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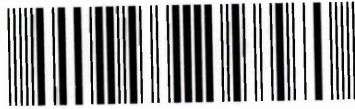
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Using Qualitative Methods to Understand Non-technological Aspects of Domestic Energy Efficiency

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Published works submitted in partial fulfilment of the requirements of Sheffield Hallam University for the degree of Doctor of Philosophy on the basis of published work

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Contents

I. List of publications

Ref no	Details of publication	My role in publication preparation
1	Walshaw, A. (2011) From House to Home: Residents' Perceptions of Housing Modernisation. *Journal or Urban Regeneration and Renewal*, 4 (3), pp. 269-278	**Sole author.**
2	Goodchild, B. and Walshaw, A. (2011) Towards Zero Carbon Homes in England? From inception to partial implementation. *Housing Studies*, 26, (6), pp. 933-949	Both authors had **equal input** into the development of the paper. The writing of the paper was divided between the two authors.
3	Ambrose, A. (2013) User and organisational responses to biomass district heating. *Journal of Urban Design and Planning,* 167 (1), pp. 35 –41.	**Sole author.**
4	Goodchild, B., O'Flaherty, F. and Ambrose, A., (2014). Inside the eco-home: Using video to understand the implications of innovative housing. *Housing, Theory and Society, 31*(3), pp.334-352.	**Second author.** Authors were ordered incorrectly in final version[1] (see footnote).
5	Ambrose, A.R., 2015. Improving energy efficiency in private rented housing: Why don't landlords act? *Indoor and Built Environment*, p.1420326X15598821.	**Sole author.**
6	Ambrose, A., Eadson, W. and Pinder, J. with Gilbertson, J. and O'Flaherty, F. (2015) *Low Carbon Pioneer Cities Heat Networks Project: a process evaluation*. London: DECC	I was the **lead author**, citing other key members of the research team as co-authors as is conventional.
7	Ambrose, A., Eadson, W. and Pinder, J. (2015) *Evaluation of the Big Energy Saving Network*. London: DECC	I was the **lead author**, citing other key members of the research team as co-authors as is conventional.
8	Ambrose, A., Eadson, W. and Pinder, J. (2016) The role of actor-networks in the early stage mobilisation of low carbon heat networks, *Energy Policy*, Volume 96, September 2016, P. 144-152	I was the **lead author** of this paper, taking the lead on all aspects of its preparation with some input from other key members of the research team.

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[1] This paper was jointly authored with Barry Goodchild and Fin O'Flaherty. I was the second author responsible for research design and data collection. I also drafted sections of the paper, with Barry Goodchild having overall editorial control. The ordering of the authors was initially intended to be alphabetical, using my then married name Walshaw. Near to publication I decided to revert to my maiden name Ambrose. Unfortunately the order remained the same as before.

II. Abstract

The overall aim of the collected published works is to investigate how different policy interventions in the field of energy efficiency (including zero carbon homes, low carbon heat networks, and domestic energy efficiency schemes) are experienced and made sense of by a range of key actors. A further aim is to understand these interventions in the context of existing theories within the field of domestic energy efficiency including socio-technical theory and Actor Network Theory.

More specifically, this research advances existing knowledge in the following areas:

- The nature of the socio-technical challenges encountered in the introduction of more energy efficient buildings, and the importance of achieving a balance between socially acceptable and technically optimal environments. (Papers 2, 3, 4, 6 and 8)

- The value of qualitative research in gaining a more nuanced understanding of our relationship with the home and the implications of this for domestic energy efficiency interventions and the design of low energy buildings (all papers).

- The influence of tenure as determinant of access to a more energy efficient home and in particular, the stubborn and complex barriers to achieving higher standards of energy performance within the private rented sector. (Papers 1, 2, 3 and 4)

- The significance of identity, setting and notions of home in the context of domestic energy efficiency interventions. (Papers 1 and 4)

As these themes suggest, this PhD is not just concerned with carbon reduction and energy saving as technical objects, but as a way of life. More specifically, it considers the interactions between the two and contends that technical or policy instruments, no matter how sophisticated, cannot succeed if they are not compatible with our ways of life (and ways of doing business) or if our ways of life cannot be reasonably adapted to accommodate them.

III. Acknowledgments

I would like to extend my sincere and heartfelt thanks to the many people who have supported and encouraged me in my research over the last four years as I worked towards the submission of this thesis. I must first thank my wonderful family who have all demonstrated such belief in me: Dr Hywel Jones, Sally Cox, Bob Ambrose, Samantha Ambrose and Jane Cox. I must also extend special thanks to my supervisors Professor Paul Hickman and Professor Barry Goodchild who have guided me so diligently through this process. I am also grateful to Professor Ann Macaskill for her guidance and to my co-authors Barry Goodchild, Dr Fin O'Flaherty, Dr Will Eadson and Dr James Pinder, who have all proven to be such collegiate colleagues. There are many friends I must thank, but in particular, I am very grateful to Emma Wells, Laura Stephens, Sadie Parr and Nadia Bashir for their unrelenting encouragement.

I dedicate this thesis to my late Grandfather, Ernest Ambrose and my daughter, whom I am yet to meet.

IV. Ethics statement

All of the research linked to this thesis has received full ethics approval from the Sheffield Hallam University Research Ethics Committee.

V. Critical appraisal of published works

1. Introduction

1.1 Background

Housing accounts for more than a quarter of energy use and carbon dioxide emissions in the United Kingdom (UK), far outweighing the energy demands of both industry and transport (Palmer and Cooper, 2013). This situation is not unique to the UK: the energy and carbon burden associated with domestic dwellings is a global challenge and is critical to the attainment of policy agendas including carbon reduction, energy security, the eradication of fuel poverty and allied to this, the improvement of health and wellbeing.

Improving the energy performance of domestic buildings is therefore an area where some of the greatest gains stand to be made in terms of carbon reduction and allied policy goals, but equally, as the publications herein reveal, the home is also one of the most complex environments in which to achieve reductions in energy use.

However, it should be noted that this thesis is not just concerned with improving the potential for carbon savings in domestic buildings, but is also driven by an underlying concern for the promotion of social justice in the context of domestic energy efficiency. This focus is implicit in the concern- expressed throughout- for extending access to low energy buildings by establishing them as a mainstream rather than a niche product. It is also evident in those publications highlighting the inequality of experience that exists between different housing tenures with regards to access to the benefits of a more energy efficient home. In this sense, the fact that access to an energy efficient home (and the associated benefits of reduced energy costs,

avoidance of fuel poverty and attainment of warmer homes in winter) remains the preserve of the few and not the many is regarded as a form of social injustice. This perspective is informed by the work of Walker and Day (2010) who argue that a compromised ability to access energy services and thereby to secure a healthy living environment and avoid fuel poverty are expressions of social injustice.

I am not the first to explore the challenges associated with improving domestic energy efficiency and allied issues of social justice and a significant amount of research has already been conducted in this area. However, the knowledge generated thus far is fragmented in nature, having emanated from a range of different disciplines. The relevant bodies of literature and theoretical frameworks are reviewed in section 2 and are best understood as a series of seven clusters, emerging respectively from architecture and building science; sociology; housing studies and from the theoretical positions of Socio-Technical Theory and Actor Network Theory. Each body of knowledge raises new considerations for the study of domestic energy efficiency but also leaves gaps, to which my own work seeks to respond.

As such, my research has operated at the interfaces of housing studies, energy studies and planning, providing a rare interdisciplinary perspective on the issue of domestic energy efficiency. Overall, the programme makes a series of original empirical, conceptual and methodological contributions to knowledge that cut across these fields.

1.2 Key themes

The eight publications presented here collectively provide an account of how different policy interventions in the field of energy efficiency (including zero carbon

homes, low carbon heat networks and domestic energy efficiency schemes) are experienced and made sense of by a range of key actors. More specifically, this research advances existing knowledge in the following areas:

- The nature of the socio-technical challenges encountered in the introduction of more energy efficient buildings and the importance of achieving a balance between socially acceptable and technically optimal environments. (Papers 2, 3, 4, 6 and 8)

- The value of qualitative research in gaining a more nuanced understanding of our relationship with the home and the implications of this for domestic energy efficiency interventions and the design of low energy buildings (all papers).

- The influence of tenure as determinant of access to a more energy efficient home and in particular, the stubborn and complex barriers to achieving higher standards of energy performance within the private rented sector. (Papers 1, 2, 3 and 4)

- The significance of identity, setting and notions of home in the context of domestic energy efficiency interventions. (Papers 1 and 4)

An account of the origins of the research that underpins the eight articles is set out in Appendix 1.

1.3 Structure of the document

This document is structured around four main sections in addition to this one. Section two critically discusses the main clusters of literature and theoretical frameworks relevant to this thesis. This section culminates in the identification of a series of gaps or deficiencies in the existing literature and linked to this, outlines the research questions explored through the eight publications. Section three provides

both an overview and critical appraisal of each of the publications and an account of the development of my research over the course of the eight papers. The final section discusses the key contributions that the papers collectively make to the field and provides some concluding thoughts.

2. Development of themes

This section provides a critical appraisal of the main bodies of literature and key theories that form the backdrop to this thesis. These bodies of literature are best understood as seven clusters, emanating from across building science; sociology; housing studies and from the theoretical perspectives of Socio-Technical Theory and Actor Network Theory.

2.1 Understanding domestic energy efficiency through building science

Architecture and building science publications concerned with low energy buildings tend to focus on issues of design and performance and are informed by quantitative data generated through technical assessments. There has been a particular focus in building science on understanding why low energy buildings often fail to perform as well as their design specification when occupied (the performance gap) (Sunikka-Blank and Galvin, 2012). Architects and building scientists have thus far given inadequate consideration to the influence of occupant behaviour on building performance, as this would require qualitative exploration-an unfamiliar skillset within this field (Ambrose et al, forthcoming). Moreover, quantitative techniques are also favoured by policy makers who are often the commissioners of research (Boehm et al, 2013).

The approaches typically adopted within building science can leave many unanswered questions regarding the performance gap, leading prominent commentators from within the field to criticise the lack of engagement with occupants when assessing building performance (Stevenson and Leaman, 2010). In this context, Stevenson and Leaman state that there are insufficient mechanisms for engaging with occupants in order to help understand how buildings perform in

occupation. This problem, they argue, partly results from the challenges of gaining access to the private space of the home (Stevenson and Leaman, 2010).

To summarise, building scientists and architects have arguably become over reliant on quantitative methods and technical instruments to evaluate the performance of low energy buildings. The absence of established mechanisms for engaging the end user in the assessment of building performance (and the absence of the skills required to do this) leaves unanswered questions in relation to the performance gap. It has also contributed to the limited insights we have into the relationship between occupant and the low energy home.

2.2 Sociological approaches and behaviour

In contrast, sociologists interested in domestic energy efficiency have prioritised the exploration of occupant behaviour and contend that changes to our practices and routines are key to reducing domestic energy demand. The work of Shove (2003; 2009; 2010), Gram-Hanssen (2013, 2014) and other proponents of Schatzi's (1996; 2001) Social Practice Theory (practice theory) exemplifies this approach, which has influenced international thinking on energy reduction (see for example IEA, 2012).

Practice theory frames consumption as a response to other activities such as the need to keep warm, clean and entertained, etc. and contends that we should understand these activities as practices or 'ways of doing', e.g. cooking, washing, socialising (Mourik et al, 2012). Practice theory therefore proposes that instead of targeting people's energy consumption, we should instead target particular practices, which it is claimed are habitual and consolidated as social conventions regarding cleanliness or expectations of thermal comfort, for example (Mourik et al, 2012).

This approach is guided by Schatzki's (2001; 2002) conception of practice theory which presents practices as operating independently from their setting and of individual actors. Humans, it is contended, are merely agents who carry out social practices (Reckwitz, 2002). In this sense, practice theory overlooks the influence that the setting where practices are being played out may have on the nature of those practices. In doing so, practice theorists overlook established bodies of work from ecological psychology, which contend that behaviour and the setting of that behaviour are closely linked (Barker 1963: 1965).

Psychologist Lewin argued that in order to explain human behaviour we must examine both the person performing it and the environment where it is performed (Ittleson et al, 1974). Lewin's student, Barker, subsequently proposed that the situation in which the individual is located is a more significant determinant of behaviour than personality and argued that behaviour should therefore be studied 'in situ' (Popov and Chompalov, 2012). Barker did not consider setting in the concrete terms of a building, but argued that the immediate environment surrounding an individual shapes their behaviour. The work of Lewin and Barker highlights how the interplay between individual factors and the surrounding environment is critical to understanding energy behaviour.

Practice theory as conceived by Schazki (2001) and Shove (2009) adds to this earlier work, by acknowledging the wide range of factors affecting our behaviour including socio-cultural, political and economic factors only alluded to by Barker. It also challenges (through reference to Behavioural Economics) the idea of an economically rational actor, revealing our decisions to be far more complex in reality (Prendergast et al, 2008). However, in other ways, it overlooks a great deal through its minimisation of the role of the agent and thus its neglect (or at least

oversimplification) of the influence of identity and of setting. In particular, practice theory fails to acknowledge the significance of one very significant setting with regards to energy consumption: the home; a space that both reflects and shapes our identity and our everyday lives (Kearns et al, 2000, Cooper-Marcus, 2005).

In summary, the adherence of practice theorists to the idea that practices can exist independently of setting and identity (and thus their neglect of wisdom from ecological psychology) undermines their potential contribution to this field. A particular weakness in the way that practice theory has been applied to the study of domestic energy efficiency is the fact that (although it has considered energy behaviour in domestic settings) it has failed to consider the domestic environment in the role of home and to consider the influence of that setting on the individual and their behaviour.

2.3 Towards an integrated approach to the study of domestic energy efficiency?

Uniting insights from sociology (emphasis on behaviour), psychology (studying behaviour 'in-situ' and in the context of identity) and building science (understanding building performance) would yield holistic insights into the opportunities for energy and carbon saving in housing. It may also help address persistent questions about the performance gap. However, at present, this kind of interdisciplinary collaboration is rare as Stevenson and Leaman observe:

"Traditionally, the evaluation of housing performance has consisted of either physical monitoring or occupancy satisfaction questionnaires, but quantitative and qualitative feedback are rarely related to each other as they span across disciplines [...]. The evaluation of user perceptions and behaviour in relation to building performance in housing is therefore an emerging research area." (pp.437)

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Janda (2011), supports this view in her paper, *'Buildings don't use energy people do'*, stating that purely architectural solutions are necessary but not sufficient in isolation to achieve required carbon reductions and calls for the closer integration of user perspectives and building performance.

These sentiments resonate with those of Lynch and Hack (1984) who contend that the design of housing should proceed from an empathetic understanding of users. This, they insist, is the only way to ensure that buildings meet their design objectives (social, economic or environmental). This message has rarely been heeded, leading Marshall to renew this call in 2011. Similarly, Goodchild and Karn (1997) assert that social sustainability is as important as ecological sustainability in the design of buildings.

In summary, the absence of an integrated approach (or willingness to work across disciplines in the field of domestic energy efficiency) has resulted in an evidence base characterised by a schism between practice theory and building science. Thus, efforts to balance considerations of social and ecological sustainability have so far been unconvincing.

2.4 Key theories

The study of domestic energy efficiency, as a field, is underdeveloped in theoretical and conceptual terms and has thus far been heavily reliant on practice theory as a lens through which to make sense of key challenges, as previously outlined (Mourik et al, 2012). This has had the effect of restricting theoretical development in the field to the study of energy behaviour.

As the papers included here illustrate, I have taken a pragmatic approach to the application of theory. As such, I have chosen not to ally my work to one particular

theory or perspective and instead work with several theories that aid the meaningful interpretation of the data and help to distil and draw out the broader implications for the field. A full account of the theories and concepts applied over the course of the eight papers is provided in section 3. However, the related theories of Socio-Technical Theory and Actor Network Theory have been drawn on more extensively than other theories and concepts, featuring in half of the published works (papers 2, 3, 4 and 8).

Given the emphasis within this body of work on understanding how low energy and carbon innovations can become part of mainstream solutions to key domestic energy efficiency challenges, there was a natural gravitation towards Transition Management (Loorbach, 2010). Transition Management is a theory of governance that focusses on the acceleration of sustainability related transitions. The emphasis placed by Transition Management on accommodating the perspectives of multiple stakeholders and developing shared solutions also resonates with my overall aim of understanding how domestic energy efficiency interventions are experienced by a range of different actors. However, Transition Management is broad in focus and arguably better suited to studying low energy transitions at a strategic level, rather than the household or small case study levels at which my work operates.

2.4.1 Socio-Technical Theory

Within Transition Management, the work of Geels (2005) and Geels and Schot (2007) in relation to Socio-Technical Theory (STT) felt better suited to the interpretation of my data given its focus on what happens when technological innovations meet established social systems. STT is primarily concerned with how an innovation is conceived and how it progresses from a protected 'niche' to mainstream adoption through layers of social, technical and economic challenges,

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and how the interests of a wide variety of actors need to co-evolve to facilitate this (Geels, 2005; Raven 2007). Due to this complexity, not all innovations make it out of the protected niches in which they are nurtured (Geels and Schot, 2007). Where they do, however, they will decisively change organisations and the lifestyles and aspirations of the consumers adopting them (Hargadon and Douglas, 2001).

The principles of STT seemed particularly appropriate when seeking to understand why- when the technology behind them is entirely viable- innovations such as low energy housing or low carbon heat networks are proving so difficult to mainstream.

The application of STT enabled me to move beyond identifying, for example, why we might be failing to deliver more low energy homes in the UK or why biomass district heating is failing to deliver espoused benefits, and appreciate that these particular innovations in fact exemplified the classic challenges of bringing any innovation to the mainstream in the context of established social systems. The application of STT therefore heightened my awareness that- in relation to successful domestic energy efficiency transitions- social acceptability is as important as environmental credentials and technological viability (Goodchild and Karn, 1997).

As a young theory, so far STT has only been used to understand the relationship between specific technologies and individuals (i.e. air source heat pumps) and specific low-energy practices which take place outside the home (e.g. car sharing, cycling).Prior to the publication of papers 2, 3, 4 and 8 it had not been used to understand the interactions between collections of technology, such as those found within the low energy home, and the complex dynamics of a household, for example.

My work seeks to test the application of the theory to more complex scenarios, such as the house building industry (see paper 2) and the low energy home (see paper 4),

to aid an understanding of why low energy housing has not yet penetrated the mainstream outside of the protected niche of social housing. These new applications of STT are arguably ground breaking and Papers 3 and 4 provide the only examples of the application of the theory to the study of the home. As demonstrated within papers 2, 3, 4 and 8, STT is both applicable to and illuminating within these more complex contexts and should not be limited to the study of the narrow relationship between technology and individual.

STT does however have its limitations. Like practice theory, STT seldom considers the setting in which the technology being studied is used, where the practice takes place, or the influence that an individual's identity may exert on that practice. This weakness is largely attributable to the narrow application of STT as a means of studying the relationship between the individual and specific pieces of technology or practices in isolation, neglecting the influence of a range of important contextual factors including setting and identity.

2.5 Actor Network Theory

In a later publication (paper 8), I sought to apply a theory related to STT: Actor Network Theory (ANT) to help understand barriers to the widespread mobilisation of low carbon heat networks in UK cities. I was drawn to ANT in this context on the basis that it provides an effective framework for elucidating the processes by which technological innovations come into being, or fail to (Banks, 2011). Echoing elements of STT, the primary contention of ANT is that the interests of a wide range of different actors need to be brought into alignment in order to bring an innovation to fruition and for it to penetrate the mainstream. ANT provides a framework for understanding the processes through which this alignment is achieved (or not).

A distinctive (and controversial) feature of ANT is its treatment of both human and non-human entities as actors or 'actants' as proponents of the theory prefer to refer to them. However, unlike STT, ANT does not assume that all actants are equal and acknowledges - albeit descriptively rather than analytically- inherent tensions between economy and environment (Blowers, 1997; Hajer, 1995). In essence, where practice theorists and building scientists simplify the world by separating technology and behaviour, STT and ANT help us to appreciate the complexities and entangled nature of our socio-technical world (Cressman, 2009).

ANT originated from within science studies but is increasingly applied to the study of planning issues, in particular those related to energy infrastructure (see for example, Rydin and Tate, 2016). It therefore seemed worthy of consideration as a theoretical framework through which to extract broader meaning and policy lessons from the data generated in relation to low carbon heat networks (LCHNs) and the barriers to their deployment (data set out in paper 6). Preliminary analysis of the data suggested that the issues identified as obstructing or frustrating LCHN deployment lay not in their technical viability but in the inability of any one party to engender a collective commitment to their mobilisation. In essence, the problem appeared to be one of actors.

Key proponent of ANT Latour (1999) developed a circulatory system which outlines five steps to an effective actor network, as follows:

- Organisation of the world: the formation of arguments to support the overall objective, underpinned by a technical evidence base.
- Autonomisation: the position reached when the network of actors have assembled sufficient evidence to support their cause and are considered an

'authority' on the matter. Thus, they are well positioned to convince others of their arguments and form alliances.

- Alliances: the enrolment of powerful groups and institutions into the network. I.e. prospective customers; suppliers of heat and financiers.
- Public representation: promoting public acceptance of the idea.
- 'Links and knots': achieving all of the previous steps in a joined up fashion.

When Latour's Circulatory System was laid over the data it enabled the identification of specifically where (within the five stages of the circulatory system) the efforts of government and local authorities to engender support for more widespread deployment of LCHNs were falling down. More detail regarding the application of the Circulatory System to the case of LCHNs can be found in section 3.8.

ANT has been criticised for suggesting that non-human entities have agency and for failing to distinguish between human and non-human actants (e.g. the heat network itself and its components would be considered an actant). This approach is premised on the belief that we should not assume passivity on the part of non-human entities and should avoid the assumption that they are only capable of influencing a situation when mobilised by humans (Callon & Law 1997). However, insights from STT and environmental psychology would support this view through their recognition that a (technological) object can exert influence on a situation as part of the setting in which the situation is enacted (Barker 1963:1965). ANT also relies on what can be observed and therefore could be said to miss some of the underlying motivations that drive actors, including personal factors such as aspects of identity. However, the recognition of non-human entities as actants represents the extent of ANT's engagement with setting and other contextual factors. In relation to ANT's neglect of

identity, the reasons for this are clear: ANT relies on the observation of the performances of actants and proponents of the approach might therefore argue that identity is not something that can be observed (Law 1997; Law & Singleton 2000). However, their stance in relation to setting is less obvious.

A further relevant criticism of ANT is that it is usually discussed in the abstract and that case studies of its application are rare (Law, 1997). Paper 8 provides a key example of the useful and enlightening application of ANT to a specific case study.

2.6 Further relevant bodies of work

There are also two further bodies of work of direct relevance to this thesis, which sit apart from the theoretically focussed work of practice theorists and proponents of STT or ANT and the technical approaches of the building scientists. These bodies of work relate respectively to energy inefficiency in private rented sector housing and the broader, related issue of the role of tenure as a determinant of access to a more energy efficient home.

2.6.1 The PRS retrofit challenge and the principal-agent thesis

A further body of work of relevance relates to the need to upgrade the energy performance of the existing housing stock in order to reduce carbon emissions and alleviate fuel poverty. This challenge is particularly urgent in light of the slow rate at which we are replacing our ageing housing stock with purpose built low energy housing, which means we cannot avoid the need to retrofit energy efficiency measures (GBC, 2016).

My research in this area has focussed on the particular barriers to improving energy efficiency in the private rented sector (PRS) in England. This issue sits separately to the other clusters of literature outlined because exploration of this topic has not been

explicitly concerned with building science nor behaviour, and has not benefitted from much theoretical or conceptual development.

The PRS in England exhibits the poorest energy performance of all tenures whilst growing faster and housing a higher proportion of vulnerable households than any other tenure (ACE, 2014). Energy performance in the PRS therefore sits in contrast to standards of energy performance in social housing, which have improved significantly over the last decade (DCLG, 2014).

The PRS problem, as it is known, is acknowledged in the policy literature (see for example, ACE 2014) and is evident in official statistics (DCLG, 2014). However, there is limited academic research considering how and why poor energy performance has proliferated and prevailed in the PRS. The existing literature suggests that landlords' aversion to investing in energy performance measures is attributable to the principal-agent problem (Jaffe and Stavins, 1994); an economic concept applied to the case of landlords and energy efficiency (IEA, 2007).

The principal-agent problem is described by the International Energy Agency (IEA) as the situation where *"two parties engaged in a contract have different goals and different levels of information"*. Jaffe and Stavins (1994) were first to apply the concept to energy consumption and state that *"If the potential adopter* [of energy efficiency measures] *is not the party that pays the energy bill, then [....] adoption will only occur if the adopter can recover the investment from the party that enjoys the energy savings."* Thus, the concept was felt to be well suited to conveying the situation in the PRS whereby it is assumed that principals (tenants) are poorly informed about energy efficiency and therefore unlikely to pay a premium for it.

Knowing this, agents (landlords) are unwilling to invest on the basis that they will not recoup the cost of their investment through the rent they charge (Barton, 2012).

The IEA (2007) have cemented principal-agent as the dominant explanation for sub-optimal take up of energy efficiency interventions and cited energy inefficiency in the PRS as one of four examples of this. In doing so, they characterise landlords and tenants as economically rational actors and thus oversimplify a situation that paper 5 reveals to be far more complex. Moreover, in positing a universal explanation, the IEA overlooks the influence of local contextual factors on the dynamics of the problem.

More recently, this universal explanation has been challenged through more contextually specific studies. Paper 5 exemplifies this, as do Liddell and Gray (2014). The latter conducted a study of fuel poverty in the Northern Ireland PRS and conclude that energy efficiency measures are more urgently required in the PRS than in any other tenure, due to disproportionately high levels of fuel poverty in the sector. They argue that PRS tenants are at greater risk of fuel poverty than those in other tenures because the building fabric is poorer; the cost of heating greater and incomes are lower.

Liddell and Gray's study confirms that energy inefficiency affects PRS tenants particularly acutely. It also highlights how a lack of interest in improving energy efficiency amongst landlords perpetuates the problem. However, many more studies like this are required to build a robust evidence base relating to the dynamics of the problem, its consequences and potential solutions.

In summary, the limited academic attention paid to the issue of energy efficiency in the PRS- particularly research that is embedded in particular countries and contexts- has resulted in only very broad and unspecific insights into the reasons why poor standards of environmental performance prevail in the PRS and the consequences for tenants (McCarthy et al, 2016).

2.6.2 Tenure and access to an energy efficient home

Issues of energy efficiency in the PRS point to a broader inequality of experience between occupants of different housing tenures concerning energy efficiency, particularly in the UK where social housing has benefitted from significant modernisation (DCLG, 2014). Moreover, social housing agencies have so far completed the majority of low energy house building[2]. This reflects the fact that social housing agencies- due to their reliance on public funding, are required to be more innovative, whereas private developers are more conservative (Ball 1999; Carmona 2001, Archer and Cole, 2016).

In spite of clear evidence to suggest that tenure is a determinant of access to a more energy efficient home, this issue has received limited explicit empirical investigation. Instead, the literature makes implicit reference to tenure by examining issues which are more prevalent within certain tenures than others (i.e. fuel poverty) or by examining the impact of energy efficiency improvements within certain tenures (usually social rented) or amongst certain groups (i.e. low income groups) (Milne and Boardman, 2000).

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[2] Low energy housing schemes can be equated with schemes that have scored
4, 5 and 6 under the Code for Sustainable Homes (now abolished in 2012). In 2012, of the 9468 homes for which Code level 4 completion certificates were issued, 80% were publicly funded. Similarly in 2012, of the 234 homes for which Code Level 5 and 6 completion certificates were issued, 90% were publicly funded. Calculated from Hansard, Written Parliamentary Answers, 26 March 2013: consulted May 2013 at
http://www.publications.parliament.uk/pa/cm201213/cmhansrd/cm130326/text/130326w0003.htm.

One exception here is the work of Kemp (2011) who compared housing conditions between tenures, providing an assessment (based on secondary data) of the standard of accommodation experienced by low-income households in the PRS compared to other tenures. This assessment touches on energy efficiency and concludes that in this regard, private renters do not fare any worse than social renters. These findings are contested by evidence from the Association for the Conservation of Energy (ACE, 2014) and Liddell and Gray (2014).

2.8 Concluding thoughts

This section highlights seven bodies of work that provide the context to my research. Each cluster raises important considerations for the study of domestic energy efficiency but also illustrates the fragmented nature of the evidence base and highlights gaps that remain. Three main gaps in the existing literature are identified:

> 1. *Inadequate consideration of the user perspective in relation to low energy buildings*

In building science, limited attention is paid to the user perspective and human behaviour in assessing the performance of low energy buildings. This is a consequence, in part, of an overreliance on technical instruments and quantitative methods, resulting in partial insights into the critical relationship between occupant, building and the technology within it.

> 2. *The separation of practices from setting and identity in the study of domestic energy efficiency*

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Practice theorists hold deep convictions regarding the role of behaviour in reducing energy demand yet rarely acknowledge the critical influence of identity and setting (and interactions between the two) in shaping energy behaviour and housing and lifestyle choices.

> *3. The need for further research into the relationship between tenure and access to the benefits of more energy efficient housing*

Our knowledge of (and acknowledgment of) tenure as a determinant of access to the benefits of an energy efficient home remains limited. Our understanding of the specific issue of poor energy performance in the PRS is particularly limited and the need to test universal theories through the generation of more contextually specific knowledge regarding the dynamics of the problem, its consequences and solutions is underlined.

The papers presented here individually and collectively contribute to addressing the gaps and weaknesses within the existing literature as outlined above, by addressing a series of questions concerned with:

- The nature of the socio-technical challenges encountered in the introduction of more energy efficient buildings, and the importance of achieving a balance between socially acceptable and technically optimal environments. (Papers 2, 3, 4, 6 and 8)

- The value of qualitative research in gaining a more nuanced understanding of our relationship with the home, and the implications of this for domestic energy efficiency interventions and the design of low energy buildings (all papers).

- The influence of tenure as determinant of access to a more energy efficient home and in particular, the stubborn and complex barriers to achieving higher standards of energy performance within the private rented sector. (Papers 1, 2, 3 and 4)

- The significance of identity, setting and notions of home in the context of domestic energy efficiency interventions. (Papers 1 and 4)

The investigation of these questions also enables an assessment of the potential for STT and ANT to help us better understand the challenges encountered in pursuit of improved domestic energy efficiency and the perspectives of key actors involved in this transition (Paper 2, 3 and 8).

3. Findings and critical reflection

This section begins with an overview of the ontological and epistemological position underpinning the published works, charting my development as a pragmatic researcher. It goes on to provide a discussion and critical appraisal of each publication, its underpinning research and analytical framework.

3.1 Ontological and epistemological positioning

Much of the data underpinning the eight publications discussed in this section was generated through contract research. Securing and delivering research contracts for public sector research commissioners necessitates a pragmatic approach to the development of methodologies, as firm adherence to a particular research paradigm may prejudice access to funding opportunities. As Boehm et al (2013) assert, there is a discernible belief amongst social policy makers that the most authoritative

research is objective, neutral and scientific, which therefore suggests a preference for positivist approaches.

My personal position- reflected across the eight publications- is closely aligned to that of Boehm et al (Op.cit), who contend that a reliance on positivist methods in isolation (especially large-scale surveys) within social policy risks reinforcing existing "*world views, power relations and a narrow construction of social issues.*" (pp.309). They go on to argue that more 'open approaches' are required to capture the complexities of everyday life, yet are unlikely to be implemented given the dominance of particular epistemological leanings amongst the commissioners of social policy research.

These sentiments echo my own experiences of research commissioners and these issues are, in my experience, even more pronounced amongst commissioners of research in the traditionally technically oriented fields of energy and environmental sustainability. The significance of securing the publication of eight papers based on predominantly qualitative datasets within journals allied to the fields of energy studies and social policy is therefore underlined and signals a step-change in the research paradigms of these fields.

Instinctively I lean towards methodological pluralism, perhaps because of my research training as a qualitative researcher within a contract research environment. Within this environment, mixed methods approaches (usually involving a combination of surveys and interviews) are effective in striking a balance between objective and subjective approaches, which generally satisfy both research commissioners and researchers. Onweugbuzie and Leech (2002) take this point

further, arguing that the avoidance of a polarised methodological approach helps researchers to maintain credibility with research funders.

My advocacy of methodological pluralism is informed by my recognition of the limitations and benefits of both survey research on the one hand and more phenomenologically informed approaches on the other. In relation to large scale surveys, my personal experiences reflect those of other commentators, who caution against a reliance on this method in isolation from other approaches, especially in the context of studying an environment as complex as the home. In particular, Seamon, (1982, pp.120-121) has criticised the reductionist nature of positivist surveys evident in attempts to *'convert the so called subjectivity of behavioural and experiential processes into empirically measurable images, attitudes, preferences, territories […] that can be identified and ordered in some regular matrix form, usually mathematical.'* Similarly, Coatham and Jones (2008) observe that research subjects are naturally inclined to express their experiences of regeneration as 'holistic visions' using 'emotive aesthetic reasoning', which cannot be captured by quantitative techniques.

Seamon (2000), goes on to advocate alternative phenomenological methods that rest on an 'undissolvable unity' between people and the world and that analyse the statements of people, their behaviour and the setting in which they live. Evidently, Seamon's views on phenomenology are closely aligned to my own, given my concern (outlined in section 2) for learning from the field of ecological psychology and studying behaviour 'in situ', taking account of the influence of identity and setting. At the same time, a purely phenomenological approach may obviate scope for triangulation by overlooking opportunities to glean important insights into broader trends that are possible through surveys. Such insights are particularly valuable in

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determining how widely experienced particular beliefs or phenomena are, and providing a frame for more detailed qualitative investigation (Devine-Wright, 2007).

The obvious conclusion, therefore, is that there is a role for a variety of methodological approaches in the study of domestic energy efficiency. Such is the implication of methodological pluralism, with its insistence that findings generated by one method are triangulated against the findings generated by other methods (Ambrose et al, forthcoming). However, methodological pluralism avoids the question as to which approach should have priority. Often- as has already been suggested- it is contended that qualitative methods can usefully complement quantitative studies based on surveys, as argued by Devine-Wright (2007). However, it is my belief that rather than being viewed as a supplement to quantitative surveys, there is a case for prioritising qualitative methods, particularly in the context of studies of domestic energy and especially in relation to those seeking insight into the relationship between occupant and home. The prioritisation of qualitative research methods will be particularly important in rebalancing the field in light of the long-standing dominance of quantitative methods identified by Stevenson and Leaman (2010), which leads to partial insights into the success or otherwise of domestic energy efficiency interventions.

The adoption of this stance means that I am not easily able to pinpoint my specific position on the epistemological spectrum of positivism to interpretivism, although I will naturally lean more towards the latter than the former. Instead, I relate more to the emergent paradigm of the pragmatic researcher (Onwuegbuzie and Leech, 2010), which seeks to bypass what Onwuegbuzie and Leech describe as the 'divisive' and 'counterproductive' debate between quantitative and qualitative

researchers and to galvanise a generation of researchers who appreciate the relative merits of each. Pragmatic researchers also seek to dispel the so-called Incompatibility Thesis, which opposes methodological pluralism (Howe, 1988), and to move beyond the idea that a researcher's epistemological leaning dictates their career-long choice of methods.

The concept of research pragmatism therefore resonates strongly throughout my research, reflecting my commitment to identifying the most appropriate methodology for the research question at hand. In relation to the study of domestic energy efficiency, my pragmatic response to the traditional reliance within the field on technically and quantitatively driven research approaches is to seek to redress the imbalance through the introduction of qualitative insights into the drivers of, and responses to, some of the most pressing challenges in the field.

My pragmatic outlook also drives me to seek to build bridges across the schism that currently exists between approaches to understanding domestic energy efficiency based on building science, and those focussed on behaviour. In this sense, my research identity encompasses aspects of research bricolage: an approach driven by the desire to identify the most effective response to any given research problem (Gordon, 1999), and informed eclecticism which describes a mixed methods approach that seeks to weave together theories and methods from a range of disciplines (Barker et al, 2001).

3.2 Paper 1: From House to Home: Residents' Perceptions of Housing Modernisation

This paper draws data from a longitudinal evaluation of a social housing modernisation programme in Wakefield, England (2007- 2011) which involved a large-scale longitudinal survey and 49 in-depth interviews with tenants, as well as

images from a photo-elicitation exercise. The paper is set in the context of the Decent Homes programme[3] and uses a case study to consider its strengths and weaknesses whilst also critiquing the heavily quantitative nature of previous housing modernisation evaluations.

It is argued that the benefits of comprehensive housing renovation can extend beyond the functionality of the property to improve occupants' emotional wellbeing. However, it is also contended that these benefits were curtailed by the narrow 'bricks and mortar' focus of Decent Homes and is critical of the failure of the programme to invest in the gardens and public spaces that many residents considered an extension of the home. Although the focus of this paper is not explicitly on energy efficiency, housing modernisation is similar and overlapping in many ways, as it represents a change in the appearance and performance of the home.

In terms of its analytical framework, the paper draws on the concept of the psychosocial benefits of home (Saunders, 1990; Giddens, 1991 and Kearns et al, 2000) and adds to this literature by considering the psychosocial benefits of home in the context of housing modernisation. In doing so, it was possible to demonstrate that comprehensive housing modernisation (as opposed to the piecemeal approaches of the past) can support the attainment of the psychosocial benefits of the home, thus revealing insights into the interrelationship between housing conditions, notions of home, and the emotional wellbeing of occupants.

These findings have subsequently been echoed by an ongoing study of housing modernisation and health in Scotland (Go Well), which similarly found that aspects of

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[3] The Decent Home programme was launched in 2001 and required all social housing units in England to be brought up to the Decent Homes Standard, defined as homes that were warm, weather tight and had modern facilities.

housing modernisation led to greater attainment of certain psychosocial benefits (Go Well, 2012). However, the two studies are quite different. Go Well relied on the traditional approach of large scale surveys, which enabled them to pinpoint the relationship between specific improvements (i.e. new bathrooms) and particular psycho-social benefits (i.e. status). However, this approach offered limited insights into 'how' and 'why' particular improvements led to enhanced psychosocial benefits. Through deep qualitative methods (depth-interviews, photo elicitation, diary keeping and video), the Wakefield study provides a greater depth of insight, revealing (to cite just one example) *how* new windows and doors created a sense of greater security by leading to sounder sleep and thus enhanced wellbeing. The study is therefore a testimony to the benefits of methodological pluralism and served to heighten my awareness of the complementarity of quantitative and qualitative methods as part of an integrated approach. On this occasion, a large-scale longitudinal survey highlighted ostensible impacts linked to the improvement programme and the subsequent qualitative investigation revealed the drivers and benefits for occupants of the impacts identified.

This paper is the only academic article considering the impact of the Decent Homes programme- the most significant housing modernisation programme the UK has ever seen. Other publications refer to the programme but are concerned with asset management (Morrison, 2013) and the role of surveyors (Kempton, 2004). It is also one of a small number of papers concerned with (physical) housing modernisation in the UK more broadly[4], and is the only paper to explore lived experiences of housing modernisation through the words and images of beneficiaries. In doing so, this paper represents my first response to the appeals of Lynch and Hack (1984) to consider

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[4] See also Cole et al, 1999 on tenant participation and Bell and Lowe, 2000 on energy efficiency and the publications of the Go Well team on health.

built environment interventions from the users' perspective. This project was fortunate to benefit from generous funding from the research commissioner, which allowed me to experiment with phenomenological methods (videos, photo-elicitation). This experimentation heightened my awareness of the potential for visual methods (as well as lengthy quotes from in-depth interviews) to transport the research audience into the world of the research subject, thus highlighting the impact of their policies and investment decisions on the everyday lives of beneficiaries.

In this sense, the project also responded to the calls of Coatham and Jones (2008) for more longitudinal and participatory approaches to the evaluation of regeneration initiatives and (pre-emptively) to Stevenson and Leaman's (2010) plea for a greater understanding of how buildings- whether new or renovated- perform in occupation. Stevenson and Leaman acknowledge that researchers attempting to do this will face the challenge of gaining access to the private space of the home. In this sense, the research underpinning this paper was pioneering in its use of a menu of non-traditional, participatory research methods to encourage participation. Moreover, the participatory methods applied signalled a move away from the purely positivistic methods traditionally employed to explore housing satisfaction (Jacobs and Manzi, 2000; Boehm et al, 2013).

The limitations of the paper primarily relate to the limited reflection on the strengths and novelty of the methodology and thus it misses an opportunity to espouse the benefits of deep qualitative approaches and the prioritisation of the user perspective.

3.3. Paper 2: Towards Zero Carbon Homes in England? From inception to partial implementation

This paper is based on an empirical investigation of the reasons why many house builders were reluctant to cooperate with the policy target of Zero Carbon Homes

(ZCH) by 2016[5] (introduced as part of the Code for Sustainable Homes (CSH) in 2006). Interviews were conducted with different types of housing developers from national house builders to small specialist companies. The paper is now regarded as the standard account of the landmark ZCH policy from 2007 to its cancellation in 2010.

The focus of the paper was on CSH and ZCH as prominent examples of the UK government's (at that time) pursuance of policies based on ecological modernisation- which advocates transitions to clean and efficient forms of production which are believed to represent the future of economic growth (Janicke, 2008). Through ZCH, the government sought to accelerate the pace of environmental innovation in the housing industry, which has traditionally been incremental. In essence, it sought to move low and zero carbon housing from a niche market to the mainstream. The paper therefore considers both the implementation of CSH and ZCH specifically and approaches to environmental policy making more broadly.

The paper revealed that the desired step-change was unlikely to be achieved, that incremental change would probably prevail, and that energy saving measures in housing would remain contentious. It was contended that attainment of the target had been stifled by recession, housing shortage, and planners' acceptance of commuted sums in lieu of higher standards of environmental design. However, there had been benefits to the pursuit of ZCH. It had encouraged experimentation and debate and signalled to the housing industry that higher standards of environmental design were inevitable.

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[5] Under the Code for Sustainable Homes launched in 2006- the government at that time committed to a target that all new homes should be 'zero carbon' by 2016. It was short-lived and cancelled in 2010.

The key actor in focus here is the housing developer, who (outside of the social housing sector) the government at that time looked to for the delivery of the higher standards of environmental performance in housing that were aspired to. This paper provides rare insights into the perspective of housing developers and the difficulties surrounding attempts to accelerate the pace of socio-technical change within the industry. The findings therefore resonate beyond ZCH, generating lessons relevant to any attempt to significantly alter practice within the building industry. Lessons include: the importance of contextual sensitivity when applying models of policy making outside of the context in which they were developed (ecological modernisation is a European model) and the need to ensure that different policy agendas do not work against one another (i.e. addressing housing shortage and improving housing quality).

Another contribution of the paper is in its recognition of the heterogeneous nature of the house building industry (capacity and attitudes vary between different types of developer), and the influence of regional variations in the housing market on the viability of the policy.

ZCH provides a prime example of an attempt to effect a socio-technical transition and the paper demonstrates the complexity of attempting to effect a shift in the culture of an entire, heterogeneous industry- a process that relies on the coalescence of multiple smaller scale socio-technical transitions. It therefore introduces new considerations to the work of Geels et al (2005, 2007)- who have thus far focussed on smaller scale transitions associated with particular technological items (i.e. heat pumps) or practices (cycling).

The paper also adds to the literature by considering the issue on which the future of low energy housing rests: the ability of government to persuade or require the building industry to provide low energy housing, especially at a time of housing crisis where the drive for quantity may eclipse the pursuit of quality. The main limitations of the paper are associated with the small-scale dataset, which made it difficult to generalise about the industry as a whole.

This paper also signals a bolder engagement with theory following the relatively light engagement with conceptual frameworks illustrated by paper 1. The analytical framework used within this paper was drawn from STT and represents my first application of the theory. As outlined in section 3.1, STT is particularly valuable in terms of illustrating what occurs when an innovation meets a 'regime' or established set of practices and ways of working. It was therefore well suited to understanding the difficulties encountered in seeking to rapidly introduce an innovation to the mainstream, and the ways in which the regime (in this case, the house building industry) resists this. The value of STT for drawing out broader policy lessons that go beyond individual case studies was underlined. In this case, STT was instrumental in revealing that attempts on the part of government to rapidly transform the practices of the building industry were laudable but misguided, and were always likely to encounter resistance from the regime.

3.4 Paper 3: User and organisational responses to biomass district heating

In 2013, I became aware of the distinct challenges around the management and use of homes heated using low carbon heat networks (LCHNs). LCHNs have been favoured by successive governments as a means of meeting the country's heat demand whilst achieving carbon savings (DECC, 2011). Funding from the Economic and Social Research Council (ESRC) was used to conduct a comparative study of

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two similar apartment blocks, both heated using Biomass District Heating (BDH) (a form of LCHN) but managed by different housing providers in different ways. Interviews were conducted with those responsible for the management and maintenance of the schemes and with residents. Following the demonstration of its worth in the context of paper 2, STT again provided the theoretical framework for analysis, illuminating what occurs when technological innovations (in this case Biomass District Heating (BDH), a form of LCHN) meet rigid social systems (the practices and expectations of housing providers and residents) (Geels, 2005; Geels & Schot, 2007). This paper represents my first attempt to juxtapose the perspectives of building users (in this case tenants) with those of 'gatekeepers' (in this case landlords) who play a key role in determining tenants access to, and experiences of, more energy efficient homes. This approach represents a progression in terms of the application of STT- a theory usually focussed on the narrow relationship between individual and technology. On this occasion, STT was used to explore the relationship between an particular technology (BDH) and two different components of a social system- the provider of housing and the end user. STT performed well in this context and this paper is therefore key in demonstrating the versatility of the theory.

It was revealed that the two housing associations had adopted BDH systems as an expedient and cost effective means of meeting planning requirements on renewable energy. In practice, they experienced many difficulties including technical problems; upskilling maintenance personnel; a lack of suitably qualified engineers to remedy breakdowns; interrupted biomass supply; and difficulties deciding how billing would be managed.

In theory, tenants stood to gain substantially from reduced heating costs and warmer homes as a result of the BDH systems, yet decisions taken by their landlords proved critical in determining their access to these benefits. In one scheme, the billing arrangements enabled tenants to access lower cost heating. In the other scheme, different arrangements caused an escalation in heating costs.

The findings resonated beyond the specific case of BDH, identifying that similar problems could arise in relation to the introduction of most innovations that do not fit easily into the existing practices and expectations of adopting organisations and end users. STT helped to draw out these broader considerations and its value in understanding why innovations can fail even once the technology is established was underlined. Overall, the study gave credence to the idea that the ability of an innovation to fit into society is critical to its diffusion (Hargadon and Douglas 2001).

This paper consolidates a number of themes within my research, including my commitment to advancing understandings of how domestic energy efficiency initiatives are experienced by a range of key actors (including the end user); providing evidence of tenure as a determinant of access to the benefits of low energy housing; and employing STT to identify broader lessons regarding the facilitation of smoother socio-technical transitions.

A strength of this paper is its juxtaposition of user and organisational responses to the innovation, highlighting the different challenges faced by each party and the interplay between the two. The main limitations relate to its length, which restricted the discussion of methods and perhaps led to a lighter application of theory than might otherwise have been possible.

3.5 Paper 4: Inside the eco-home: using video to understand the implications of innovative housing

This paper is concerned with the origins, benefits and limitations of the methodology (three videos) underpinning an ESRC funded study of user perspectives in purpose-built low energy housing. The study reflects the pervasive theme within my work of highlighting how domestic energy efficiency interventions are experienced by a range of key actors, but on this occasion places particular emphasis on the occupant or end user, a party so often overlooked in the study of building performance. This research also represents the advancement of an approach first outlined in relation to paper 1 which involves the use of phenomenological methods (video on this occasion) to help narrow the gap between occupants and the designers, developers and housing providers responsible for the provision of the low energy homes. The aim here was to enable the providers of low energy housing to better understand the user's experience of their product.

The use of video as a method of research and of communication in the context of the home is in itself novel and offers unparalleled insights into the world of the research subject. Video captures and conveys subtle cues about lifestyle, values, the life the respondent has led and the peculiarities of their relationship with the home, in ways that traditional research methods cannot. The paper also acknowledges the challenges associated with this approach including the inability to offer anonymity to participants, the resulting ethical hurdles and associated problems of recruitment.

The paper also considers issues of identity to emerge from the project. Not only did the video footage provide further evidence that identity and the home are bound up together, as contended by Lewin (Popov and Chompalov, 2012), Barker (1963,1965) and Cooper-Marcus (2005) but also that there are specific issues surrounding

identity and the low energy home. For participants who aspired to a 'green' lifestyle or who wished to 'stand out', low energy housing provided a means of reconciling housing, identity and lifestyle. However, these identity gains only really exist while low energy housing for sale remains a niche market. On the other hand, for those assigned to low energy housing through the social housing system, it could feel as if an unduly complex way of life had been inflicted on them. Tenure therefore again emerges as a determinant of access to and experiences of energy efficient housing.

The use of abductive reasoning (Bertilsson 2004 and Chiasson, 2005) to interpret the data opened up new theoretical arguments and in doing so, challenged the status of practice theory as the dominant framework for understanding domestic energy use. More specifically, it is argued that practices in relation to energy consumption in the home cannot be separated from their setting or the identity of the occupant. In essence, it is argued that if we accept that the home is more than just a functional object and is, in fact, a 'mirror of the self' (Cooper-Marcus, 2005) then identity theory is as relevant as practice theory in the study of domestic energy behaviour. In this sense, this paper represents a paradigm shift, presenting evidence that challenges the status of practice theory as the dominant theoretical framework in relation to the study of domestic energy efficiency. In this vein it is argued that- in response to this new evidence- practice theory must evolve to take account of the significant influence that identity and setting exert on our energy related choices and behaviour. Moreover, the paper is also ground breaking in its illustration of the value of applying methods inspired by phenomenology within the field of energy studies. On this occasion, the use of film was particularly instrumental in broadening our understanding of the factors that drive energy behaviour and shape our responses to domestic energy efficiency interventions.

3.6 Paper 5: Improving energy efficiency in private rented housing: Why don't landlords act?

This paper considers private landlords' attitudes towards improving the energy performance of their properties, against the backdrop of the (now defunct) Green Deal[6]. The paper argues that worsening conditions in the Private Rented Sector (PRS) indicate that policy has so far failed to compel private landlords to improve energy performance, suggesting that poor conditions in the sector are a systemic issue and that we don't know enough about how landlords approach such investment decisions. This paper spotlights the third key provider of housing; private house builders. Paper 2 explored the perspective of private house builders; paper 3 considered the experiences of social landlords; and this paper seeks to understand the perspective of another gatekeeper of access more energy efficient housing: the private landlord.

The extent and nature of poor conditions in the sector are well documented in the policy literature (Citizens Advice, 2014; ACE, 2014), yet little academic research has been undertaken to explore why private landlords are reluctant to invest in energy performance. Here I begin to address this gap by providing empirical insights into the factors preventing them from taking action on energy efficiency. The paper also seeks to empirically test the assumptions underlying the principal-agent thesis and linked to this, Bradbrook's (1991) argument that the Green Deal should have resolved the problem by transferring the cost of improvements to the tenant.

It is argued that the range of factors influencing landlords' thinking on this matter extend beyond economic factors to encompass local contextual factors; socio-cultural factors and knowledge deficits as well as local housing market

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[6] which offered loans to private property owners to install energy efficiency measures, repaid by the tenant out of the savings (theoretically made) from reduced energy bills.

characteristics. As such, the paper provides a basis for further empirical investigation and more informed policy making.

The reluctance to invest in energy efficiency displayed by participating landlords and the inability of tenants to influence this, again points to tenure as a critical determinant of access to an energy efficient home, revealing landlords as 'blockers' to tenants' access to energy efficient housing.

On a conceptual level, the data challenges the universal validity of principal-agent, and points to the need to build a body of empirical insights into the problem that are contextually sensitive and capable of challenging the assumption (which underpinned the ill-fated Green Deal) that landlords and tenants are both economically rational actors.

The paper does not engage with theory but was timely and policy relevant, published at a critical juncture ahead of the introduction of new legislation allied to the Energy Act (2011) aimed at tackling energy performance in the PRS. However, the wider resonance of the data reported in the paper is limited by the scale of the study, which focused on one local authority area.

The study provides an example of research pragmatism in response to the need to garner detailed insights into the drivers of landlords' inertia on a limited budget that would not allow for a large scale survey. In this sense, depth of insight was prioritised over the identification of generalisable trends. A full qualitative study of this issue had not previously been undertaken and the insights garnered provided much deeper insights into the issue than had previously existed, enabling a robust critique of the principal- agent thesis as overly simplistic.

3.7 Paper 6: Low Carbon Pioneer Cities Heat Networks Project: a process evaluation

In 2013, I led an evaluation of the government's flagship initiative for promoting low carbon heat networks (LCHNs): Pioneer Cities. The study- commissioned by the Department for Energy and Climate Change (DECC)- involved 86 interviews with stakeholders involved in the mobilisation of LCHNs across five English cities. The research followed the principles of ANT, using in-depth interviews to track the experiences of the key actors (including end users) as they attempted to move towards the deployment of LCHNs. This focus on such a wide range of actors within the scope of one project represents quite a departure from previous papers, which have tended to spotlight the perspectives of one or two actors. This issue is considered in more detail in paper or section? 3.

It was concluded that the initiative had helped participating Local Authorities (LAs) move closer to their aim of establishing new heat networks through the provision of funding to hire expert consultants to produce detailed feasibility studies. However, at the end of the evaluation, the authorities faced the considerable challenge of finding mainstream funding to progress their plans against a backdrop of wavering commitment from prospective heat customers. In a context of public sector retrenchment, the dominance of the gas infrastructure, and energy policies promoting choice in the energy market (heat networks require a monopoly supplier), the challenge ahead was considerable.

The report is restricted by the limitations placed on length and content by DECC and focusses heavily on the lessons specific to Pioneer Cities with limited reflection on the broader obstacles to increased heat network deployment in the UK. The report

did, however, go on to inform the government's ongoing Heat Networks Delivery Unit and provides the foundation for (and technical appendix to) Paper 8.

3.8 Paper 7: Evaluation of the Big Energy Saving Network

The Big Energy Saving Network (BESN) aimed to promote engagement with the energy market (in the form of switching energy supplier) amongst the most vulnerable in society. I led the national evaluation of BESN between 2013 and 2014. In this paper, the spotlight turns to a particular type of end user: the vulnerable consumer, and seeks to understand domestic energy efficiency and the energy market from their perspective.

The evaluation followed a theory of change approach (contrasting assumptions about how the project is intended to work with the reality), and a combination of surveys and in-depth interviews were used to inform the evaluation of process and impact.

The evaluation found that BESN had reached a larger number of vulnerable consumers than anticipated, had improved their understanding of the value and process of switching energy provider or tariff, and had galvanised over half of workshop participants to take action to improve their energy deal. The high quality training given to those delivering BESN and the transfer of responsibility for the scheme from civil servants to VCS organisations experienced in working with vulnerable groups, were key to its success.

A key contribution made by the study is the identification of salient broader lessons into which approaches are most effective in engaging vulnerable groups in energy and financial inclusion initiatives: helping to address a significant gap in policy knowledge. These lessons have resonated beyond BESN and beyond the energy

sector, see for example a report for the Consumer Council for Water by Ambrose et al (2016).

Leading this evaluation deepened my concern for social justice issues within energy policy and the extent to which policy interventions reach and benefit those who need them most. It also prompted reflection on how exposure to fuel poverty and other energy injustices is not just determined by the physical fabric of the property and occupant's practices, but also by exogenous factors including energy pricing and individual capacity to navigate the complexities of energy markets.

3.9 Paper 8: The role of actor-networks in the early stage mobilisation of low carbon heat networks

In this paper, data from the Pioneer Cities evaluation is re-analysed through the prism of ANT, to identify where efforts to mobilise heat networks are falling down. This paper represents the culmination (to date) of my development as a researcher and perhaps, alongside paper 4, my most advanced application of theory yet. The paper also considers the perspectives of a wide range of actors in tandem, something previous papers have not attempted to the same extent. ANT is a dense and challenging theory to work with and is contested on several grounds, as outlined in section 2.5. This paper provides one of few examples of the application of ANT to aid understandings of key policy challenges.

As outlined in section 2.5, within ANT, Latour's (1999) Circulatory System provided the theoretical framework for analysis. A key reason why this paper represents one of my most theoretically sophisticated works is not simply because of its engagement with the complexities of the Circulatory System but also because the papers seeks to advance the system. This is achieved through the introduction of the supplementary concepts of interessement (primary actors recruiting other actors) and enrolment

(definition and acceptance of roles) (Boelens, 2010). These concepts were added to the framework to sit between 'Organisation of the World' and 'Autonomisation'. This was done to counter the criticism that ANT focusses too heavily on the inputs and outputs of networks, neglecting the work involved in identifying and enrolling the required actors (Hawkey et al, 2013). When laid over the data, this framework perfectly illuminated the stages at which processes of network mobilisation were stalling.

At the 'Organisation of the World' stage, local authorities (depleted from public sector retrenchment) needed to enlist technical consultants to create a credible evidence base to support their aim of heat network development. However, due to the temporary nature of this expert input and the lack of relevant internal experience, local authorities struggled to establish themselves as an 'authority': a pre-requisite of autonomisation and the formation of alliances. When combined with the absence of compelling incentives from government, this led to the assemblage of loose networks of wavering actors.

Analysis using ANT suggested that the issues described are fundamentally problems of 'translation', whereby network leaders are unable to translate their vision into a language that other actors can understand and appreciate as being in their own interests (Latour, 1999; Rutland and Aylett, 2013). If issues of translation are resolved then public representation will follow. The inability of local authorities to master translation raises questions about their suitability as network leaders.

However, the paper also debates the possibility that long established gas networks across the UK, which provide relatively affordable heat and consumer choice, and may render the prospect of a disruptive shift to an alternative system unappealing.

The article concludes that if increasingly depleted local authorities are to lead infrastructure projects - government will need to support them through more compelling incentives and/or regulation.

The paper successfully combines a strong theoretical element with policy relevance, and the application of a modified version of the Circulatory System enabled salient policy lessons to emerge regarding the mobilisation of complex infrastructure projects comprising a wide range of different stakeholders and interest groups.

4. Discussion

This final section provides a discussion of the key methodological, empirical, conceptual and theoretical contributions to knowledge made by this body of work and is structured around the gaps in knowledge identified at the end of section 2. It culminates in a series of learning points for policy and practice and suggestions for the future development of the research agendas set out within this thesis.

4.1 Inadequate consideration of the user perspective in relation to low energy buildings

The papers included here are not united by any particular theoretical tradition. They are instead bound by a commitment to highlighting socio-technical entanglements and a conviction that using qualitative research methods to understand how energy efficiency interventions are experienced by a range of actors, especially the (thus far underrepresented) end users will provide new and detailed insights into key policy challenges (Lynch and Hack, 1984 and Marshall, 2011).

Section 2 highlighted how, in building science, the tradition of using quantitative methods to evaluate the performance of low energy buildings and within practice theory, a narrow focus on behaviour (in isolation of setting and identity), has resulted

in limited insights into the relationship between occupant and home and how energy efficiency interventions fit into this. Thus, the truism that 'buildings don't use energy, people do' has been largely ignored (or, in the case of practice theory, oversimplified) (Janda, 2011) and may be at least part of the reason why the performance gap persists and remains poorly understood. The papers included here go some way towards addressing what is missed by these two dominant approaches, by adopting an interdisciplinary approach that prioritises the thus far missing user perspective and takes account of the influence of setting and identity when considering behaviour.

In paper 1, the application of this approach highlighted the complex relationship between occupant and home and demonstrated the impact that physical interventions in the home can have on that relationship. In relation to the Decent Homes programme, the interventions were 'low tech' and did not significantly challenge beneficiaries' notions of how a house should look and function and how a home should feel and appeared to enhance the psychosocial benefits of home for residents. Paper 4, on the other hand, highlights how a move from the low-tech environment of traditional housing to a relatively 'high tech' low energy home, with unfamiliar technology and unconventional architectural styles, could destabilise the occupant-home relationship, especially where the move was not elective. This point is exemplified by the plight of social housing tenants assigned to low energy homes, which were poorly understood by them and their landlords. The disruption to the relationship between occupant and home that occurs in this scenario can give rise to a resistance to low energy housing and associated technologies (as illustrated by Paper 4) that may undermine the market for this form of housing.

In this sense, these two papers provide empirical support for the assertions of Lynch and Hack (1984), Goodchild and Karn (1997) and Marshall (2011), that the user experience of low energy housing (and therefore consideration of its social as well as ecological sustainability) has not been sufficiently considered or accommodated in the design or study of low energy housing.

In heeding the advice of Lynch and Hack (1984) and others, I have sought to apply ideas emanating from planning to the fields of housing studies and energy studies and in doing so have signalled a departure from the tradition of using quantitative methods to understand issues of housing satisfaction. Moreover, the application of qualitative methods to an area where they are rarely applied (energy studies) has enabled me to generate new insights regarding where efforts to promote more energy efficient housing (through low energy homes, retrofitting and LCHNs) are failing, revealing a series of previously unidentified flaws in the assumptions underpinning key policies and initiatives developed in recent years. Examples of some of the assumptions and oversimplifications challenged by my research include the idea that:

- improvements in the physical condition and performance of a property will result only in improvements to its functionality (paper 1)
- the practices of the large and heterogeneous house building industry can be rapidly transformed through the application of European policy models (paper 2)
- the introduction of technology or buildings with the potential to yield energy and financial savings will deliver these benefits regardless of their ability to fit in with our ways of life and ways of doing business (papers 3, 4 and 8)

- private landlords are economically rational actors who will act to improve the energy efficiency of their properties if they are not responsible for the financial burden of doing so (paper 5)
- our ability to access the benefits of more energy efficient housing is determined by the performance of that building and our own behaviour only (neglecting the influence of 'blockers', exogenous factors and individual capacity to navigate the energy market) (papers 2,3,4,5 and 7).

A focus on the user perspective also poses a challenge to STT. Geels et al (2015) help us to understand the interaction between particular energy saving technologies and their operators, echoing elements of practice theory (Schatzki, 2001, 2002) by isolating the interaction between the individual and a particular technology or practice from personal characteristics and the setting in which the interaction occurs. However, as Papers 1 and 4 reveal, it was the cumulative impact of the collection of technology found in the low energy home and the overall appearance and feel of the property (inside and out) that shaped occupants' attitudes towards and use of their home, rather than relationships with individual technologies. Thus, my research indicates that contemporary studies of domestic energy efficiency overlook long-standing wisdom from ecological psychology regarding the influence of setting and identity on attitudes, behaviour and experiences. This wisdom will be significant in understanding whether more energy efficient housing will ever enter the mainstream and whether it will achieve its potential when in occupation. Paper 4 provides clear insights, elicited through the use of video, into how personal factors including identity, are pivotal in an individual or household's acceptance of the low energy home and determine their willingness to accommodate the demands of this environment in order to maximise the potential for energy and financial savings.

A better understanding of user perspectives in low energy housing and the role that identity and setting play in this is, in turn, likely to influence the attitudes of developers and landlords in the sense that greater consumer support may help promote more widespread development of such housing. Papers 2 and 5 highlight the perception amongst housing developers and landlords that energy efficiency is unimportant to house buyers and renters. More evidence in relation to the user perspective may also challenge this assumption, revealing that consumer choices in relation to low energy housing are more complex than this and bound up with identity, deep-rooted ideas about the environment, socio-cultural expectations of how homes should look and function and with practical considerations about the user friendliness of technology.

Overall, the difficulties in adjusting to the prospect of more energy efficient housing experienced by occupants (papers 3 and 4), developers (papers 2 and 3), landlords (paper 5) and other stakeholders (papers 6 and 8) suggest that the desired step-change sought by successive governments through policies allied to ecological modernisation, will be difficult to attain. Thus, the empirical evidence set out within these papers supports the principles of STT and ANT, suggesting that bringing low energy (or heavily retrofitted) housing into the mainstream would require immense effort (and some serendipity) to create the right conditions and align the interests of a vast array of stakeholders (Geels, 2005; Raven 2007). Papers 6 and 8 indicate that this is unlikely to be possible, having proved elusive even in relation to one specific and not particularly radical intervention- LCHNs. The conclusion of paper 2, that incremental change is likely to prevail in relation to low energy housing and associated innovations, still holds true and is arguably more veracious than ever in light of the recent cancellation of ambitious policies such as CSH and ZCH.

4.2 The significance of setting and identity in the study of low energy housing

The insights into the relationship between occupant and home to emerge from my research support the idea that our identity is closely bound up with the home (papers 1 and 4) and that together setting and identity influence our behaviour and choices as well as habits, routines and practices. Although it is not new to identify the interconnectedness of identity, setting and behaviour, it is new to examine this thesis within the specific (and incredibly important) setting of the home. Critically, the findings set out in papers 1 and 4 serve to challenge the (seldom challenged) status of practice theory as the dominant framework for understanding practices and choices in relation to energy. The data presented in paper 4 indicates that the practices and choices captured using video were heavily influenced by their setting and by the identity of the individual. Thus, it is proposed that, in the context of domestic energy efficiency, practice theory needs to evolve to incorporate considerations from ecological psychology, accepting the significance of and interrelationships between behaviour, the home and identity and studying energy use 'in-situ', as Barker (1963, 1965) advocated.

Paper 4 demonstrates how practice theory and considerations of setting and identity can be integrated in the study of domestic energy efficiency. This required an interdisciplinary approach of the sort rarely witnessed in this field, which united relevant considerations from sociology, psychology and building science. The rare application of an integrated approach of this nature has resulted in a fragmented evidence base characterised by a schism between practice theory and building science. Through my research I have sought to argue that neither the provision of low energy buildings that work (in theory), as some architects have contended or

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changing the routines and practices of occupants, as practice theorists argue, will be sufficient in isolation to achieve the required step change in the environmental impact of housing.

4.3 Tenure as a determinant of access to the benefits of a more energy efficient home

Papers 1 to 5 collectively initiate a new body of empirical knowledge relating to the role of tenure as a determinant of access to and experience of more energy efficient housing. This has been achieved by exploring, through qualitative research, the perspectives of critical actors with the greatest capacity to derail (or block access to the benefits of) an energy efficiency intervention or innovation.

Papers 1, 3 and 4 suggest that tenants (social or private) are likely to experience the greatest difficulties in accessing the benefits of more energy efficient housing as a result of the gatekeeping role played by landlords. Such gatekeepers, it is revealed, may make assumptions about the importance of energy efficiency to their tenants or make decisions in their own self-interest that adversely affect tenants' access to the benefits of a more energy efficient home. Owner occupiers also have limited opportunities to access low energy housing, due to the reluctance of housing developers to depart significantly from traditional building techniques (paper 2) or adopt low energy technologies (papers 2, 6 and 8).

However, as paper 4 suggests, occupants themselves can play a similar role by resisting a move to low energy housing or by failing (or feeling unable) to make the best use of the opportunities for carbon and energy savings that it affords them. This may result from a reluctance to depart from established socio-cultural expectations of how a home should look and function; it may be due to personal views on the

need for energy saving or may be because they feel ill equipped and lacking the relevant knowledge to cope with the transition from low to high tech environment. Taken together, the papers demonstrate a majority resistance to low energy housing that spans the range of potential producers and consumers of this product.

However, most commonly it is private landlords and housing developers that appear to hold the balance of power, emerging as the most obstinate 'blockers' or gatekeepers obstructing access to energy efficient housing amongst the house buying or renting population. As demonstrated in papers 2, 5, 6 and 8 assumptions made about consumers' lack of concern for energy efficiency, *inter alia*, inform their assessment of the likely financial benefits of delivering improved energy performance. Contrary to the simplistic assertions of the principal-agent thesis (as applied by IEA, 2007), paper 5 also revealed that landlords' decisions regarding investment in energy efficiency measures are determined by a range of socio-cultural and financial factors including their own lack of understanding of the benefits of improved energy efficiency. This complexity suggests that there is no simple solution to this issue, as the failure of the ill-fated Green Deal has proven.

These findings regarding blockers and gatekeepers also highlight a weakness in relation to STT, which does not address the issue of inequality and power imbalances between actors in relation to socio-technical transitions. Implicit in the work of Geels (2005) and Geels and Schot (2007) is the assumption of a harmony of interests between relevant stakeholders and interest groups, overlooking inherent tensions between economy and environment (Blowers, 1997; Hajer, 1995) as well as so-called 'modernisation losers' who resist change (something that developers and landlords may fear becoming) (Janicke, 2008). Papers 2 to 5 provide clear evidence regarding the power wielded by housing providers (housing associations, private

landlords, housing developers) in terms of facilitating the existence of and access to the benefits of more energy efficient housing.

Papers 1, 3 and 4, on the other hand, demonstrate the potential benefits for occupants of living in energy efficient housing, *if* delivered sensitively and with consideration for the end user. These findings provide empirical support for the findings of Hadagon and Douglas (2001) that the ability of an innovation to fit into society will determine its ability to deliver espoused benefits.

Overall, these findings support the views of Ball (2009), Carmona (2001) and Archer and Cole (2016) that- in the absence of decisive legislation- private investors are likely to remain conservative about investing in innovation. Thus, social housing is likely to remain the main site of innovation in relation to the mass development of energy efficient housing, albeit on a much reduced scale in light of the relaxation of environmental standards in planning and the retrenchment of public sector funding for social housing.

4.4 Concluding thoughts

The published works discussed are all concerned with different aspects of the pressing global challenge of reducing the environmental impacts associated with domestic dwellings. The urgency and complexity of this challenge is acknowledged either explicitly or implicitly within each publication and each spotlights a different aspect of this challenge and explores it from the perspective of different actors. Overall, it is argued that the transition to more energy efficient domestic environments will be smoother and more socially just if guided by policies rooted in a detailed understanding of the needs and expectations of all of the actors involved, including end users and housing providers (landlords and developers). Developing

the detailed understanding required relies on the more widespread application of qualitative research methods to the study of domestic energy efficiency and the adoption of an interdisciplinary approach.

The ethos underpinning the publications included here, is one of responding to policy problems and priorities in the field, as opposed to seeking to adhere to a particular discipline, methodological tradition or philosophy. The result is a collection of papers that reflect the key policy challenges encountered in relation to housing and energy efficiency over the last ten years or more, enabling the identification of a series of broad policy lessons, as follows:

- Comprehensive improvements in the physical condition of housing have the potential to positively influence the relationship between occupant and home and aid the attainment of psychosocial benefits. However, where such improvements require occupants to make the transition from a low to a high tech environment, these benefits may not flow as readily.

- Incremental improvements in the environmental performance of new and existing housing are likely to prevail. Greater progress might be assured if consumer attitudes towards more energy efficient housing (or at least developers' perceptions of these attitudes) were to improve- but ideas about how homes should look and function are socio-culturally entrenched and not easily altered.

- Environmental policy making in housing should take account of contextual sensitivities; the heterogeneity of housing providers and occupants and consider the social acceptability of innovations alongside their technological viability and ecological credentials.

- Policies and interventions to drive up environmental performance in the PRS should take account of the full range of factors influencing private landlords' investment decisions and avoid the assumption that landlords (and tenants) are economically rational actors.

- The design of more energy efficient housing should take account of the relationship between identity and the home and of established socio-cultural norms regarding how a home should look and function. Design should also strive to ease the transition from the predominantly low-tech environments we currently occupy to the high tech environment of the low energy home.

Overall, the papers underpinning this thesis have made salient contributions to existing knowledge across a number of areas and have introduced a range of new considerations to the academic and policy debates surrounding domestic energy efficiency. They have underlined the value and importance of qualitative research in promoting understanding of the experiences of a wide range of actors, especially end users; highlighted the significance of identity and setting in the context of domestic energy efficiency; raised awareness of the potential for STT and ANT to help us to understand transitions to more energy efficient housing and exposed the influence of tenure on access to and experiences of more energy efficient housing.

However, this new knowledge does not represent a complete picture of the barriers and challenges we face in driving up domestic energy efficiency. Further research is therefore essential across all of the areas outlined and should; in particular, prioritise the application of qualitative research methods as part of interdisciplinary studies of the many stubborn policy challenges that exist in relation to energy efficiency in a domestic setting.

It will also be important for future research in this area to look beyond the confines of dominant theories (notably practice theory), to critique them and assess their suitability for helping us to advance our understanding of the field and overcome the disciplinary siloes that currently characterise it. Something underlined by this thesis is the sheer complexity of the challenge of improving domestic energy efficiency and the web of socio-technical factors that must be navigated by anyone seeking to understand or address it. This complexity cannot truly be understood and unravelled from the perspective or any one discipline, profession or theoretical frame and demands an interdisciplinary response. The fact that STT and particularly ANT are premised on a recognition of the complex and socio-technically entangled world that we inhabit means that they provide useful starting points for the exploration of issues of domestic energy efficiency. It will be important for future studies to elaborate these theories in order to further test their suitability for helping us to make sense of this dynamic issue.

Appendix 1: Origins of the programme of study

My enduring concern for the social justice implications of the built environment and more specifically, to better understand the relationship between domestic buildings, their quality and design and the everyday lives of occupants can be traced back to my time as an undergraduate. During this period I became absorbed in the plight of the residents of stigmatised post-war housing estates and conducted interviews with the occupants of condemned high rise housing. Their stories were powerful and challenged popular narratives. This experience affirmed my belief in the potential of qualitative research methods to provide a window into the worlds of others; enabling us to understand- in detailed and nuanced terms- the everyday consequences of policy and practice decisions and the assumptions and biases underpinning them.

My concern for reducing the environmental impact of housing emerged during my time as a planning practitioner working on the local implementation of policies to drive up the environmental performance of new housing. Within this role, I grappled with multiple barriers to the mass development of low energy housing and became curious about why - when the many of the technological barriers had been resolved- we still struggled to achieve the required step change in the environmental performance of housing.

I left planning practice in 2008 to work in contract research. Within this environment it can be difficult to control the direction of your research due to the need to respond to current policy problems and dilemmas and to follow the availability of funding. This can make for impactful research but can make it difficult to carve out a niche of specific expertise. In spite of this, I have been successful in pursuing my long standing research interests in the built environment, the environmental performance

of housing and the relationship between dwelling and occupant both through and

alongside my contract research role, as the publications herein attest.

Bibliography

Ambrose, A., Goodchild, B and O'Flaherty F (forthcoming), Understanding user responses to low energy housing: a call for in-depth, qualitative methods. *Energy Research and Social Science*

Ambrose, A., Damm, C., Foden, M., Gilbertson, J. and Pinder, J. (2016) *Delivering Affordability Assistance to water customers: cross sector lessons*. Sheffield: CRESR, Sheffield Hallam University.

Archer, T. and Cole, I. (2016) *Profits before Volume? Major housebuilders and the crisis of housing supply*. Sheffield: CRESR, Sheffield Hallam University

Association for the Conservation of Energy (ACE) (2014) *Private rented sector energy efficiency regulations (domestic) (England and Wales). Consultation response submitted to Department of Energy and Climate Change*. ACE: London.

Ball, M. (1999) Chasing a snail: innovation and housebuilding firms' strategies, *Housing Studies*, 14(1), pp.9–22.

Banks, D. (2011) A brief summary of Actor Network Theory. Available from: https://thesocietypages.org/cyborgology/2011/12/02/a-brief-summary-of-actor-network-theory/ [Accessed 7th January 2017]

Barker R.G (1963). On the nature of the environment, *Journal of Social Issues,* 19:4, 17-38.

Barker R.G (1965). Explorations in ecological psychology, *The American Psychologist* 20:1, 1-14

Barker, A., Nancarrow, C. and Spackman, C. (2001), *Informed eclecticism: a research paradigm for the twenty-first century,* International Journal of Market Research. 43 (1), pp. 3-28

Future Marketers: Future Curriculum: Future Shock?. Available from: https://www.researchgate.net/publication/233551107_Future_Marketers_Future_Curriculum_Future_Shock [accessed Feb 8, 2017].

Barton B. (2012) *Energy Efficiency and Rental Accommodation: Dealing with Split Incentives*. Report for the University of Waikato Centre for Environmental, Resources and Energy Law. University of Waikato: Hamilton.

Bertilsson, T.M. (2004), The Elementary Forms of Pragmatism: On Different Types of Abduction, *European Journal of Social Theory* 7 (3), pp.371-389

Bradbrook A. (1991) The Development of Energy Conservation Legislation for Private Rental Housing. *Environmental and Planning Law Journal,* 8 (2), pp. 91-1107.

Bell, M. and Lowe, R., (2000). Energy efficient modernisation of housing: a UK case study. *Energy and buildings, 32*(3), pp.267-280.

Blowers, A. (1997) Environmental policy: ecological modernisation or the risk society? *Urban Studies*, 34(5 –6), pp. 845–871.

Boehm, M., Bowman, D. and Zinn, J.O. (2013). Survey research and the production of evidence for social policy. *Social Policy and Society*, 12:02, 309-18.

Callon, M and Law, J (1997). After the Individual in Society: Lessons on Collectivity from Science, Technology and Society. *Canadian Journal of Sociology* 22 (2). pp. 165-182.

Carmona, M. (2001) *Housing Design Quality*, Spon Press: London and New York

Centre on Innovation and Energy Demand (CIED) (2015). *Research Briefing 02: Low Energy Housing Innovations and the role of intermediaries* [online]. Available from: http://cied.ac.uk/files/file.php?name=3461-cied-research-briefing-nov-print.pdf&site=440. [Accessed 5th July 2016].

Chiasson,P. (2005). Abduction as an Aspect of Retroduction. *Semiotica* 153 (1/4): pp.223-242

Coatham V. and Jones T. (2008) Forgotten Voices? The importance of longitudnal evaluation of urban regeneration projects, *Journal of Urban Regeneration and Renewal*, 2, 1, 74-85

Cole, I., Hickman, P. and Reid, B., (1999). *Accounting for the uncountable: tenant participation in housing modernisation*. Joseph Rowntree Foundation: York.

Cooper-Marcus, C. (2005) House as a Mirror of Self: Exploring the Deeper Meaning of Home. Berwick, Me, Nicolas-Hays (1995 US original).

Cressman, D. (2009) *A brief overview of Actor-NetworkTheory: Punctualization, HeterogeneousEngineering and Translation*. [online]. Available at: http://blogs.sfu.ca/departments/cprost/wp-content/uploads/2012/08/0901.pdf [Accessed 4th January 2016]

Department for Communities and Local Government (DCLG) (2014) *English Housing Survey:*
Energy Efficiency of English Housing. Annual report on England's housing stock, 2012. DCLG: London

Department of Energy and Climate Change (DECC) (2011), The Carbon Plan: delivering our low carbon future. London, DECC.

Devine-Wright P (2007) Reconsidering public attitudes and public acceptance of renewable energy technologies: a critical review, Manchester Architecture Research Centre, University of Manchester, Working Paper 1.4

Geels, F.W. (2005). Technological Transitions and System Innovations: A Co-evolutionary and Socio-technical Analysis. Edward Elgar: Cheltenham

Geels, F.W and Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy* 36(3): 399–417.

Geels, F., Schwanen, T. and Sorrell S, (2015). *The socio-technical approach to low energy innovation: The research strategy of the Centre on Innovation and Energy Demand* [online]. Available at: http://cied.ac.uk/files/file.php?name=cied-research-strategy.pdf&site=440 [Accessed 31st May 2016]

Giddens, A. (1991), *Modernity and self-identity: Self and society in the late modern age*. Polity Press: Cambridge.

Goodchild, B. and Karn, V. (1997), *Standards, quality control and house building in Britain*. In Directions in Housing Policy: Towards Sustainable Housing Policies for the UK (Williams, P. (ed.)). Paul Chapman Publishing: London, pp. 156–174.

Gordon, W (1999), *Good thinking: a guide to qualitative research*. Admap: Henley-on- Thames

Go Well, (2012). Briefing Paper Number 17: Housing improvement, housing quality and psychosocial benefits from home. University of Glasgow.

Gram-Hanssen, K. (2013). Efficient technologies or user behaviour, which is the more important when reducing households' energy consumption? *Energy Efficiency,* 6 (3)

Gram-Hanssen, K. (2014). New needs for better understanding of household's energy consumption – behaviour, lifestyle or practices? *Architectural Engineering and Design Management* ,10(1-2)

Green Building Council (GBC) (2016). *Retrofit: domestic buildings [online].* Available at: http://www.ukgbc.org/resources/key-topics/new-build-and-retrofit/retrofit-domestic-buildings. [Accessed 24th October 2016].

Hajer, M. A. (1995), *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*, Oxford University Press: Oxford

Hargadon, AB. and Douglas, Y. (2001), When innovations meet institutions: Edison and the design of the electric light. *Administrative Science Quarterly* 46(3): 476–501.

Hawkey, D,. Webb, J., and Winskel, M. (2013). Organisation and governance of urban energy systems: district heating and cooling in the UK. *Journal of Cleaner Production*, (50), pp. 22-31.

International Energy Agency (IEA) (2007) *Mind the Gap: Quantifying Principal–Agent Problems in Energy Efficiency*. OECD/IEA: Paris.

Ittelson, W. H., Proshansky, H., Rivlin, L., & Winkel, G. (1974). *An Introduction to Environmental Psychology*. New York: Holt, Rinehart and Winston.

Jacobs, K. and Manzi, T. (2000), Evaluating the Social Constructionist Paradigm in Housing Research, *Housing, Theory and Society*, 17, pp. 35–42.

Jaffe, A. B. and Stavins, R. N. (1994) The energy-efficiency gap: What does it mean? *Energy Policy,* 22 (10), pp. 804-810.

Janda, K.B. (2011) Buildings don't use energy: people do, *Architectural Science Review,* 54 (1), p.15-22

Janicke, M. (2008) Ecological modernisation: new perspectives, *Journal of Cleaner Production,* 16, pp.557–565.

Kearns, A., Hiscock. R., Ellaway, A., and McIntyre,S. (2000), Beyond four walls: The psycho social benefits of home: Evidence from West Central Scotland, *Housing Studies,* Vol. 15, No. 3, pp. 387–410.

Kemp, P. (2011) Low income tenants in the private rental housing market. *Housing Studies,* 26 (7/8), pp. 1019-1034.

Kempton, J., (2004). Stock condition data for decent homes: impact of surveyors' judgments. *Structural Survey,* 22(3), pp.126-130.

Latour, B. (1999). On recalling Actor Network Theory. [online]. The sociological Review, 47 (S1), pp. 15-25.

Law, J. (1997). Traduction/Trahison: Notes on ANT. Available at: http://www.lancaster.ac.uk/sociology/stslaw2.html
[Accessed 7th January 2017]

Law, J. & Singleton, V. (2000). Performing Technology's Stories: On Social Constructivism, Performance, and Performativity. *Technology and Culture*, vol. 41, pp. 765-775.

Liddell, C. and Gray, B. (2014), *Fuel Poverty in Northern Ireland's Private Rental Sector*. Ulster University: Londonderry

Loorbach, D. (2010), Transition Management for Sustainable Development : A prescriptive, complexity based governance framework. Governance, 23 (1). pp.161-183

Lynch K & Hack G (1984). *Site Planning*. MIT Press: Cambridge

Marshall S (2011) 'Them and Us'- thinking of the User. *Journal of Urban Design and Planning*, 161, DP2.45

McCarthy, L., Ambrose, A., and Pinder, J. (2016) *Energy (In)Efficiency: Exploring what tenants expect and endure in the private rented sector in England.* Eaga Charitable Trust: Kendal

Milne, G. and Boardman, B., 2000. Making cold homes warmer: the effect of energy efficiency improvements in low-income homes A report to the Energy Action Grants Agency Charitable Trust. *Energy policy*, *28*(6), pp.411-424.

Morrison, N., (2013). Meeting the Decent Homes Standard: London Housing Associations' Asset Management Strategies. *Urban Studies*, p.0042098012474512.

Mourik, R., Rotmann, S and Breukers, S. (2012). *Development of a policy evaluation framework to monitor and evaluate DSM projects: A theoretical underpinning of the proposal* [online]. Available at: www.ieadsm.org/publication/t24-initital-paper/. [Accessed 5th December 2016]

Onwuegbuzie, A.J. and Leech, N.L. (2005). On becoming a pragmatic researcher: The importance of combining quantitative and qualitative research methodologies. *International journal of social research methodology*, *8*(5), pp.375-387.

Palmer, J., and Cooper, I. (2013), *United Kingdom housing energy fact file.* Department of Energy and Climate Change: London

Popov, L and Chompalov, I (2012), Crossing Over: The Interdisciplinary Meaning of Behavior Setting Theory, *International Journal of Humanities and Social Science* 2, (19)

Prendergast, J., Foley, L., Menne, V., and Isaac, A. (2008), *Creatures of Habit: the art of behavioural change*, Social Marketing Foundation

Raven R (2007) Co-evolution of waste and electricity regimes: multi-regime dynamics in the Netherlands (1969–2003). *Energy Policy* 35(4), pp.2197–2208.

Reckwitz, A. (2002) Toward a Theory of Social Practices: A Development in Culturalist Theorizing , *European Journal of Social Theory,* Vol. 5 (2), pp. 243-263

Rutland, T and Aylett, A. (2008). The work of policy: actor networks, governmentality, and local action on climate change in Portland, Oregon. *Environment and planning D Society and Space,* (26). pp.627-646

Rydin, Y. J., & Tate, L. (Eds.). (2016). *Actor networks of planning: exploring the influence of actor network theory.* Routledge.

Saunders, P. (1990), *A nation of home owners,* Unwin Hyman: London.

Schatzki, T. R. (2001). *Introduction: Practice Theory.* In The Practice Turn in Contemporary Theory, edited by Schatzki, T., Knorr Cetina, K., and Von Savigny,E. 10–23. Routledge: London

Schatzki, T. R. 2002. *The Site of the Social. A Philosophical Account of the Constitution of Social Life and Change.* University Park: Pennsylvania State University Press. Schatzki 1996

Seamon D (1982) The Phenomenological Contribution to Environmental Psychology, *Journal of Environmental Psychology*, 2, 119-140

Seamon D (2000). A way of seeing people and place: Phenomenology in environment-behavior research. In: S. Wapner, J. Demick, T. Yamamoto and H. Minami, Editors,*Theoretical perspectives in environment-behavior research*, Kluwer Academic/Plenum Publishers, New York.

Shove E (2003) Converging Conventions of Comfort, Cleanliness and Convenience, *Journal of Consumer Policy*, 26:4, pp. 395–418

Shove E (2009*) Habits and their creatures* [online]. Available at:. Available at: http://www.research.lancs.ac.uk/portal/en/publications/habits-and-their-creatures(fff7464b-6b27-4d45-a71c-2a3cb10c472c)/export.html . [Accessed: 16th June 2016]

Shove E. (2010). *Beyond the ABC:* climate change policy and theories of social change *Environment and Planning A,* 42:6, pp. 1273-85

Stevenson F, Carmona-Andreu I & Hancock M (2012). *Designing for comfort - Usability barriers in low carbon housing.* Proceedings of 7th Windsor Conference: The Changing Context of Comfort in an Unpredictable World.

Stevenson F, Carmona-Andreu I & Hancock M (2013) *The usability of control interfaces in low-carbon housing.* Architectural Science Review, 56(1), pp. 70-82

Stevenson, F. and Leaman, A. (2010) Evaluating building performance in relation to human behaviour: new challenges, *Building Research and Information*, 38 (5) pp.437-441

Sunikka-Blank, M. and Galvin,R. (2012). Introducing the prebound effect: the gap between performance and actual energy consumption, *Building Research and Information*, 40 (3) p.260-273

Walker, G. and Day, R., 2012. Fuel poverty as injustice: Integrating distribution, recognition and procedure in the struggle for affordable warmth. *Energy policy*, 49, pp.69-75.

Winner, L., (1993). Upon opening the black box and finding it empty: social constructivism and the philosophy of technology. *Science, Technology, & Human Values*, 18(3), pp.362-378.