Energy Use in Social Housing Residents in the UK and Recommendations for Developing Energy Behaviour Change Interventions

Abstract

This paper presents a qualitative exploration of domestic energy consumption practices in the UK social housing sector, and perceived effectiveness of varying intervention techniques in motivating energy reductions. The study was conducted using a sample of *N* = 20 social housing residents, who had recently taken part in a 'serious game' energy behaviour change intervention trial, thus making them uniquely positioned to provide such insight and feedback on these issues. A series of one-on-one open-ended interview sessions were conducted in residents' homes at the end of the intervention period, using an open-ended discussion framework. Thematic analysis revealed that residents were highly engaged with the topic of energy saving, but that several psychological barriers existed which prevented many residents from changing them behaviour. In line with the Theory of Planned Behaviour and the Norm Activation Model, these barriers included lack of awareness of the issue, action inertia, and perceived lack of behavioural control. Some residents did make savings following the trial, and our interviews provide useful insight into their decision making and behaviour change processes, including evidence for cross-contextual spillover effects, where residents made savings in other areas. However overall, the serious gaming approach did not inspire engagement from the target population, who frequently mentioned lack of time and/or desire to use overly 'technical' solutions for energy savings. Recommendations for ongoing intervention development are discussed, including preference for tailored non-technical visualisation tools and less time intensive versions of the game, and implications for future energy policy development are considered.

1.0 Introduction

In accordance with EU-2050 targets, the UK government is committed to achieving an 80% reduction in carbon emissions by 2050, in comparison to the 1990 baseline (Committee on Climate Change [CCC], 2017; HM Parliament, 2008). One central component of this involves improving the energy efficiency of the UK's residential building stock, which is amongst the oldest and least energy efficient in Europe (HM Parliament, 2008; Dixon & Eames, 2013). Indeed, government figures show that direct emissions from buildings accounted for 19% of all UK greenhouse gas emissions (GHG) in 2016 (CCC, 2017), within which 76% GHG was attributable to domestic households. Individual behaviour is regarded as one important factor which contributes directly to emissions from homes, and thus the topic of encouraging behaviour change to reduce domestic energy demand has attracted much research interest in recent years (Ölander & Thøgersen, 2014; Steg, Perlaviciute, & van der Werff, 2015). However, despite this, and contrary to government objectives, research has shown that direct emissions from buildings *increased* for the second year running in 2016, by approximately 2%, with progress made in reducing emissions from homes between 2008-2012 now at a standstill (Department for Business, Energy & Industrial Strategy [BEIS], 2017). Evidently, there remains a need for development of renewed strategies designed to reignite progression in the field of energy demand reduction in homes in the UK.

The present research provides a detailed qualitative exploration of domestic energy consumption practices within the UK social housing sector. Vulnerable populations such as this are often overlooked when it comes to energy behaviour change research. Yet, given the high prevalence of fuel poverty experienced in this sector, i.e. the high proportion of people who struggle to afford to adequately heat their homes in winter (Healy & Clinch, 2004), the potential benefits associated with achieving more conservative energy use here may be wide-reaching (see, Boomsma, Jones, Pahl & Fuertes, 2018). With this in mind, the main aim of the current research was to deepen understanding of the psychological influences that impact

upon behaviour and energy demand in this sector, with a view to informing the development of tailored behaviour change strategies designed to encourage more conservative energy use and thus alleviate the experience of fuel poverty. We present the results of a series of one-on-one interview sessions, which were conducted with a sample of 20 social housing residents, who had previously taken part in an energy behaviour change pilot intervention programme. This intervention was conducted as part of the EnerGAware project (**Ener**gy **G**ame for **Aware**ness of energy efficiency in social housing communities), and involved a longitudinal trial of a new 'serious game' designed to reduce energy demand in the social housing sector. Participants were interviewed at the end of the intervention process, in order to provide insight into factors affecting energy demand at the end of the trial period, the main psychological barriers that prevent users from using less energy, and the perception of the effectiveness of such techniques in changing behaviour. We now provide an introduction to the topic of energy behaviour change, and discuss the need to utilise a qualitative approach in order to gain in-depth understanding of the myriad factors which influence the decision-making processes utilised by energy consumers in this context. We then provide the specific rationale for the current research, which utilises this methodological approach with the aim of informing future policy and intervention development.

1.1 Energy behaviour change: existing approaches and serious gaming

There are many challenges when it comes to engaging people in the topic of energy consumption. Energy has been described as "doubly invisible", given that the amount of energy use is a largely abstract concept, and that it may be difficult to accurately link consumption with engagement in every day behaviours (Burgess & Nye, 2008). Further challenges stem from the fact that people typically pay for energy long after using it, and the rate at which future consequences are discounted is often extremely high (Frederick, Loewenstein & O' Donoghue, 2002). Add to this the fact that people often display a reluctance to act to change their behaviour (Ölander & Thøgersen, 2014), given our general preference as decision makers to maintain previous

circumstances or the 'status quo' (an effect sometimes referred to in the literature as 'action inertia', Thaler & Sunstein, 2008; Tykocinski, & Pittman, 1998; Hafner, Elmes & Read, 2019a), and the topic of promoting behaviour change within the field of energy demand may appear insurmountable. However, by tapping in to an understanding of the psychological processes involved in making choices that affect engagement in energy consumptive behaviours, researchers have found ways to encourage pro-environmental behaviour change in this context. For example, research into smart energy monitoring systems (SEM's) has shown that providing real-time financial information on current usage and/or normative information on the usage behaviour of similar peers can encourage direct reductions in energy demand (Abrahamse & Steg, 2013; Schultz, Estrada, Schmitt, Sokoloski & Silva-Send, 2015). Other avenues of research have explored means of increasing the visibility of energy using thermal imaging techniques (which allow consumers to clearly "see" where they are wasting energy), in order to encourage engagement in energy saving, with demonstrable success (see, Goodhew, Pahl, Auburn & Goodhew, 2015).

The field of serious gaming has also been effective in reducing energy consumption in the short-term. 'Serious games' have been described as games which 'go beyond the purposes of entertainment, and instead in directions which educate, or promote health or well-being' (Waltz & Deterding, 2015). Examples of serious games being used to motivate behaviour change abound across many domains, including education, health and sustainability. Serious games aim to tap in to behaviour change principles already widely established in psychology. This begins with drawing attention to the issue, in order to increase awareness of the problem, as well as providing an element of social comparison and competition, usually incorporated through the use of social media platforms and leader-boards (Abrahamse & Steg, 2013; Waltz & Deterding, 2015).

In the field of energy, serious games have been successfully used to motivate behaviour change by overcoming the problem of the invisibility of energy, and providing users with a direct visual representation of where energy is being used or wasted, and as well as providing specific

examples of how the user can change their behaviour to reduce their consumption levels. For instance, in one example, Reeves, Cummings, Scarborough and Yeykelis (2015) present the results of a 30-day trial of the game "Powerhouse", in which users were taught how to conserve energy using the platform of a virtual family home. The game incorporated real-time feedback on consumption levels, and was found to lead to reduced energy demand (in comparison to a no-game control), at the end of the trial period (for a full review of this literature please see Boomsma, Hafner, Pahl, Jones & Fuertes, 2018; Johnson, Horton, Mulcahy & Foth, 2017).

Consequently, there certainly appears to be potential for serious gaming to change behaviour in the context of domestic energy consumption. However, less is known about the extent to which these findings would generalise to different populations, and accordingly whether there is potential to use gaming to address wider social issues, such as the experience of fuel poverty for vulnerable households. The main EnerGAware intervention was designed to explore these issues, using a longitudinal trial of a new serious game for energy; 'EnergyCat' (see, Hafner, Fuertes, Pahl, Boomsma, Jones, Casals & Gangolells, 2019b). We now introduce our target population: the social housing sector, before providing background on the EnergyCat game. We then provide a detailed rationale for the current research, which provides a detailed qualitative exploration of perceptions of energy usage and energy saving intervention potential amongst UK social housing residents who are uniquely placed to such provide feedback, having recently taken part in the empirical trial.

1.2 The Social Housing Sector

Housing is the single highest expenditure item for Europeans, at about a quarter of the average total household budget for all housing in 2015, increasing from 21.7% in 2000 (Pittini, Koessl, Dijol, Lakatos & Ghekière, 2017). What is more, research has shown that there is a direct correlation between housing and rising inequality at a global scale, with an increasing share of poor households pushed into poverty due to rising housing costs across many European countries

in recent years (Pittini et al., 2017). Social housing provides low-income households with subsidised, sub-market rents, and represents about 12% of the total European housing stock, making this a significant target for energy efficiency measures by Governments of EU member states. The proportion of social housing does vary significantly between countries; the Netherlands has the highest share of social housing in Europe, accounting for 32% of the total housing stock, followed by Austria (23%) and Denmark (19%). The UK (18%), Sweden (18%), France (17%) and Finland (16%) also have a relatively large social housing sector (CECODHAS, 2011). Within the UK, social housing residents are now substantially more concentrated within the poorer parts of income distribution than in the past. Research has shown that 70% of current social housing residents have incomes within the lowest two-fifths of overall income distribution within the UK, compared with only 19% in the top half in 2004-2005 (Hills, 2007). What is more, the proportion of social householders in paid employment fell from 47% to 32% between 1981 and 2006; resulting in twice the national rate of unemployment for those of working age for this population. Residents also have high rates of disability, are more likely than other tenures to be lone parents or single, and to be aged over 60 (Hills, 2007).

Rising financial pressures in the housing market, increased cost of fuel, the liberalisation of energy markets and decreased levels of welfare provision in Europe since the 1970s, has also resulted in an increasing number of households living in social housing that cannot afford the costs of heating. In 2011, 9.8% of households in the EU could not afford to heat their home adequately, whilst 8.8% of households were in arrears on their utility bills (Thomson & Snell, 2013). In the United Kingdom and other European countries, this problem has become known as “fuel poverty” (Thomson, Snell & Liddell, 2016). This is further driven by rising fuel prices that are not offset by efficiency improvements, which are often lacking in poorer households. In addition, low-income earners are more likely to be unemployed, and are likely to pay more per unit for energy as they

are often not in a position to choose payment plans that offer reduced tariffs, such as direct debit (Druckman & Jackson, 2008).

There is evidence for an indirect link between the experience of fuel poverty and health and well-being. For instance, Boomsma, Pahl, Jones and Fuertes (2017) found that subjects who struggled to keep their homes warm were more likely to experience poorer health, due to an increased likelihood that they also experienced housing problems such as damp and mould (see also, Liddell & Guiney, 2015). Consequently, development of a behaviour change tool specifically designed to meet the needs of this population subset has great potential not only in the strive for domestic energy reduction at the societal level, but also in order to help reduce the experience of fuel poverty, potentially benefitting health and well-being for this vulnerable population. Given impacts found across wider populations (Ro, Brauer, Kuntz, Shukla & Bensch 2017; Reeves et al., 2015; Cowley & Bateman, 2017), one of the main aims of the EnerGAware project was to explore the potential for a new serious game for energy reduction in helping to achieve these goals.

1.3 EnergyCat

Building upon previous research, a new serious game for energy 'EnergyCat' (http://www.energycatgame.com/), was developed and trialled in the EnerGAware programme. This game used a virtual home environment in which users played the role of a cat ('EnergyCat'), who aimed to teach the human residents about more efficient domestic energy practices. A 12-month longitudinal trial of the game was conducted using a sample of social housing residents, and any changes in energy awareness or engagement in energy saving behaviours were assessed by comparing responses to a baseline versus final term survey (for an overview please see, Hafner et al., 2019b). The concept was developed on the basis of feedback gained from social housing residents in developmental workshop sessions, who stated that they would prefer a realistic platform to more abstract prototypes, such as a spaceship. Figure 1 provides a screenshot of the game platform.

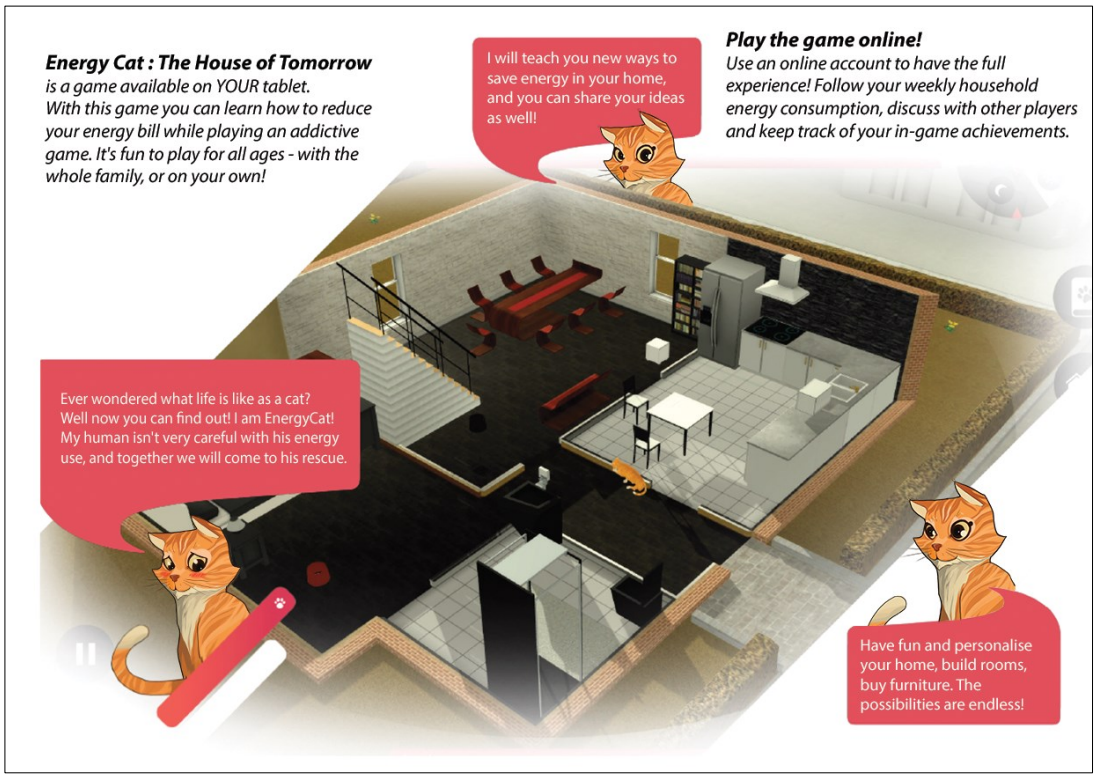

Figure 1. Sample screenshot of EnergyCat game platform.

The game was designed to teach residents how to engage in more effective 'curtailment behaviours' around the home in order to achieve energy savings. These have been defined as frequently repeated behaviours that have a direct impact on consumption levels (Gardner & Stern, 2002), and examples include regularly changing thermostat settings, closing windows when the heating is on, or turning lights off when leaving the room. It was deemed important to focus on these behaviours, as opposed to 'efficiency behaviours'; involving the installation of more efficient equipment; given that many social housing residents may lack the capital or personal freedom required for making home improvements on this scale. Thus, it was perceived that targeting curtailment behaviours would be the most effective strategy for enabling behaviour change in the UK social housing sector. The game was designed to teach subjects how to make changes in these areas, by highlighting areas of potentially high energy wastage.

Previous research has shown that a building's energy use can be 40% above expectations (Yu, Fung, Haghighat, Yoshino & Morofsky, 2011), due to the inefficient

behaviour of its occupants, who might heat empty rooms, open windows rather than turn down heating, and forget to turn the heating down when they leave (Parker, Hoak, Meier & Brown, 2006). Thus, a key aim of researchers working in the environmental field is to influence the complex interaction between people and buildings. Assuming that building occupants can influence about 40% of energy use in residential buildings, and based on the results of previous European projects for energy efficiency in social housing (see, for example, the 3-E Houses project, Porto, Hildebrandt, Arias, Fuentes, Pérez, O'Malley, Knights & Brookes, 2013; the eSESH project, Korte, Vogt, Gareis, 2013; the BECA project, Vogt, Dashja & Kote, 2015), which have achieved savings of between 7-25% (depending on the solution deployed and the location of the intervention), it was estimated that by tackling inefficient curtailment behaviours of occupants, the EnerGAware serious game could achieve a saving of between 15-30%, or up to 127.95 Mtoe/yr in the UK (or 5.35 x 10^{12} Joules / 1,488 MWh).

Whilst much previous work has focused on exploring the impacts of intervention techniques on residential energy usage directly, the research presented in the current paper was designed to explore perceptions of varying energy and behaviour change intervention techniques amongst social housing residents, as well as developing in-depth understanding of prevalent barriers to behaviour change which may prevent residents from further reducing their energy use. It was hoped that by using a qualitative approach to explore the topic of energy saving, we would be able to provide a holistic overview of the myriad factors which influence residents' behaviour, with a view to informing future intervention development in this context.

In addition, qualitative research can help us gain insight here into factors spontaneously raised by participants as impacting upon their behaviour, unprompted by the facilitator. This was important given that previous research has shown how qualitative approaches may provide a window into implicit motivations, in contrast to quantitative

approaches in which participants may over-rate the importance of influential factors as a direct consequence of survey prompts, or may be more likely/able to attempt to respond in a socially desirable manner. For instance, Hafner, Walker and Verplanken (2017) showed that whilst car buyers consistently rated environmental concern as a key concern in decision making in quantitative surveys, these were rarely mentioned in interview sessions when the topic was not raised by the facilitator. Further, participants were found to downplay symbolic and affective motivations for choice (such as image and 'gut reactions') at the outset, and only 'opened-up' about these (perhaps less socially desirable) motivations when using qualitative approaches, in which a level of trust had been established with the session facilitator (see also, Noppers, Keizer, Bolderdijk & Steg, 2014). Subsequently, the main aim of the current research was to apply a similar methodological approach in order to provide an in-depth level of insight into energy usage in the UK social housing sector.

1.4 Rationale

By providing opportunity for open ended discussion, the current research was designed to gain insight into the psychological determinants of energy awareness and engagement in domestic energy saving behaviours in the UK social housing sector, as well as determining perceptions of the effectiveness of different intervention techniques in changing behaviour. We also aimed to explore psychological barriers to behaviour change, in order to build a complete picture of the myriad factors encouraging or preventing engagement in energy saving practices, in order to further inform future intervention development.

2.0 Method

2.1 Participants

Twenty social housing residents (9 male, 11 female, mean age: 59, ranging from 32 – 80, *N*=13 experimental group, *N*=7 control group) took part in the interview sessions. The participants were selected from the sample of 82 households who had taken part in the EnerGAware serious

game intervention trial using a method of convenience sampling, in which interviews were carried out alongside the deinstallation of household monitoring equipment by project partner DCH (the deinstallation was required by our ethics protocol following completion of the pilot trial). In the main intervention trial (Hafner et al., 2019b), the 82 pilot homes were allocated to either the experimental (*N*=42) or control (*N*=40) condition using a pairing approach, in which two near-identical houses were identified on the basis of socio-demographic and dwelling characteristics, and one randomly assigned to each group. This was done in order to ensure the groups were as similar as possible at the start of the intervention, thus ensuring a valid baseline point for comparison (see, Hafner et al., 2019b).

The participant pool was representative of typical demographics found in the social housing sector (Department for Communities and Local Government, 2017); most subjects (75%) were aged 50 years or older, and either retired (58.8%) or in employment (17.67%). There was an even split in the percentage of subjects in receipt of welfare benefits (10 yes, 9 no, 1 prefer not to say), and the majority stated that either they (39%) or another member of the household (27%) had a disability.

2.2 Procedure

The research consisted of 20 one-on-one open-ended interview sessions, which lasted an average of 22 minutes. The main aim of the sessions was to give participants a chance to discuss their thoughts and opinions surrounding their own domestic energy consumption levels, and potential psychological barriers to reducing energy demand, as well as ideas for future intervention development in this context. We aimed to keep the sessions relatively unconstrained and free, in order to gain insight into the factors affecting participants beliefs and behaviour, as unprompted by the facilitator (who offered no views throughout). In this manner, we hoped to avoid the pitfalls of more structured sessions, in which participants may be inclined to discuss, or even agree with, issues raised by the facilitator. We note that the facilitator was also relatively

new to the team and had not been involved with setting up and briefing the previous pilot test, thus offering an independent and unbiased perspective. Eighteen open questions were prepared to start (and if necessary, advance) the sessions, providing the following flexible protocol:

1. Introduction (aims of the session and outline of ethical procedures)
2. Opening up unstructured discussion of energy perceptions, behaviour change intervention techniques, and associated impacts on energy consumption, encouraging a detailed narrative response: *"What was your motivation for taking part in the EnerGAware programme?"*, *"Do you think behaviour change programmes for energy are a good idea?", "If yes, why? / If not, why not?",* "*Did you enjoy taking part?*", *"What (if anything) could have been improved?"*, "*What have you learned (if anything) as a result of taking part?*", "*Did you think much about your energy use before, and how much do you think about it now?*", "*Have you changed anything about your behaviour as a result of taking part?*", *"If yes, what and why? If not, why not?",* "*Are you generally interested in trying to save energy at home?*", "*If yes, why is this important to you? / If not, why not?*", "*Is there anything you would like to change about how your home uses energy?", "If yes, what and why?"*
3. Open ended discussion of psychological barriers to behaviour change, again encouraging a detailed narrative response: "*What are the main barriers preventing your household from using less energy?*", "*Why does this impact on your behaviour?*", "*How easy would it be for you to start using less energy at home?*, "*What would motivate you to use less energy?*"

2.3 Thematic analysis

The transcripts were studied using thematic analysis, which is a process of identifying and reporting patterns (i.e. themes) within the data (Braun & Clarke, 2006). Following the procedure outlined by Braun and Clarke (2006), the transcripts were initially read several times to ensure thorough comprehension, and patterns were extracted and coded into non-overlapping themes and sub-themes, which were then compared to the original transcripts and further developed.

3.0 Results

Initial thematic analysis identified seven core themes as follows: motivations; positive project impacts; negative project impacts; energy saving intervention development; psychological barriers to behaviour change; decision making insights; and social influence in energy. The themes and sub-themes are presented in Table 1. Following initial thematic analysis, and paralleling the analytical approach used by Hafner et al., (2017), each comment generated was then coded into one of the seven core themes, in order to generate an overview of the frequency of response type. Results are displayed in Figure 2.

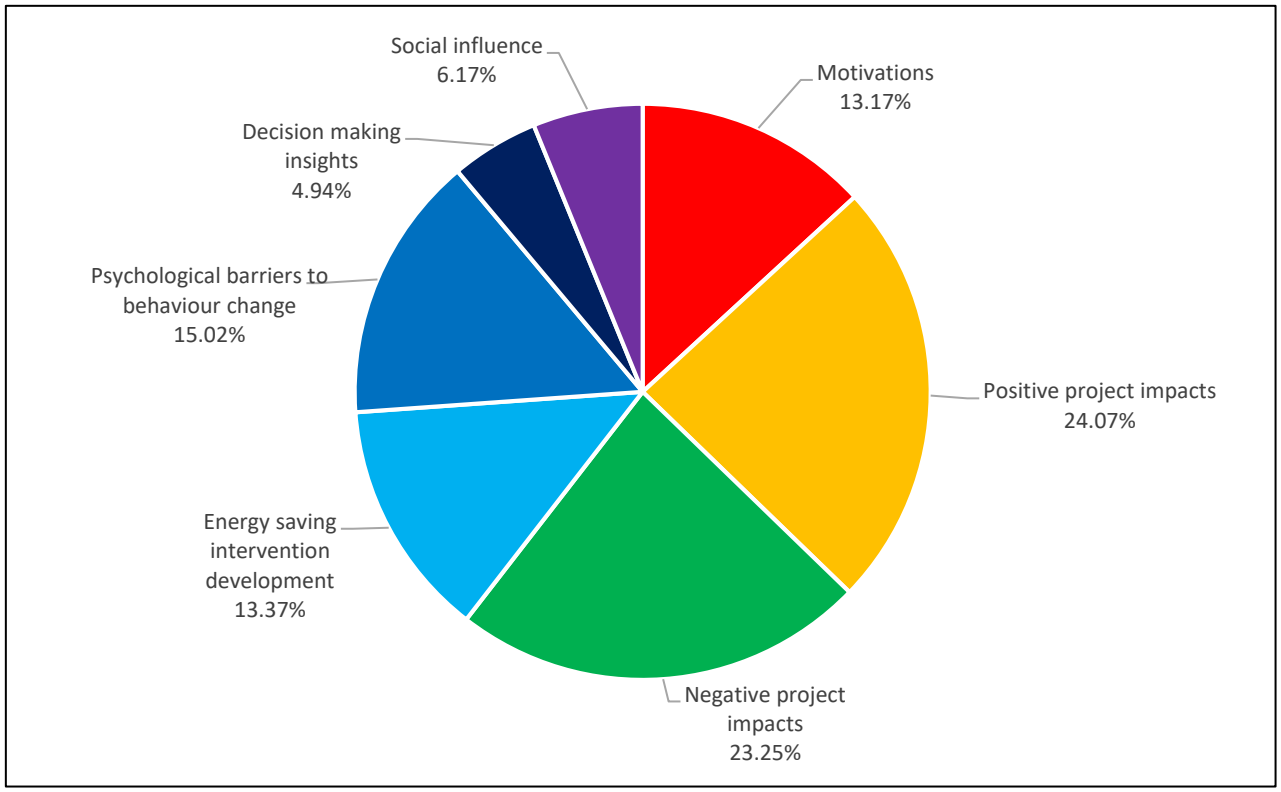

Figure 2. Pie chart showing the frequency of different types of response generated in the 20 interview sessions (collapsed), displayed as a percentage of the total number comments (*N*=486).

We now discuss each theme in turn, providing insight from each on energy perspectives and psychological determinants of domestic energy demand, using examples from our data.

Table 1. Interview thematic analysis: overview of themes and sub-themes

Superordinate Theme or Thematic Cluster	1. Motivations	2. Positive project impacts	3. Negative project impacts	4. Energy saving intervention development	5. Psychological barriers to behaviour change	6. Decision making insights	7. Social influence in energy
Sub-themes	1. Desire to learn	1. Increased energy awareness	1. No impact / on awareness or engagement in energy saving	1. Interactive tool for energy visualisation	1. Reduced perceived behavioural control	1. Role of information provision	1. Influence of family members in helping to reduce waste
	2. Desire to save money / reduce bills	2. Increased engagement in energy behaviours	2. No feedback	2. Smart meter systems	2. Action inertia	2. 'Kick-start' to overcome inertia	2. One family member taking responsibility
	3. Desire to help with research	3. Energy savings	3. Poor educational functionality	3. Simplified tips	3. Lack of awareness	3. Social snowball effect (establishing new norms)	3. Desire to change behaviour of others – Reaching out as behaviour change ambassador to engage wider population
	4. Desire to help environment	4. Surveys as an educational tool	4. Negative affect / disappointment	4. Avoidance of overly technical language	4. Already using very little / doing everything possible to conserve	4. Changing mentalities	4. Desire to change behaviour of others – Need for individuals to take responsibility
	5. Desire to free up capital for other things	5. Spillover effects	5. Usability issues	5. Simplicity of making small changes	5. Social (behaviour of others in household)	5. Behaviour change process	5. Desire to change behaviour of others – Reflection on the need for widespread change
	6. Desire to change behaviour of others in household	6. Increased comfort	6. Lack of interest in / time for gaming	6. Tool to educate others	6. Information provision – Problem of existing mixed messages		
	7. Tablet	7. Positive affect		7. Salient examples of how saved capital may be used	7. Information provision – Problem of information inaccessibility		
					8. Perception of comfort		

3.1 Motivations

The first theme to emerge concerned motivations for taking part in an energy behaviour change intervention. Financial motivations were often cited as a key reason for taking part (31% of 64 responses in this theme), e.g.:

As with everybody, it's financial, isn't it? The more you can lower your energy costs the more breathing space you've got.

This is in line with previous research which has shown that financial information can be highly effective in guiding behaviour in pro-environmental directions (see, Schultz et al., 2015). Other sub-themes to emerge from this category of response concerned a desire to help the environment (6% of 64 responses in this theme), and a desire to educate, or to change the behaviour of others in the household (16% of 64 responses), e.g.:

I wanted to help save the environment, it is important. We are all contributing by wastage.

My daughter's just turned 10 and we're going to come to the teenage years soon where we have to have two showers a day and three different changes of clothes. I suppose if I can try and educate her now before we get to that, she might think a bit more nearer the time.

As these quotes illustrate, subjects were highly engaged with the topic of energy, and many displayed a willingness to change their behaviour in order to attain higher order goals, such as saving the environment.

3.2 Positive project impacts

This theme concerned benefits that were experienced as a direct consequence of taking part in the intervention programme. The most prominent sub-themes in this category were

increased engagement in energy saving behaviours (33% of 117 responses in this theme), and increased energy awareness (33% of 117 responses), e.g.:

We've definitely kept more of a look on the use of the heating and stuff, and keeping the blinds shut, the curtains closed. Saving on heating I think is the main thing, yeah.

Interestingly, comments such as this were not found to be specific to the experimental group. This appears to illustrate that the benefits were not a consequence of the specific intervention per se, but rather were a result of simply taking part in the programme. Another sub-theme found in this category provides some insight as to why this may be the case. Specifically, in several instances, participants were found to discuss how the intervention surveys themselves were an effective educational tool (16% of 117 responses in this theme):

When the surveys came through, because it asked you certain questions and you do start thinking, 'Oh yeah, you could actually save energy here'.

Consequently, it appears that the positive impacts of engagement reported here may be at least partly attributable to the surveys themselves, which appear to have been used as a 'how-to' guide for making energy savings in some cases. Other interesting sub-themes to emerge in this category concerned environmental 'spillover effects' (10% of 117 responses in this theme). These have been defined as "the extent to which engaging in one behaviour influences the probability of conducting a subsequent behaviour" (Nilsson, Bergquist & Schultz, 2017, pp. 574). In line with previous research (Thøgersen, 2013; Lanzini, & Thøgersen, 2014), our results appear to suggest that participation in the programme had direct spillover to consumptive behaviours in other contexts, outside of the targeted domestic setting of the intervention, e.g.:

Yeah, and we've even got to the stage in the car, we used to go down to Tesco, which is about a mile and a half away, to buy a pint of milk, and you take the car. Actually it's

cheaper just to go to the shop that's within walking distance and buy the same pint of milk.

Because by the time you waste the energy in the car, you might as well just go and buy a pint of milk in the shop that's two minutes down the road that you can walk to.

In section 4.0 we return to a discussion of the theoretical implications of this finding.

3.3 Negative project impacts

Some participants were found to report the experience of negative affect or disappointment as a result of not learning how to engage in more effective energy saving practices in the pilot trial (16% of 113 responses in this theme):

I was very upset [not to learn more about my energy use] […] It's a shame. It's sad.

These comments were found to be relatively widespread, and may reflect shortcomings with the serious game pilot's implementation. However, the experience of negative affect as a result of this provides further illustration that the social housing participants were very willing to engage, and desired to learn about energy and change their behaviour. This provides further support for the potential for behaviour change in future interventions designed for this population. In addition, several subjects from the experimental group discussed usability issues with the EnergyCat game (22% of 113 responses in this theme), whilst others mentioned a lack of time for and/or interest in gaming (19% of 113 responses in this theme):

It was very tiny on the tablet so that was an issue. Then the instructions were not good.

You really had to sit for quite a while, and to be honest I just don't have the time.

3.4 Energy saving intervention development

Responses in this category concerned things that subjects would find most useful in future energy saving interventions. Subjects often referred to smart meter systems, or other

means of energy visualisation, as being the most effective method for communicating about energy (43% of 65 responses in this theme):

> *A smart meter would give you some visual idea. We had one of those meters, and that was good to watch because it tells you when you're going into the red if you're using too much. It made you think 'Maybe don't use that appliance again', or, 'Use something different'.*

Several subjects discussed how they would like a simple list of tips on energy savings (43% of 65 responses in this theme):

> *Yeah. Like a full printout of if you do this you can save this, so silly people can understand it like me! Like kilowatts and hertz and things, I mean, I don't understand any of that. If they just said you do this you save that, that would suit me fine.*

Other sub-themes centred around use of simplistic language (22% of 65 responses), e.g.:

> *They print it on the bill but I don't understand any of that. All these kilowatts and that, that don't mean nothing to me! I need it in English terms, not their technology […] Simplifying it would help a lot […] because people don't understand all that gas or electricity jargon.*

Some participants discussed how providing salient examples of how saved money might be used would also be useful for guiding behaviour change in this context (5% of 65 responses in this theme):

> *With smart meters it's pence per day that you're saving. So, when people say look after the pence, what you could do is have a little symbol next to it where it would say in 52 weeks if that was the money you were saving it would be the equivalent to a family day out for £100. Or, I don't know, if you saved this in a month it would equate to a new pair of jeans.*

3.5 Psychological barriers to behaviour change

This theme was found to concern psychological barriers to behaviour change, which had direct impact on participants' perceived ability to use less energy. In line with previous research into pro-environmental behaviour change (American Psychological Association, [APA] 2009; Pelenur & Cruikshank, 2012; Hafner et al., 2019a), some of the most prominent barriers to behaviour change were found to involve perceived behavioural control (23% of 73 responses in this theme), action inertia (in terms of a general reluctance to change) (16% of 73 responses in this theme), and a lack of awareness of the issue (6% of 73 responses in this theme):

> *[Direct debit bill payments] are like an ongoing recurring payment, and often now they charge you for paper billing, so unless you go and actually physically view it online, you kind of forget about it. I mean with mine I have to log on to see mine and if I don't have any internet, I just go, "Oh sod it I'll check it next week." Then I forget, it's one of those isn't it?*
>
> *Because children do think that everything's free, everything in this world is free. They just push that button on the wall and on comes this light.*

In terms of theoretical underpinnings, these results are consistent with the Theory of Planned Behaviour (TPB) (Ajzen, 1991), and the Norm Activation Model (NAM) (Schwartz, 1977); two of the most effective socio-psychological models in explaining engagement in pro-environmental behaviours. We later return to a discussion of these findings, in Section 4.0. Another important sub-theme to emerge in this category concerned the perception of comfort as a barrier to behaviour change (12% of 73 responses in this theme). For instance:

> *I'm always having to do secondary things like throwing blankets over me in the winter, and I don't think that's right. I shouldn't have to have blankets over me if I've got the heating on.*

This finding provides verification for the suggestion that it is no longer culturally acceptable to have to 'layer up' when the heating is on, which has been outlined as a key factor contributing to increases found in domestic consumption levels in recent years (DECC, 2013). In addition, in several instances participants mentioned problems with information provision as a direct barrier to behaviour change, either involving existing mixed messages or inaccessibility of information (8% of 73 responses in this theme):

> *The other thing I've learned, and this has always been a grey area. Some people tell you it's better this way, that way, is if you leave your heating on or do you turn it off? Some people say leave it on, and other experts say no don't […] You get this mixed message […] There just needs to be this clear message doesn't there, of instead of some people saying it is, and others saying it isn't. Then you sit there and think, 'Well who do I believe?'*
>
> *A lot of people say that they find it hard to find information as to how to best save energy.*

Identification of these problems reaffirms our earlier finding that participants were highly engaged with the topic of energy, yet there was a general perception that information on the best ways to conserve energy was both conflicting and inaccessible, constituting a considerable obstacle for those wanting clear information on how to change their behaviour.

3.6 Decision-making insights

This theme provided insight into the decision-making processes utilised in this context. One of the most prominent sub-themes to emerge was the idea of the programme being a 'kickstart' to overcome inertia and start to make behavioural changes (25% of 24 responses in this theme). This was discussed by subjects who reported positive behaviour change simply as a result of participation in the EnerGAware programme (as opposed to being the result of interaction with the game per se):

Yeah, it makes you a little bit more aware. I suppose that's why when people phone and they're asking for surveys on the phone, you get so many don't you, and you think, 'Oh God, not again' and put the phone down. But I suppose it sparks something in your brain and you think, 'Well I could do that'. I can understand why they phone because you could sit quite complacent and go along sort of thing, and it just takes something to make you realise.

It has helped a bit, but these are things that I had been thinking about I just hadn't been given the kick up the backside to actually do it, so it's helped in that respect.

This provides further illustration for the concept of action inertia as a prominent barrier to behaviour change in the context of energy demand (APA, 2009). Yet, promisingly, these results also suggest that simply engaging subjects in some kind of intervention scheme which encourages a greater level of cognitive engagement with the concept of energy can, at least in some instances, help to overcome inertia, providing the 'kickstart' needed to initiate behaviour change. Other interesting sub-themes found in this category concerned reflections on the behaviour change process (8% of 24 responses in this theme), and changing mentalities (17% of 24 responses):

I think everyone needs to get away from this it's only a couple of pence or it's only 5p. The other day, someone was saying, "Oh my energy bill," and I said to them to put a lid on the saucepan and stuff. "Yeah but that only saves a couple of pence." I said, "When you go food shopping do you take your own bags, or do you pay 5p every time?" "I take my own bags." I said, "Well why do you do that? Putting that lid on that saucepan is going to save you that same 5p, so where's the difference?" But it's getting away from this mentality. Because it works, I've brought my bills down by £100 a year and that's a huge amount of money.

In several instances, participants were found to discuss the need for a widespread shift In mentalities concerning energy usage, reflecting the need for people to hold a more stable mental representation of the concept of energy, and to understand the monetary value associated with usage of different appliances (implications of this finding are discussed in Section 4.0).

3.7 Social influence in energy behaviour change

The final theme to emerge concerned social influence in behaviour change, in terms of family members co-operating to helping each other to reduce waste (40% of 30 responses in this theme), e.g.:

> *My children really took it on board and really realised that if we do this, this, and this, we've got more money that we can spend doing something a bit more fun.*
>
> *I'm a bit careless, I sort of leave lights on all over the place! He's going, "You've left a light on again", "Oh yeah".*

Other sub-themes included the desire to reach out to a wider population and educate others on how they can use less energy (20% of 30 responses), and the need for widespread change (20% of 30 responses). For instance:

> *I've been to a lot of groups and it's a big thing that you hear a lot of, about energy and homes coming up to standard. A lot of people saying they live in older places and they're hard to heat. It's about getting this information out to them and saying, "Looks this works, just give it a go and you will notice a difference." I can vouch for it, it does work.*
>
> *I think if everyone just made a few small changes, it would make a huge difference in everyone in the country or round the world.*
>
> *I think it all ties into efficiency and everyone kind of getting on-board with being a bit more efficient about things.*

4.0 Discussion

The main aim of this research was to provide in-depth qualitative insight into domestic energy consumption practices within the UK social housing sector. In a series of interviews we explored subjects' decision-making processes, and the psychological barriers to behaviour change which continued to prevent residents from using less energy. In addition, we also aimed to gain feedback on the perceived usefulness of varying intervention techniques in encouraging engagement in the topic of domestic energy use. The interview sessions provide a useful contribution to the behaviour change literature in the context of energy demand, within which vulnerable populations have previously been largely overlooked. We now provide discussion of key insights gained from these interview sessions, in order to provide a framework of theoretically grounded suggestions designed to maximise the likely effectiveness of future intervention development in this context.

Results indicated that social housing residents were highly engaged in the topic of energy use, and often displayed a great willingness to change. However, serious gaming was not perceived to be a suitable approach for reaching this target population, given the lack of time for and/or interest in gaming frequently reported. In terms of intervention techniques that may be more effective, subjects often reported smart metering specifically, or a more general preference for an interactive tool providing real-time visualisation of their own household consumption. This is in line with previous research which has found visual tools can be highly effective in reducing consumption (see, Goodhew et al., 2015). Importantly, many subjects mentioned how such a tool should be easy to access, and should not be time intensive to use. Subjects wanted an interactive tool which would provide instantaneous consumption feedback, alongside hints and tips on energy savings. Existing SEM research has shown the importance of such feedback in changing behaviour (Schultz et al., 2015). However, it would be interesting for

future research to explore whether the inclusion of 'how-to' hints and tips within a smart-metering system which are tailored towards high consuming appliances or behaviours may help to further increase the effectiveness of such strategies. The fact that many subjects responded so positively to the surveys (often used as a form of 'how-to' guide), shows that such a strategy may have substantial potential for motivating behaviour change in this sector. It is also important to note that many people wanted information provided in simple language that was easy to understand, and which avoided overly technical 'gas or electricity jargon'. We suggest future behaviour change efforts should aim to incorporate this in order to maximise likelihood of engagement from this population.

In terms of sketching out directions for further research, we suggest that future efforts may wish to focus on the development of a multi-pronged approach to household energy intervention design, which incorporates each of the above mentioned strategies identified in our research (i.e. a visual tool which provides real-time feedback, alongside hints and tips, using simplistic language) in order to maximise the likelihood of successfully initiating energy behaviour change in domestic households. This suggestion is in line with the findings of Chelleri, Kua, Rodrigues, Nahiduzzaman and Thondhlana (2016), who explored how households could be encouraged to adopt energy saving behaviours using a variety of different intervention techniques (see also, Nahiduzzaman, Aldosary, Abdallah, Asif, Kua & Alqadhib, 2018). Chelleri et al., (2016) found that whilst technology alone was insufficient in driving behaviour change, the aggregation of several different intervention strategies (including distribution of informational leaflets and stickers, monthly feedback on energy saved and community group discussions), was successful in motivating reductions in domestic energy usage. Chelleri et al., (2016) suggest this indicates that interventions may be more effective in promoting energy conservation and

reduction when applied conjointly rather than separately, and we suggest that future efforts may wish to use this approach in order to target behaviour change in the social housing sector.

In addition, we identified many psychological barriers which prevented subjects from using less energy. Consistent with previous research into pro-environmental behaviour change (Ölander, & Thøgersen, 2014; APA, 2009; Pelenur & Cruickshank, 2012; Hafner et al., 2019a), two commonly cited barriers were action inertia, and a lack of awareness of the issue. Several subjects mentioned how easy it was to simply "carry on as normal"; either lacking the awareness or motivation to re-engage with the topic. What is more, our results suggest that the ease of cognitive disassociation between immediate engagement in energy consumptive behaviours and later-term costs further reinforced the continued impact of these barriers on behaviour, due to the temporal distance between effortful action and reward (see also, Frederick et al., 2002). However, we found that engaging subjects in an energy saving intervention was enough to initiate re-engagement with the topic in some instances; with several subjects discussing how the programme provided them with the 'kickstart' needed in order to change their behaviour. These results are promising, and suggest that future schemes which provide improved educational functionality in terms of *how* to change, and increased motivation as to *why* subjects should change (in terms of providing clearer information on potential savings) may be sufficient to increase engagement with the topic and begin to increase awareness and overcome inertia.

Other notable barriers to behaviour change concerned problems with information provision. Specifically, in several cases, subjects discussed how mixed messages from different sources were a key barrier preventing them from reducing their consumption levels. In order to address this, we suggest that one agency, such as the Energy Saving Trust (EST), could usefully be presented as the 'gold standard' for energy savings information in future schemes. If future

trials point to the EST as a source of clear, non-conflicting, non-biased information on the most effective ways to save energy, this may help to overcome the problem of existing mixed messages and thus enable behaviour change. In terms of the problem of information accessibility, given the low levels of IT literacy and access issues found in the social housing sector, it may be most useful to present this information in leaflet format, which can be referred to without having to use a computer or access the internet. Moreover, direct social interactions via community events and face-to-face contact seems to have enormous potential especially in this group of householders, and could provide social co-benefits in terms of greater peer support and communication. Indeed, Westerhoff, Sheppard, Iype, Cote and Salter (2018) state that direct community interaction can provide a useful platform for the implementation of climate action intervention schemes, as this helps to localize climate change and ground abstract ideas in specific places. Alternatively, and as previously discussed, future research could also explore means of incorporating energy-savings information into an integrated SEM system which provides real-time feedback on consumption levels. Given the higher age demographic typically associated with social housing, and the fact that some people avidly desired to avoid "*anything* technical", we suggest that future research may wish to focus on development of both means of information provision, in order to satisfy the varying needs of this population, thus maximising likelihood of widespread engagement.

Our results also provide insights into the role of social influence in determining domestic energy demand. Specifically, several subjects discussed how family members were now co-operating to reduce household consumption, suggesting that participation in interventions such as this can provide a starting point for establishing new households norms (Shove, 2003). In addition, in some cases subjects were so driven by renewed interest in the topic of energy saving that they reported a desire to reach out and help others take action. In some cases,

subjects reflected upon the need to have a social ambassador, who could vouch for the effectiveness of such a scheme (see Section 3.7). This is a highly intuitive suggestion, given that previous research has shown people are more likely to act if they can see others have already tried the process and have reported positive outcomes, as this reduces the psychological risk associated with taking a step into the unknown (Schultz, Nolan, Cialdini, Goldstein & Griskevicius, 2007). Consequently, use of 'social ambassadors' during promotion of new intervention schemes is likely to form an effective means of encouraging widespread uptake; a principle already incorporated behaviour change schemes in other contexts (e.g. 'Altogether Better', 2018). We suggest incorporating a similar process into future energy saving intervention schemes designed to reach this population. Ideally, this strategy should be incorporated into the multi-pronged approach to intervention design discussed earlier, in order to maximise likelihood of successfully initiating widespread behavioural change in domestic energy demand.

In addition, in several instances subjects were found to discuss the need for a widespread shift in mentalities concerning energy usage, reflecting the need for people to hold a more stable mental representation of the concept of energy, and to understand and appreciate the monetary value associated with usage of different appliances. This is in line with previous research which has found that a lack of a clear concept concerning energy is one of the most problematic issues when it comes to changing behaviour in this context (Burgess & Nye, 2008; Fischer, 2008). Many subjects reported positive benefits of taking part in terms of increased awareness. Consequently, these findings are promising as they suggest that simply engaging people in an educational intervention can be enough to overcome some of these effects, and can help people to form a more accurate and meaningful representation of the concept of energy in some instances.

Relatedly, we also found that environmental 'spillover' effects generalise to the context of energy consumption, and that increasing awareness about energy in one instance can spillover and impact on consumption in other areas, providing support for previous research. For instance, Littleford, Ryley, and Firth (2014) reported a contextual positive spillover effect of energy saving behaviours between work settings and home settings. However, these effects were found to be strongest for behaviours that shared equipment between the two settings (e.g. use of lights or equipment). Further, Frey (1993) suggested that spillover effects are more likely to occur when the contexts share similar material and process. Consequently, ours is the first study, as far as we are aware, to provide evidence for a positive contextual crossover to engagement in specific behaviours designed to reduce energy consumption in which the behaviours are conceptually disparate (e.g. energy use in domestic settings vs. transport mode choice). We suggest that the contextual crossover evidenced here may be the result of the deepened understanding of the concept of energy reported, in some instances, as a result of taking part in the intervention programme. Consequently, our results provide support for the potential crossover effects that may be achieved in future intervention strategies, if these place emphasis on increasing understanding of energy as a concept (Burgess & Nye, 2008).

In terms of theoretical underpinnings, our findings are consistent with previous research into the Theory of Planned Behaviour (TPB) and the Norm Activation Model (NAM) (Ajzen, 1991; Schwartz, 1977). These are widely regarded as two of the most effective socio-psychological models in predicting and explaining pro-environmental behaviours (de Groot & Steg, 2009; Steg & de Groot, 2010; Nguyen, Hung, Lee & Nguyen, 2019). The TPB posits that behaviour is determined by intentions, which are, in turn, influenced by three conceptually independent constructs, consisting of attitudes towards the behaviour, subjective norm (social influence or pressure to perform a behaviour), and perceived behavioural control (PBC) (the extent to which

an individual believes they are capable of successfully performing the behaviour) (Ajzen, 1991). Whilst according to the NAM (Schwartz, 1977), a person's pro-environmental behaviour is predicted by three core components: awareness of consequences, ascription of responsibility, and social norms (de Groot & Steg, 2009; Steg & de Groot, 2010).

The theories have been used to effectively predict engagement in many pro-environmental behaviours, including water saving (Lynne, Casey, Hodges & Rahmani, 1995), recycling (Mannetti, Pierro & Livi, 2004), and the uptake of home energy efficiency measures (Jager, 2006, Hafner et al., 2019a). Similarly, Wang, Guo and Wang (2016; see also, Wang, Guo, Wang, Zhang & Wang, 2018), found that the TPB effectively predicted behavioural intentions to recycle e-waste (electrical and electronic waste); whilst Bozorgparvar, Yazdanpanah, Forouzani and Khosravipour (2018) found evidence for both models in explaining farmer's acceptance of renewable energy in Iran (see also, Akbari, Ardekani, Pino & Maleksaeidi, 2019).

Our results are similarly consistent with both theoretical models, and provide insights into the role of each constituent factor in determining engagement with domestic energy saving. For instance, the issue of awareness was discussed directly by participants, and is further evidenced by the positive contextual spillover effects demonstrated, which appear to reflect a deepened understanding of energy as a concept. Our results are also supportive of the role of PBC and social norms in determining engagement in household energy saving behaviours, and we have made suggestions as to how we may capitalise on these psychological determinants, in order to: a) increase understanding of energy as a concept, b) increase the availability and accessibility of information, c) increase perception of personal capability/responsibility, and d) establish and promote new social norms surrounding domestic energy saving practices. We suggest that future behaviour change efforts which effectively encompass each of these drivers may have the greatest chance of achieving lasting behaviour change in this context.

4.1 Conclusions and recommendations

In all, the current research provides in-depth insight into domestic energy consumption practices in the UK social housing sector. We used a sample of subjects who were uniquely positioned to provide feedback on energy perceptions and energy saving intervention development, having recently taken part in an energy saving intervention trial. The issues discussed in the interview sessions were raised spontaneously by participants themselves, thus providing a reasonably unconstrained reflection of factors impacting upon decision-making processes in this context. Results provide a generally positive picture of the potential for energy behaviour change in the social housing sector. Specifically, residents were found to be generally highly engaged with the topic of energy, and displayed a willingness to change. In addition, many subjects reported positive impacts of taking part in the EnerGAware programme; with some stating they had used the surveys as a simple form of 'how-to' guide for making savings. Given the positive response to such a simple intervention format, and the positive 'spillover' effects reported by some subjects, which appeared to reflect a deepened understanding of the concept of energy, our results suggest that there remains substantial potential for initiating positive energy behaviour change in this sector.

Yet, digitalised serious gaming solutions were not found to be an optimal strategy for reaching this target population. Participants were often time poor, or were simply not interested in digitalized or 'technical' intervention techniques. However, we recognise that this finding may be, to some extent, attributable to limitations of this version of the EnergyCat game in particular. Thus, if improvements were made in order to provide users with a less time-intensive, less complicated, version of the game, then there may still be potential for users in this context to achieve energy savings following an intervention period. We have discussed how future schemes should focus on using a multi-pronged approach to intervention development in

order to maximise cross-sectional behaviour change potential in this context, and future efforts may wish to further explore the potential for ICT based solutions to enable behaviour change when used in conjunction with the additional strategies identified in the current research. This remains a promising avenue for further research. We have also provided suggestions for future research which can begin to overcome some of the many psychological barriers identified in the current research, including action inertia, lack of awareness of the issue, and problems with information provision.

Our results also suggest that social influence may play a pivotal role in ensuring continued engagement with the topic of energy, and we suggest that future interventions should encourage interactions around the topic of energy amongst family members, as well as focusing on development of peer-based schemes (see, Westerhoff et al., 2018), as part of the multi-pronged approach discussed above, in order to help to establish and cement new social norms and foster support for climate change action. At present, social norms surrounding energy use are unclear, which is one explanation for lack of attention to energy use (Shove, 2003). Building on the serious gaming literature (Waltz & Deterding, 2015), and insights from the theory of planned behaviour (Ajzen, 1991), and the norm activation model (Schwartz, 1977), we suggest that incorporating elements of gameful design into new, multi-faced, integrated SEM systems which encourage interactions around the topic, and competition between household or community members, may provide a useful step for encouraging further reductions in energy demand. Such schemes should also endeavour to utilise social ambassadors in conjunction, in order to reach wider populations and encourage continued engagement. We believe that together these ideas constitute a theoretically grounded framework for future intervention development in this context; ultimately bringing us one step nearer to achieving the goal of collective reductions in domestic energy demand.

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