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Technology, users and everyday lives: the installation and use of heating systems and energy efficient technologies in UK households

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Introduction

The domestic housing sector in the United Kingdom (UK) accounts for more than 25% of carbon dioxide emissions and is generated by more than 26 million homes (Swan et al 2010). Rising energy costs which impacts on the number of households living in fuel poverty (Hills 2012) and the concerns of the so called 'squeezed middle' (Miliband 2011) has made the rollout of sustainable retrofit measures within the domestic housing stock a key policy in the UK (Boardman 2012, Ravetz 2009).

Sustainable retrofit can be defined as the upgrading of the building fabric, systems or controls leadng to an improvemen in the energy performance of the property. Within the UK there have been a wide number of programmes to deliver this improvement; the Carbon Emissions Reduction Tariff (CERT) (Druckman and Jackson 2008), Warm Front (Gilbertson et al 2006) and the Community Energy Savings Programme (CESP) (Reeves et al 2010), for example. The recently released Green Deal (DECC 2010) and Energy Company Obligation (ECO) (DECC 2010) continue the policy commitment to domestic retrofit. However, it has become increasingly recognised that understanding the behaviour of users/occupants in terms of both take-up (adoption) and day-to-day use represents a major issue for the success of retrofit programmes (Chahal et al 2012). A MORI poll undertaken for the UK government, which investigated the adoption of cavity wall insulation, highlighted a wide range of reasons for non-adoption (HM Government 2010) including: a lack of understanding, cost, fear of disruption, lack of knowledge and apathy. However, even if households adopt new technologies issues arise around how those technologies are then used within the context of everyday lives and within dynamic of their home environment (Summerfield et al 2010). What is apparent is that new technologies, once they have successfully crossed the domestic threshold, come into contact with engrained, often complex, practices and contribute to a gap between designed and actual performance (Wingfield et al 2008).

The Installation of Energy Efficient Measures

Currently, the market for energy efficient measures can be viewed as emergent (van Sandick 2010). To a certain extent basic measures, such as loft and cavity wall insulation, have been adopted by a number of households in the UK. The adoption of these has largely been driven by incentives such as those used in the CERT and CESP programmes. However, more sophisticated and technologically demanding retrofits remain in the stage of early adoption (Rogers 1995).

Although some owner-occupiers have taken on the role of 'pioneer' (Government Office of Science 2008) most of the general retrofit has been made possible through the social housing sector. Indeed, the social housing sector has been consistently seen as a useful 'test bed' for the sustainable retrofit market (HM Government 2010). Driven by the availability of existing expertise in the sector, such as asset managers, building surveyors and project managers (Jenkins 2010), the social housing sector also understand their local areas, supply chains and social landlords are often seen as trusted messengers. This poses opportunities to circumvent many of the issues preventing wide-scale deployment of retrofit measures to the private sector and begin to understand the issues associated with mass deployment of technology. This is explicitly stated by E-On in the Challenge 100 study, where it was deemed essential to have public sector involvement to support engagement (E-On 2010).

To some extent those in the social housing sector, including the landlords themselves, are in an experimental state. The learning coming out from the deployment of measures will help inform the delivery of retrofit to the majority population over the next few years. Worryingly little evaluation is occurring within the area – with the exception of those landlords who have the capacity to self-evaluate their programmes (e.g. Willey 2012). Of the information that is being collected it is not clear what, if any, is being fed back to either policy actors or those responsible for the development and deployment of technology. This is particularly concerning as the retrofit industry is currently in an infantile state and ultimately fragile against the market economy to which it is now particularly vulnerable. Significant public concern about the utility of retrofit measures and their performance will more than likely set the industry back years thus having a direct impact on our ability to meet emissions targets. For example one recent report in the UK has indicated that a number of social housing landlords are discontinuing the installation, and in some cases removing, a number of air source heat pumps from residents' homes (Inside Housing 2012). The precise cause of the problem is not clear but the result has been higher than expected costs of energy, above those incurred by a traditional heating system, levied at tenants who thought their bills would reduce. The UK Government Department of Energy and Climate Change (2012), undertaken with the UK's Energy Savings Trust, indicated that the specification and installation of heat pumps represented a major issue, while anecdotal evidence from practitioners indicates that the change in heating practices, such as consistent low temperature heating and changed ventilation practices, have not been effectively communicated to end users. While both factors contribute to ultimate energy use, here we consider the resident experience.

Using and Living with Retrofit Measures

The gap between as designed and as performs energy efficiency of properties is well documented in new build homes (Wingfield et al 2008) and many of the reasons can be logically extended to refurbished homes. Factors such as installation and build quality, specification and behaviour are all contributing factors.

However, another key factor that influences energy use, is the inability of individuals to effectively manage energy use within their homes. The use of controls is highlighted as a significant part of energy use, yet their design and, ultimately their use, creates problems for people (Peffer et al 2011). New ventilation and heating

systems may require different approaches. Moving from a gas-fired heating system with radiators, requires a different pattern of use to air-source heat pumps with under floor heating. For certain groups of householders, such as older people, new technology often presents additional challenges in the way they are understood, programmed and accessed all of which compromise the predicted efficiency of retrofit measures (Lusambili et al 2011). Similarly, for technologies, such as photovoltaic micro-generation, these can be seen to require a paradigm shift in the way in which people went about their daily lives as their consumption behaviours shift in line with the demands of the technology, and the unpredictable weather (a key factor in the UK) (Bahaj and James 2007).

There is a sense, implicit in much of the research emerging in this area, in which those responsible for retrofit are blaming householders for the lack of efficiency found after retrofitting homes and the presence of the performance gap. The current dominant response by industry, as well as policy makers, seems to rely on the provision of more information. Such information aims to improve 'customer' knowledge about 'correct' energy practices and their interactions with technology thus contributing to that current popular ideal of 'behaviour change'. However, research is beginning to show that the mere provision of information about how to use technology does not necessarily result in greater efficiency. For example a study from Bahaj and James (2007) on the use and efficiency of photovoltaic (PV) technology, showed that whilst information initially appeared to produce a marked reduction in consumption for people with PV installations, after 12 months energy consumption had returned or exceeded previous levels.

This suggests therefore that although we are aware that there is a performance gap, between predicted and actual use, we know comparatively little about what meaning and significance the presence of retrofit measures has for households. As such we still do not have adequate feedback from householders about what factors might close the performance gap and how this understanding can be used to improve the roll out of these technologies. Moreover, we know very little about the concerns and issues facing those responsible for the delivery of retrofit measures into homes (such as social housing landlords) and the lived context in which they are working. We also know hardly anything about how far those responsible for designing and installing technology are taking account of how people live, their actions, their practices, their preferences and concerns. Heaslip (2012) has argued for the need for those involved in low carbon design to embrace the notion of usability (Norman, 1998) in order to provide a useful conceptual bridge between technologists and social scientists. Generating a greater understanding of all these issues are at the core of the project that forms the basis of this paper.

Bridging the divide: overview of the study

This paper reports on emerging findings from a study that looks to develop a better understanding as to how retrofit technology can be more effective at addressing energy efficiency in the domestic housing sector. The study pays particular attention to the experiences of low income and vulnerable people in the social housing sector. The study, funded by the UKs Engineering and Physical Research Council (EPSRC), has entailed a social scientist (Brown) working more closely with technologists and both within his institution and outside. The intention behind this has been to allow a

better understanding to emerge as to the challenges faced across the socio-technical divide. Part of this work has been to engage in discussions leading to a greater sense of mutual understanding as to the potential contributions differing perspectives can bring to the area of low carbon design and retrofit. The other part of this work has resulted in a research study that has focused on improving what we know about people and their everyday lives and how retrofit technology is developed, supplied and installed in households. The research component has three main aims:

1. To better understand the issues faced by technology providers, developers and housing providers when supplying energy reducing technologies to vulnerable households
2. To better understand the barriers and concerns to participating in energy reducing programmes by vulnerable households
3. To develop a co-developmental link between technology providers, developers and housing providers and vulnerable households in order to better address fuel poverty in the UK.

A number of methods are being deployed in the study including: the production of a systematic literature review, analysis of existing survey datasets, focus groups and interviews with tenants and landlords, user-design workshops and interviews with manufacturers and installers of retrofit technology. This paper reports on issues emerging from a preliminary analysis of the data from the qualitative research with tenants. The data here draws on six focus groups involving a total of 34 participating tenants, 15 in-depth one-to-one interviews with tenants and a user-design workshop containing six people.

The analysis is selective in order to illustrate some of the themes and issues arising from the experience of non-technicians (householders) when coming into contact with retrofit measures and technology.

Emerging findings

Three key themes, arising from the data, are discussed here. These are: the experience of householders of getting the measures installed in their homes; what their experiences have been in learning to use the measures; and, how people have been seen to narrate their 'resistance' to this particular 'technologisation' of their homes.

Getting measures installed

Some of the problems experienced by residents were those that could be seen as process issues; that is how the measures were introduced into the domestic environment. Similar to findings from other studies (Gilbertson et al 2006) it was quite common for people to complain about the disruption and inconvenience caused by having 'workmen' in their home or having to prepare their home for the measures (particularly prevalent when loft insulation was installed and the space had to be cleared).

> *The thing is with loft insulation, I'd partly … we put it in ourselves and then we boarded it. When they came round and said we've only got six inches and*

it needs to be eight inches, I was going to pull all my walls up and put it in again. There is no point.

We don't. I couldn't empty the loft when they came round to do it. Because I couldn't empty it they wouldn't do it so it never got done.

However, where they had experienced a shift – particularly in terms of heating systems – residents tended to express concern as to whether the new equipment would work or not. This was a particular concern for one person as they were moving into a new home with a young family during the winter period:

I was quite worried. Obviously, it's your heating is everything, isn't it? I kept thinking, is it going to be a nightmare. Is it going to keep switching off? Am I going to be able to control it right? That was it really. The cost was, I don't know, I was a bit scared at first…it was like, oh my god. Am I going to be warm? Is it something that's got to stay if I don't like it? It was all them thoughts that went through my head.

Learning how to use technology

However, one of the areas we have focussed on throughout the qualitative work so far has been how people were learning to use the new technology that had been installed. There were some comments from tenants that the landlord, or the contractor, had provided some instruction as to how to use the new system. It appeared though that this was minimal and, for some people, insubstantial:

Int: *Were you shown how to use a new boiler.*
P1: *Only a one day effort.*

For other people the length of supported familiarisation with the new equipment had been significantly less than this:

He just went upstairs and he went, "right", he said, "don't touch anything on this. We [the landlord] don't really know what we are doing. Only such a body can deal with this solar. If you just want to—if you want your radiators on, just press on there and then press that to turn it off and that was it".

For this tenant the power to control their home environment had all been removed as a result of their landlord warning them against adjusting the control system to their heat pump:

P1: *That's it. The only thing we have is an on and off button. We are not allowed to touch anything else.*
Int: *You've said that a couple of times now. You are not allowed to.*
P1 :*This is what we've been told right from the beginning is, it's all new. We don't know the full thing of it yet. Don't touch this and don't touch that.*

In this case, and for this landlord, the apparent restrictions on use appear to arise due to the lack of familiarity they have with the technology. So, not only are householders living with unfamiliar technology the people responsible for ensuring the technology

is installed correctly are also unfamiliar with how it should work.

People, however, rarely reported being satisfied with not knowing how the technology worked and so it has been very common to hear that people have taken a degree of agency and sought to learn about how best to operate the equipment. Aside from personal research on the Internet, the most common way people used to learn about the technology was by calling upon knowledgeable 'others' such as their family members, friends and neighbours. There was a sense that people would seek out those who 'knew about computers and technical things':

> *My daughter is quite good, she's sent it down and advised I know she's checked. I've got it on that little thing, we had one on the wall.*
>
> *I'm lucky, I've got a son who is technical. He teaches me these things and I can say to him, because you can say, bloody well slow down. Just show me and show me in plain English what I'm doing and where I'm going wrong. That is how I do my computer.*
>
> *My mother is 84. She quite often gets confused with any new equipment at all. We do have to sit down and explain everything to her. I think the elderly do need more help.*

Alternatively, people in the local area who were known to take an interest in energy efficiency were often used as key sources of knowledge, as one participant recounted, "*a lot of people come with problems to me"*.

Lusambili et al (2011) found a similar reliance upon social networks in their research. In their study, those people who were most excluded, lacking in connections in their social networks, often did not know how their system worked. However, Lusambili et al point out that even those who relied on their social networks to understand how their system worked did not mean that they used the technology efficiently. It simply meant that there was other people who were able to understand the principles for the control interface, not how the heating system as a whole worked. This, they found, can led to inefficient use of systems thus compounding the performance gap.

Resisting technology

For a number of people we have spoken to, learning how to use their heating system provoked significant levels of discomfort. One person talked about how learning technology, which he was not particularly engaged in, was just 'aggravation':

> *I'm 58, so I consider myself to be, even though I'm technically aware of technology to put it bluntly. Unless it's something I'm really interested in, I just don't want to know. I don't want the aggravation of having to work it all out and see how it works and then do it. Older people than me think housing associations tend to have a higher proportion of older people rather than younger people who shy away from technology completely anyway.*

For a number of people the technology, specifically the way the technology was controlled, was seen as mysterious and a number of people objected to being made to feel like a non-expert of their own home:

> *If I start turning off switches … I'm not an idiot. Obviously, these switches are to do with the immersion, but is it all right to turn them off turn both of them off or something. Something needed to be done. I don't know what the one switch is doing. It's hasn't stopped the water from coming out boiling.*

A number of people openly acknowledged that they did not understand how their systems worked, and implied that they realise they are probably not using them efficiently:

> *I can't say I fully understand. But I understand enough to work them, I think.*
>
> *I'd understand it if mine worked efficiently or properly, but it doesn't.*

When tenants had serious problems with the new technology, particularly where it was malfunctioning, this led to a new crisis of expertise within the landlord. Often the social housing organisation did not have the necessary expertise to advise on resolving the fault and residents had to wait a number of days, and in at least one instance, a number of weeks to have their system repaired:

> *If you rang up [the landlord] it was like, we don't deal with that…It would have to be a certain person that came. That's who we would be waiting for like two or three weeks this person to come out.*

Conclusions

These are early findings from a project that has involved the production of empirical research but also softer engagement by the authors in areas outside their usual comfort zone.

The findings discussed here throw new light on some of the issues arising when households are asked to adopt and use measures and technologies that aim to make homes more energy efficient. Numerous issues emerge, not least of all the apparent lack of intuitive design inherent within many of the key retrofit technologies currently being pushed to the market. This appears to have the potential to maintain the performance gap unless more attention is paid to understanding and responding to the issues arising. Furthermore, it is worrying that not only are retrofit measures being seen, almost as, an invasive and mysterious technology by the householders; this sense appears also to be shared by their landlords. At the moment the key actors in the social housing sector who have to either live with or use the technology have little idea as to how they work and have concerns about inappropriate use.

Some interesting discussions are being held between the social scientist in this study (a psychologist in this case) and technologists and it is clear that there is an awareness of the need to accommodate what social science has to offer into the development of low-carbon retrofit technology. It seems as though integration between social science and policy is showing signs of process, for example within the department responsible

for these issues in the UK (DECC) there is a specialised team of social scientists set up to help grapple with some of these issues. However, there appears a lack of understanding about how best to utilise the skills of social scientists (such as psychologists, sociologists and anthropologists) alongside technologists. The need for there to be a successful integration between those involved in creating and delivering policy, developing and installing technology, and people is clear within the sustainable retrofit arena. At the moment however, it appears as though there is disconnect within the supply chain. This disconnect manifests in terms of the practical challenges faced in ensuring technology is installed within people's homes (Lusambili et al 2011) but there also appears to be an ideological disconnect. The ideological disconnect potentially arises as a result of technology being developed in isolation from the needs and actions of the end user. Part of this, as Heaslip (2012) notes, is a usability issue as those involved in buildings, and in homes in particular, are still not fully engaged in how they will be used – when compared to more general product design (Leaman 2000; Stevenson & Leaman 2010; Rubin & Chisnell 2010). In turn, the complexity of human behaviour can be overwhelming and it may be that technologists do not know how or where to start accommodating this. However, social scientists must look inwards and examine how well the knowledge held within the discipline about people and their practices can be best transferred to technologists and policy makers.

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