linked to external circumstances.	External circumstances
A majority of tenants did not use energy saving light bulbs widely in their home due to: 1) Negative perceptions of the technology (e.g. preference for traditional design)	
2) Knowledge and awareness of recent product designs which meet tenant needs (e.g. range of fittings, speed of activation and light quality).	Access to knowledge and skills
Turn off all appliances completely when not in use	
Barriers to switching off appliances completely when not in were due to: 1) Convenience reasons (e.g. time taken to switch appliances on, access to sockets).	Convenience of technology
2) Limited knowledge of this energy use practice in connection with certain appliances (e.g. concern of damage to appliances from switching on and off at the mains).	Access to knowledge and skills
Kettle use	
Tenants who already part filled the kettle reported they did so because: 1) They were motivated to save energy and were provided with knowledge and skill of how to do this.	Access to knowledge and skills
2) The practice was convenient (i.e. kettle boils quicker).	Convenience of technology
Washing machine use	
Changes in practice were linked to external circumstances related to washing requirements for infants.	External circumstances

INTERVIEW TOPICS	KEY TEMPLATE IDENTIFIED
Lighting use	
Interviews found no significant impact on lighting use due to the technical or information intervention.	
Awareness and use of energy efficient appliances	
Some tenants have limited knowledge of energy efficient appliances.	Access to knowledge and skills
The uptake of energy efficient appliances is limited by the budgets of some tenants who prefer to choose the cheapest product with regards purchase price.	External circumstances
Perceived impacts on energy costs	
Within the group a majority of tenants use pre-payment meters or weekly budget plans to for payment of bills and use this to judge energy use.	
Generally tenants who use pre-payment meters consider themselves more aware of their energy use and use the meter to plan energy use linked to available budgets at a particular time of the week.	Access to knowledge and skills
Increased fuel bills were reported by some tenants after the interventions.	

Table 3: Summary of template analysis

Key template	Frequency of occurance
Access to knowledge and skills	13
Technical intervention	10
Habit	6
External circumstances	4
Quality of technical intervention	3
Convenience	4
Thermal comfort	2

A discussion of results and the templates identified now follows.

4.1. Access to knowledge and skills

This key template relates to energy use practice being impacted by a tenant's access to knowledge or skills. Limited access to related knowledge or skills may prevent effective use of the introduced technology. This was most notably observed in the case with the programmable heating controls (all properties had some level of programmable controls prior to the technical intervention) and to a lesser extent the thermostatic controls and radiator controls (new technologies not previously installed).

> *"...well we don't understand the little book we got, it's tiny writing and you're like, and you think, oh it goes on and on, so we just put it on when we want" (306FSL)*

> *"Oh I didn't know, oh I wasn't aware of that [facility of radiator controls]" (83FRF)*

These issues around access to knowledge and skills are consistent with Social Practice Theory (SPT). Shove [20] identified competence as one of three elements in SPT, the others being material and image. The results of the interview indicate that, for simple technologies, the tenants were able to develop competence in use. Thermostat and radiator valve use was similar across the tenant groups who received, or did not receive, the information intervention. For example, 69% of tenants (Table A8) reported changed energy use practice to begin using the thermostat to control temperatures, using the technology to maintain temperatures at 20˚C or below. Tenants reported that they found the temperature controls simple to use and it was generally recognised that higher thermostat temperatures would lead to higher energy consumption.

For technologies which tenants perceived as more complex, tenants were less able to develop competence in use. Post technical intervention, use of programmable heating controls increased by between 23% (information intervention group) and 31% (no information intervention group) (Table A7).

Also, some tenants reported that they were aware that showers used less energy than baths and they found showers simple to use. Post technical intervention, use of showers as the main bathing practice rose by between 61% (information intervention group) and 15% (no information intervention group) (Table A10). Therefore, whilst tenants perceived the technology was easy to gain competence with, the information intervention group were more likely to change their bathing practice and use the shower in preference to the bath.

Access to knowledge and skills was not identified as an issue for controlling drafts and maintaining thermal comfort, implying that tenants already have sufficient knowledge and skills for these themes. However, access to knowledge and skills was associated with use of low energy light bulbs, appliance standby and kettle use. Post technical intervention, reported use of energy savings light bulbs increased by 15% (information intervention group) and 8% (no information intervention group) (Table A14). Reported occasional or frequent turning off of appliances increased by 8% (Table A15). Reported frequent or occasional

boiling of the amount of water needed in the kettle increased by 23% (information intervention group) and 8% (no information intervention group) (Table A16).

4.2. Technical intervention

This key template can be described as a change in energy use practice as a result of the technologies installed. Here the technology leads to changes in the energy use practice of tenants because the practice involves (or begins to involve) a form of interaction with such technology. This is consistent with SPT which identifies material (objects, infrastructure) as one of three elements forming a practice [20]. Material can be considered as enabling or constraining certain practices. It is also consistent with the schema of Midden et al [25] which describes technology playing four roles of intermediary, amplifier, determinant and promoter.

The introduction of the programmable heating controls, thermostatic controls and radiator controls from the technical intervention created a change whereby tenants began using the technologies to manage the use of heat in the home. For example, before the technical intervention 88% of tenants did not programme their central heating to automatically switch on at chosen times of the day. After the interventions 62% of tenants continued the practice of heating the space without using programming controls, the remainder reported they frequently or occasionally used the programmer (Table A7). In this case the technology can be seen as an *intermediary* according to Midden et al's schema [25], the technology being the vehicle for the space heating.

In the case of hot water use for bathing, there was a significant change in reported bathing, with bath use 65% and shower use 23% pre intervention, bath use 19% and shower use 62% post intervention (Table A10). The technical intervention provided a more efficient shower, and in this case the technology can also be seen as an *intermediary*.

After the technical intervention, there was a change in reported draft control, with 73% controlling drafts pre-intervention and 35% controlling drafts post intervention (Table A11). These tenants reported that they had ceased draft controlling behaviour because drafts had been reduced to a minimum and they no longer perceived it to be a problem. In this instance the technology takes the role of *determinant* to provide a context to shape practice.

> *"Well it's all double glazing and that now and all the doors so you don't really need to" (15FRF)*

4.4. Habit

This key template refers to cases where energy use practice continues in the same or similar ways, regardless of the technologies introduced as part of the technology intervention.

For 62% of tenants (Table A7), a change in material (central heating programmer) did not result in a change in heating control practice. Those tenants who did not actively programme their central heating controls to come on at timed intervals reported that they preferred to switch the heating off manually using a switch on the boiler itself. The same tenants reported that they had always turned their heating and/ or hot water on and off at the back boiler manually before the retrofit. It appears that this 'manual switching' energy use practice continued after the new central heating and combi-boiler was installed as part of the technical interventions.

For 38% of tenants, a change in material (central heating with feature electric fire) did not result in a change in space heating practice. It was Gentoo Group's intention that the retrofit of efficient central heating would provide an alternative to using the gas fire as a method of space heating. The default retrofit was of central heating only, with installation of an electric fire at the tenant's request (all 26 tenants had an electric fire installed). Prior to the interventions all tenants regularly used the gas fire, post technical intervention 38% of tenants reported regularly using the electric fire. This previous experience with the gas fire along with perceptions of wasted energy by using central heating may have created a habit of continuing to use the fire as a source of heat.

> *"I'd have me gas fire back...It's rubbish that [electric] one...even with the pipes [central heating] on in the morning the room's still a bit cold and I put that on and it takes ages to warm it up...I mean I know it's more energy like but I miss me gas fire" (17FRF)*

Showers were introduced as part of the technical interventions, although 19% of tenants continued to have baths instead of showers (Table A10). These tenants reported that they always had baths because they liked the experience of having a bath. This may be simply a preference, but it may also be a habit or routine as a majority of tenants had always had a bath and no option of a shower, therefore they are used to the habit or routine of having a bath.

> *"Oh I'm a bath person to be honest, but still have showers occasionally" (99FR)*

These issues around habit are consistent with SPT. Shove [20] identified image (meanings, conventions, ideas and interpretations) as one of three elements in SPT. Changes in material (technical intervention) have not resulted in changes in energy use practice for some tenants, who verbalise their decisions as relating to conventions (e.g. the "way" of doing things) and meanings (e.g. "being" a bath person).

4.6. External circumstances

This key template refers to cases where an external circumstance not directly related to the retrofit project impacts on energy use practice. Energy use may change due to other changing circumstances in tenants' lives and this may or may not contribute to the goals of the retrofit project to improve energy efficiency and reduce carbon emissions.

A number of tenants (15%) stopped closing curtains at night to keep heat in (Table A12). Tenants reported that this was because they had taken the curtains down to allow works to be completed, but then had not (yet), put curtains back up. Interpreting this within the SPT, a material change which could be considered temporary had become semi-permanent and part of energy use practice.

3 tenants (11%) moved from frequently filling the washing machine and keeping temperatures low, towards occasionally doing this (Table A17). The cause of this behaviour change was the arrival of infants into the household, within the 12 month period between baseline interviews and follow up interview. The three tenants affected said that that they required higher temperatures to be used in the washing machine with washes without full loads due to more frequent cleaning requirements and more soiled clothing.

4.7. Quality of technical interventions

This key template refers to cases where the quality of the installation of technical interventions impact energy use practice. As explained in section 4.2., SPT identifies material (objects, infrastructure) as one of three elements forming a practice [20]. Material can be considered as enabling or constraining certain practices. The technical interventions were designed with the purpose of enabling energy use practice which results in reduced energy consumption. If the technologies are not retrofitted to the standard expected, this will affect the degree to which they enable energy use practice which reduces energy consumption.

Due to installation issues mainly related to the fitting of double glazed windows a number of tenants continued to experience drafts in the home after the technical intervention. These tenants continued draft controlling practice. (Note: this issue was reported to Gentoo Group and the installation quality was rectified for the tenant.) In this instance the technology still takes the role of *intermediary* but it's effectiveness as a conduit is limited.

> *"Just under all me window sills, gaps by the workmen who've put them in probably... there's gaps and you can just feel it all coming through, the upstairs ones are the worst, terrible" (13FRF)*

Some tenants reported an issue with the location of the central heating controls and thermostat in the hallway, often in front of the double glazed door. This area was perceived as subject to fluctuations in temperatures, and to generally be cooler than the main living spaces. This impacts on the way tenants used thermostat controls because they perceived a need to

adjust temperature settings to compensate for the location of the thermostat in a room with fluctuating temperatures.

> *"It's not the best place to put it 'cos it's right in direct sunlight in the passage so you get, it can be a freezing, freezing cold day and you get the sun beating in that bit window and it says it's 22 degrees or something and you're sitting here [in the living room] dithering [feeling very cold] so it turns itself off all the time...it is other times, when the sun's moved away from there it's absolutely freezing out in the hallway and you can be sitting in here and you can be absolutely red hot, but out there it'll say it's like 11 so to me it's in a silly place...and you're constantly turning it up and down, up and down all the time" (322SLF)*

4.8. Convenience of technology

This key template describes the situation where tenants seek convenience. This may lead to a change in energy use practice where technical interventions affect perceptions of practice which is 'easier' and/or 'quicker'.

Before the technical intervention all tenants switched on the back boiler to warm up the hot water tank over a period of one to three hours. After the technical intervention, tenants reported that access to hot water was much quicker, easier and more convenient. Tenants reported that they used the shower instead of the bath after the interventions because it was much quicker and more convenient to use. An increased frequency of bathing was also reported by tenants. Therefore, in the context of SPT, an additional material used for bathing practice (shower as well as bath) has led to an interaction with the image of bathing practice. Thus it is possible that the increased convenience of hot water may have increased energy and water use. Within Midden et al's schema [25] the technology has acted as an *amplifier*.

> *"Right yeah yeah, so it's instant shower whenever you need...and the bairns* [children] *love it so they're in the shower all the time. But with the bath like the old one you used to wait forever like say five o'clock you used to put it on, wait till six o'clock so you could get them in the bath..." (15FRF)*

With regard to boiling only the amount of water needed when using the kettle, tenants who already were using the kettle in this way, said this was because they had learned about this behaviour from energy efficiency campaigns or parents and found it quicker and easier (convenient) to boil the kettle with less water in it.

Tenants reported that convenience was preventing them from the energy use practice of switching off all appliances completely when not in use (i.e. off standby). Tenants wanted to use the appliances quickly and/or easily and the nature of some appliances limited the convenience of switching off appliances completely. Tenants reported that the location of power sockets also prevented changes in energy use behaviours to save energy, as tenants found it difficult and inconvenient to access certain sockets. For these examples, in the context of SPT it appears the material embedded within the appliance use practice is limiting

the potential for the tenant to reduce energy use (i.e. the technology takes time to initialise). In addition, the tenant's image of appliance use practice is one of an idea to need or want quick response from appliances.

4.9. Thermal comfort

The bathroom was reported to be cold before the retrofit and some said this was still the case after the technical interventions, due to the addition of an extractor fan and in some cases drafts from windows. Tenants said that they would only bathe quickly in the shower because it was cold in comparison with the bath. Therefore it may be that tenants' habit of continuing to use the bath instead of using the shower was because the thermal comfort of the room had not changed significantly.

4.10. Comparison of pre and post retrofit results, and impact of information intervention

Comparing self-reported behaviour pre and post intervention, results indicate:

- A greater tendency to shower rather than use the bath, a greater use of thermostatic radiator valves, a greater use of central heating controls, a greater use of the central heating thermostat, a reduced use of the feature fire
- A reduced tendency to control drafts and close curtains, a reduced tendency to add clothing rather than turn the heating up
- A reduced tendency to fill the washing machine and keep temperatures low, an increased tendency to only boil the amount of water needed, an increased tendency to use low energy light bulbs, an increased tendency to turn off unnecessary lights

There was a significant difference between self-reported change in energy use practice between the sample group that received the information intervention compared with the group without it (Table A6). 61% of tenants who received the information intervention reported a change, compared with 23% of tenants not receiving the information intervention reporting a change. This may be due to biases in the way people report their views, such as social desirability. Tenants' actions may have been influenced by other information-related influences, such as the media or information provided by energy suppliers. 58% of all tenants interviewed stated that they had made no change following the technical intervention (Table A6).

However in response to later questions, respondents reported changes in actions related to energy use practice. This indicates that tenants may not be conscious of their changing energy use practice and that their statements may not necessarily match their actual actions.

5. Conclusions

Gentoo wished to undertake a retrofit of social housing in order to enable tenants to reduce their energy bills. The company specifically targeted technical interventions which they believed would enable reduced energy bills to be achieved.

In social practice theory 'competence' (the skills and knowledge to make equipment work) works in unison with 'image' (the ideas of a practice being correct and normal) and 'material' (the physical infrastructure) to enable a practice to occur [49]. In this sense it is not enough to simply provide the materials (or infrastructure) to change energy use, and have an image (ideas or conventions) of such energy use, it is also critical for tenants to have competence (knowledge and skills) in using the newly introduced technology. Access to knowledge and skills was identified during the research as a key template from the tenant interviews, which reoccurred most frequently. In the context of a retrofit of social housing, it is therefore recommended that knowledge and skills (competence) be delivered along side technical intervention (material). This competence could be delivered in many ways. In this research, an information intervention was provided. The information intervention only affected the reported engagement with technology for programmable heating controls and mains fed showers, but not the thermostat and radiator valves. The information intervention also affected engagement with existing (rather than newly retrofitted) technology, specifically low energy light bulbs and the kettle. In the context of a retrofit of social housing, it is therefore recommended that competence be considered an ongoing area of development that can lead to change in energy use practice for existing as well as new technologies.

The second key template identified from tenant interviews was the technical intervention. Analysis of the interviews resulted in identification of technology taking the role of intermediary or determinant, using the roles identified in Midden et al's [25] schema. In this context it is recommended that, at the design stage of a retrofit, the roles of the technology be considered. In particular, enabling technology to take the role of amplifier may be an additional way to enable the technology to become embedded in routine and practice. The quality of the technical intervention can affect the degree to which they become embedded in routine and the role of the technology as intermediary was found, in such cases, to be limited.

The third key template identified from the tenant interviews was habit. This was seen, for example, with respect to continued use of the feature fireplace and the bath. When an action is repeated several times to an individual's satisfaction, deliberation over the action is reduced and it becomes a habitual action, and is automatically triggered in particular circumstances without a mediating goal. In this case using conventional communication approaches will have minimal impact because habits undermine attention to information regarding other possible courses of action [50]. Verplanken and Wood [51] argue that habits need to be disrupted either by individuals making specific plans to carry out alternative actions or by using (or creating) changes in the environment in which individuals act, in order to force individuals to reconsider their options. In the context of a retrofit situation in social housing, the changes in the fabric of the home and energy-related technologies provide scope for destabilising contexts and altering the image of the energy use practice.

Convenience may lead to a change in energy use practice related to the material change, because it is 'easier' and/or 'quicker' to engage with the technology to achieve the practice goals. Inconvenience may also limit changes to energy use practice. For example, the results indicated some tenants found showers quicker, and some tenants had not replaced curtains after window replacement. This consideration of convenience is consistent with findings from social practice theory. For example, Hand et al's [49] interpretation of showering with reference to the temporal organisation of daily life argues that 'speed' and 'convenience' are of defining importance and crucial in explaining both the general increase of showering and the decline of bathing. They argue that the key difference between bathing and showering is that the latter is associated with speed, immediacy and convenience. In relation to tenants' general energy use behaviour, a study by Edwards and Pocock [52] notes that behaviour related to energy consumption is embedded in practices that are linked to the establishment and maintenance of effective household routine. In the context of a social housing retrofit, the retrofit can disrupt the household routine and enable a new routine or practice to emerge.

This research has provided an insight into the interaction between occupants and retrofit technologies in the context of a social housing retrofit. In order to provide the depth of analysis needed, a sample of 26 households was chosen for pre and post retrofit interviews. The authors recognise that this is a small sample of social housing households, although the Retrofit Reality project was at the time one of the largest retrofit programmes in the UK.

In order to maximise the energy saving and carbon reduction potential of the UK's retrofit strategy, it is recommended that policy makers and implementers of retrofit programmes ensure that addressing energy use practice and the three strands of technology, competence and image is a key part of strategy. The recommendations are as follows.

1. Competence. Coinciding with the retrofit programme and potentially longer-term than the retrofit itself, a tailored learning programme is recommended, to better enable tenants to adjust their levels of competence and thereby alter energy use practice. This research has not analysed different methods of improving competence. However, the research did identify that, for most tenants, finance was a driver for tenants to engage in practices which are less energy intensive. The research also found that an information intervention led to slightly higher self reported engagement with some retrofitted and some existing technologies.
2. Convenience. Post retrofit, tenants reported reduced effort to save energy with respect to draught control. Tenants also reported increased frequency of showering. Both these results could lead to tenants increasing their energy use. Qualitative discussion around these issues indicated that the introduced technology led to a feeling of convenience of the energy use practice which developed. Retrofit programmes should therefore ensure that the technology role as intermediary is highly efficient, and that the technology role as determinant positively interacts with the SPT concept of image to support practice which is less energy intensive.
3. Technology quality. In order to ensure that the technology role as intermediary is highly efficient, is it important that the installation quality of the retrofit work is appropriate.

4. Disruption. The implementation of a retrofit programme is an opportunity to disrupt habits. Any retrofit programme therefore needs to recognise the unique opportunity which the disruption provides in enabling households to reconfigure their routines and practice.

6. Acknowledgements

Funding for this research was provided by Gentoo Green, One Northeast and Northumbria University.

7. References

[1] Department of Energy and Climate Change, The UK Low Carbon Transition Plan. National strategy for climate and energy, Department of Energy and Climate Change, London, 2009.

[2] Great Britain. The Energy Act 2011 Chapter 16. The Stationary Office Ltd, London, 2011.

[3] B. Boardman, Examining the carbon agenda via the 40% house scenario, Building Research and Information 35 (2007) 363–378.

[4] Energy Saving Trust, Sustainable Refurbishment: Towards an 80% reduction in CO2 emissions, water efficiency, waste reduction, and climate change adaptation, Energy Saving Trust, London, 2010.

[5] B.K. Sovacool,. What are we doing here? Analyzing fifteen years of energy scholarship and proposing a social science research agenda. Energy Res Soc Sci (2014), http://dx.doi.org/10.1016/j.erss.2014.02.003.

[6] P.C. Stern, Individual and Household Interactions with Energy Systems: Toward Integrated Understanding, Energy Res Soc Sci (2014), http://dx.doi.org/10.1016/j.erss.2014.03.003.

[7] B. Boardman, S. Darby, M. Hinnells, G. Killip, J. Palmer, G. Sinden, C.N. Jardine, 40% House. Environmental Change Institute, University of Oxford, Oxford, 2005.

[8] S. Retallack, T. Lawrence, M. Lockwood, Positive Energy: Harnessing people power to prevent climate change, IPPR, London, 2007.

[9] T. Wiedmann, J. Minx, D. Guan, J. Barrett, M. Lenzen, R. Wood, Development of an embedded carbon emissions indicator – Producing a time series of Input-output Tables and Embedded Carbon Dioxide Emissions for the UK by Using a MRIO Data Optimisation System, Department for Environment, Food and Rural Affairs, London, 2008.

[10] W. Smith, J. Pett, Energy efficiency refurbishment programmes help, but are the end-users doing their bit?, Association for the Conservation of Energy, London, 2005.

[11] K.B. Janda, Buildings don't use energy, people do, in, C.M.H. Demers, A. Potvin (Eds.), Proceedings of the 26th International Conference on Passive and Low Energy Architecture (PLEA), University of Laval Press, Quebec City, 2009, 9-14.

[12] Z.M. Gill, M.J. Tierney, I.M. Pegg, N. Allan, Low-energy dwellings: the contribution of behaviours to actual performance, Building Research and Information 38 (2010) 491-508.

[13] F. Stevenson, A. Leaman, Evaluating housing performance in relation to human behaviour: new challenges, Building Research & Information 38 (2010) 437-441.

[14] P.F.G. Banfill, A.D. Peacock, Energy-efficient new housing - the UK reaches for sustainability, Building Research and Information 35 (2007) 426–436.

[15] G. Milne, B. Boardman, Making cold homes warmer: the effect of energy efficiency improvements in low-income homes, a report to the EAGA Charitable Trust, Energy Policy, 28 (2000) 411-424.

[16] E.G. Hertwich, Consumption and the rebound effect: an industrial ecology perspective, Journal of Industrial Ecology 9 (2005) 85-98.

[17] R. Galvin, Making the 'rebound effect' more useful for performance evaluation of thermal retrofits of existing homes: Defining the 'energy savings deficit and the 'energy performance gap', Energy and Buildings 69 (2014) 515-524.

[18] A. Warde, Consumption and Theories of Practice, Journal of Consumer Culture 5 (2005) 131-153.

[19] E. Shove, Comfort, cleanliness and convenience – the social organisation of normality, Routledge, London, 2003.

[20] E Shove, The ABC of energy efficiency and behaviour, Keynote presentation, First European Conference on Energy Efficiency and Behaviour, October, 18-20, Maastricht, the Netherlands, 2009

[21] M. Hand, E. Shove, D. Southerton, Explaining Showering: a Discussion of the Material, Conventional, and Temporal Dimensions of Practice, Sociological Research Online, 10 (2005), available at http://www.socresonline.org.uk/10/2/hand.html , accessed on 09/12/11.

[22] E. Shove, D. Southerton, Defrosting the freezer: From novelty to convenience, Journal of Material Culture, 5 (2000), 301-319.

[23] K. Gram-Hanssen, Standby Consumption in Households Analysed With a Practice Theory Approach, Journal of Industrial Ecology 14 (2009) 150-165.

[24] K. Gram-Hanssen, Residential heat comfort practices: understanding users, Building Research & Information 38 (2010) 175-186.

[25] C. Midden, F. Kaiser, T. McCalley, Technology's four roles in understanding individuals' conservation of natural resources, Journal of Social Issues 63(2007) 155-174.

[26] K. Araujo, The Emerging Field of Energy Transitions: Progress, Challenges, and Opportunities, Energy Res Soc Sci (2014), http://dx.doi.org/10.1016/j.erss.2014.03.002.

[27] L. Steg, Promoting household energy conservation., Energy Policy 36(2008) 4449–4453.

[28] P.D. Luyben, Prompting thermostat setting behaviour: public response to a presidential appeal for conservation, Environment and Behaviour 14(1982) 113–128.

[29] W. Abrahamse, L. Steg, C. Vlek, J.A.. Rothengatter, The effect of tailored information, goal setting and tailored feedback on household energy use, energy-related behaviours and behavioural antecedents, Journal of Environmental Psychology 27(2007) 265–276.

[30] J. Thøgerson, Social marketing of alternative transportation modes, in: T. Gärling, L. Steg, (Eds.), Threats to the quality of urban life from car traffic: Problems, causes and solutions, Elsevier, Amsterdam, 2007.

[31] D. McKenzie-Mohr, Fostering Sustainable Behaviour through Community-Based Social Marketing, American Psychologist 55(2000) 531–537.

[32] S. Bamberg, Effects of implementation intentions on the actual performance of new environmentally friendly behaviours – result of two field experiments, Journal of Environmental Psychology 22(2002) 399–411.

[33] W. Abrahamse, L. Steg, C. Vlek, J.A. Rothengatter, A review of intervention studies aimed at household energy conservation, Journal of Environmental Psychology 25(2005) 279–291.

[34] T. Hargreaves, Mi. Nye, J. Burgess, Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors, Energy Policy 38 (2010) 6111-6119.

[35] R.G. Burgess, In the field: An introduction to field research, Routledge, London, 1984.

[36] D. Silverman, Doing qualitative research, Third Edition, Sage Publications, London, 2010.

[37] EST, Energy Saving Trust Website, available at: http://www.energysavingtrust.org.uk/, accessed on: 07/11/08

[38] A. Strauss, J. Corbin, Basics of Qualitative Research, 2nd ed., SAGE Publications Ltd, Thousand Oaks, 1998.

[39] N. King, Using Templates in the Thematic Analysis of Text, in C. Cassell, G. Symon, Essential Guide to Qualitative Methods on Organizational Research, SAGE Publications Ltd, Thousand Oaks, 2004.

[40] T. Waring, D. Wainwright, Issues and Challenges in the Use of Template Analysis: Two Comparative Case Studies from the Field, The Electronic Journal of Business Research Methods 6 (2008) 85 – 94.

[41] N. King, C. Cassell, G. Symon, Using Templates in the Thematic Analysis of Text, in: Essential Guide to Qualitative Methods in Organizational Research, SAGE Publications Ltd, London, 2004.

[42] L. Baker, T. Lavender, D. Tincello, Factors that influence women's decisions about whether to participate in research: An exploratory study, Birth 32 (2005) 60-66.

[43] E. De Gregorio, M. Gallon, A. Verde, Troubled groups in situation: qualitative analysis of psychotherapeutic sessions with deviant adolescents, Quality & Quantity: International Journal of Methodology (2013), 1-12.

[44] R. Kyburz-Graber, K. Hofer, B. Wolfensberger, Studies on a socio-ecological approach to environmental education: a contribution to a critical position in the education for sustainable development discourse, Environmental Education Research, 12 (2006), 101-114.

[45] A.A.H. Smit, P.P.J. Driessen, P. Glasbergen, Conversion to Organic Dairy Production in the Netherlands: Opportunities and Constraints, Rural Sociology 74 (2009), 383-411.

[46] P. Salzman,, On reflexivity, American Anthropologist, 104(2002) 805-813.

[47] A. Coffey, The Ethnographic Self, Sage Publications, London, 1999.

[48] D.L. Wolf, Situating feminist dilemmas in fieldwork,. in: D.L. Wolf (Ed.), Feminist dilemmas in fieldwork, Westview Press, Colorado, 1996.

[49] M. Hand, E. Shove, D. Southerton, Explaining Showering: a Discussion of the Material, Conventional, and Temporal Dimensions of Practice, Sociological Research Online, 10(2005), available at http://www.socresonline.org.uk/10/2/hand.html , accessed on 09/12/11.

[50] B. Verplanken, H. Aarts, A. van Knippenberg, Habit, information acquisition, and the process of making travel mode choices, European Journal of Social Psychology 27(1997) 539-560.

[51] B. Verplanken, W. Wood, Interventions to break and create consumer habits, Journal of Public Policy and Marketing 25(2006) 90-103.

[52] J. Edwards, B. Pocock, Comfort, convenience and cost: The calculus of sustainable living at Lochiel Park, Centre for Work + Life, University of South Australia, 2011, available at http://www.unisa.edu.au/hawkeinstitute/cwl/documents/Lochiel-Park-report.pdf , accessed on 16/11/11.

Appendix 1: summary responses from semi-structured interviews

Reported motivations for energy saving behaviour

Table A1: Tenant responses to money motivation question

I would like to reduce my energy use in order to save money				
Sample Group	Strongly Agree	Agree	Disagree	Disagree Strongly
All tenants	7 (27%)	19 (73%)	0	0

Table A2: Tenant responses to environmental motivation question

I would like to reduce my energy use to help the environment				
Sample Group	Strongly Agree	Agree	Disagree	Disagree Strongly
All tenants	5 (19%)	21 (81%)	0	0

Table A3: Tenant responses to primary motivation question

Which is the priority out of the two; saving money or helping the environment?			
Sample Group	Saving Money	Helping the Environment	Depends on Situation
8 of 26 tenants	6 (75%)	1 (13%)	1 (13%)

General energy consumption behaviour

Table A4: Gas consumption behaviour change

Do you carry out actions to cut down on your gas use in your home?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	13 (100%)	0	0	13 (100%)	0	0
No information intervention	13 (100%)	0	0	13 (100%)	0	0
Total	26 (100%)	0	0	26 (100%)	0	0

Table A5: Electricity consumption behaviour change

Do you carry out actions to cut down on your electricity use in your home?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	13 (100%)	0	0	13 (100%)	0	0
No information intervention	13 (100%)	0	0	13 (100%)	0	0
Total	26 (100%)	0	0	26 (100%)	0	0

Table A6: Reported energy use behaviour change

Do you think your behaviour relating to energy use has changed in any way since the modernisation?			
Sample Group	No change in behaviour	Slight change in behaviour	Change in behaviour
Information intervention	5 (38%)	6 (46%)	2 (15%)
No information intervention	10 (77%)	2 (15%)	1 (8%)
Total	15 (58%)	8 (31%)	3 (12%)

Space and water heating, and thermal comfort

Table A7: Programmable heating controls

Do you programme your central heating controls to come on at different times?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	1 (8%)	0	12 (92%)	4 (31%)	0	9 (69%)
No information intervention	2 (15%)	0	11 (85%)	6 (46%)	0	7 (54 %)
Total	3 (12 %)	0	23 (88 %)	10 (38 %)	0	16 (62 %)

Table A8: Thermostat use

Do you keep your thermostat temperature at no more than 20˚C?							
	Before technical intervention			After technical intervention			
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely	Don't know
Information intervention	0	0	13 (100%)	9 (69%)	2 (15%)	2 (15%)	0
No information intervention	0	0	13 (100%)	9 (69%)	1 (8%)	1 (8%)	2 (15%)
Total	0	0	26 (100%)	18 (69%)	3 (12%)	3 (12%)	2 (8%)

Table A9: Radiator controls

Do you use the radiator controls to provide heat as and when required?					
	Before technical intervention			After technical intervention	
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent or Occasional	Never / Very Rarely
Information intervention	0	0	13 (100%)	10 (77%)	3 (23%)
No information intervention	0	0	13 (100%)	11 (85%)	2 (15%)
Total	0	0	26 (100%)	21 (81%)	5 (19%)

Table A10: Bathing

Do you tend to have showers instead of baths?						
	Before technical intervention			After technical intervention		
Sample Group	Mainly Showers	Baths or Showers	Mainly Baths	Mainly Showers	Baths or Showers	Mainly Baths
Information intervention	2 (15%)	1 (8%)	10 (77%)	10 (77%)	2 (15%)	1 (8%)
No information intervention	4 (31%)	2 (15%)	7 (54%)	6 (46%)	3 (23%)	4 (31%)
Total	6 (23%)	3 (12%)	17 (65%)	16 (62%)	5 (19%)	5 (19%)

Table A11: Controlling drafts

Do you try to control drafts in your home to stop heat escaping?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	9 (69%)	0	4 (31%)	3 (23%)	0	10 (77%)
No information intervention	10 (77%)	0	3 (23%)	6 (46%)	0	7 (54%)
Total	19 (73%)	0	7 (27%)	9 (35%)	0	17 (65%)

Table A12: Closing curtains at night

Do you close curtains at night to keep the heat in?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	10 (77%)	3 (23%)	0	7 (54%)	6 (46%)	0
No information intervention	12 (92%)	1 (8%)	0	11 (85%)	2 (15%)	0
Total	22 (85%)	4 (15%)	0	18 (69%)	8 (31%)	0

Table A13: Wearing warmer clothing

Do you put on warm clothing rather than turning the heating up?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	10 (77%)	0	3 (23%)	7 (54%)	3 (23%)	3 (23%)
No information intervention	8 (62%)	2 (15%)	3 (23%)	5 (38%)	3 (23%)	5 (38%)
Total	18 (69%)	2 (8%)	6 (23%)	12 (46%)	6 (23%)	8 (31%)

Electrical Appliances and Lighting

Table A14: Use of energy saving light bulbs

Do you use energy saving light bulbs?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	9 (69%)	0	4 (31%)	11 (85%)	0	2 (15%)
No information intervention	11 (85%)	0	2 (15%)	12 (92%)	0	1 (8%)
Total	20 (77%)	0	6 (23%)	23 (88%)	0	3 (12%)

Table A15: Switching off electrical appliances

Do you turn off all appliances completely when they are not in use?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	11 (85%)	1 (8%)	1 (8%)	11 (85%)	2 (15%)	0
No information intervention	8 (62%)	3 (23%)	2 (15%)	7 (54%)	5 (38%)	1 (8%)
Total	19 (73%)	4 (15%)	3 (12%)	18 (69%)	7 (27%)	1 (4%)

Table A16: Kettle use

Do you only boil the amount of water you need when using the kettle?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	10 (77%)	0	3 (23%)	11 (85%)	2 (15%)	0
No information intervention	7 (54%)	2 (15%)	4 (31%)	9 (69%)	1 (8%)	3 (23%)
Total	17 (65%)	2 (8%)	7 (27%)	20 (77%)	3 (12%)	3 (12%)

Table A17: Washing machine use

Do you fill your washing machine and keep temperatures low?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	12 (92%)	1 (8%)	0	12 (92%)	1 (8%)	0
No information intervention	10 (77%)	3 (23%)	0	7 (54%)	5 (38%)	1 (8%)
Total	22 (85%)	4 (15%)	0	19 (73%)	6 (23%)	1 (4%)

Table A18: Lighting use

Do you turn off unnecessary lights around the house?						
	Before technical intervention			After technical intervention		
Sample Group	Frequent	Occasional	Never / Very Rarely	Frequent	Occasional	Never / Very Rarely
Information intervention	13 (100%)	0	0	13 (100%)	0	0
No information intervention	12 (92%)	1 (8%)	0	13 (100%)	0	0
Total	25 (96%)	1 (4%)	0	26 (100%)	0	0

Awareness and Perception of Energy Costs

Table A19: How tenants monitor their energy use

How do you normally keep track of your energy use?						
	Before technical intervention			After technical intervention		
Sample Group	Look at Bills	Look at Pre-payment Meters	Look at bills and pre-payment meter	Look at Bills	Look at Pre-payment Meters	Look at bills and pre-payment meter
Information intervention	3 (23%)	7 (54%)	3 (23%)	4 (31%)	6 (46%)	3 (23%)
No information intervention	6 (46%)	7 (54%)	0	6 (46%)	7 (54%)	0
Total	9 (35%)	15 (58%)	2 (8%)	10 (38%)	13 (50%)	3 (12%)