Visions of Domestic Electricity Use in a Changing Sociotechnical System

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Declaration

This work has not been submitted in substance for any other degree or award at this or any other university or place of learning, nor is being submitted concurrently in candidature for any degree or other award.

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Summary

The domestic sector accounts for approximately one third of the UK's energy demand. As such there is scope for significant change in domestic electricity demand to facilitate the transition towards a more sustainable electricity system. This thesis uses qualitative focus groups and interviews with public and expert participants to investigate how and why electricity is used in the home, and to unpick the assumptions within visions of possible future change to the electricity system. Public and expert interviewee suggestions for changes to increase the flexibility of domestic demand (a key aspect of enabling increased penetration of renewable generation technologies) were rooted in ecological modernisation, where technological solutions such as home automation were advocated as the most appropriate mechanisms for achieving change. Additionally, experts posited that information provision about the need for change to the wider electricity system, and thus ways in which people use electricity in the home, would 'educate' the public and result in acceptance and change. Solutions adopting assumptions of economic-rationality were also identified in public and expert discourse, where financial mechanisms were suggested to have the ability to influence behaviour. However, contradictory evidence suggested that financial mechanisms will not provide sufficient incentives for change, as people instead are influenced more directly by the desire to fulfil immediate needs. Despite this, evidence was found amongst residents with solar photovoltaic panels, who had shifted their electricity demand to synchronise with times of maximum solar electricity generation to save money, suggesting that in some contexts people may change behaviour in response to financial interventions. Implications for further research are discussed, along with the need for public participation and engagement in innovation processes to be conducted further upstream to enable the various hopes and concerns relating to visions of possible change to be accommodated for in policy and technological innovations.

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List of Abbreviations

The following abbreviations are used in this thesis:

CCC	Committee on Climate Change
DC	Direct Current electricity
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
FiT	Solar Feed-in Tariff
HVDC	High Voltage Direct Current
IPPC	Intergovernmental Panel on Climate Change
MLP	Multi-Level Perspective (Model of technological transitions; Geels, 2002)
RCEP	Royal Commission on Environmental Pollution
Solar PV	Solar Photovoltaic panels that convert solar energy into direct current (DC) electricity
STS	Science and Technology Studies
UKERC	UK Energy Research Centre

1 Introducing the Thesis: Domestic Electricity Use in a Changing Sociotechnical System

1.1 Introduction and Context

Electricity networks are vast, complicated systems that have co-evolved with society to influence (and be influenced by) how we behave in the home, workplace and other contexts. They can only function if electricity demand and supply are balanced, and instigating change or developments in their operation will only be achievable if they can be integrated into existing routines of functioning social processes, or if new routines, behaviours and social processes can be established (Grunwald, 2012). As such, understanding the meaning associated with electricity use – and the practices and routines that electricity enables – is vital if desired changes in electricity system management are to be achieved.

Changes in societal use of – and indeed reliance upon – electricity, coupled with legislation and political motivations for change have resulted in the need for significant changes in relation to how electricity is generated, distributed, used and managed. As such, the UK government faces the challenge of transitioning towards a future electricity system which is simultaneously more secure (in terms of providing and maintaining a sufficiently reliable supply of energy provision); affordable (to ensure that people with differing financial means have access to and can afford to use energy in their everyday lives); and lower-carbon (reducing Carbon Dioxide emissions from the generation and distribution of electricity) (CCC, 2010). This 'energy trilemma' was neatly summed up in 2014 by then-Secretary of State for Energy and Climate Change, Ed Davey, who described the "*challenge of keeping the lights on, at an affordable price, while decarbonising our power system*" (DECC, 2014a).

Until relatively recently, despite scientific consensus linking observations of global changes in climate to anthropogenic greenhouse gas emissions (*e.g.* IPCC, 2001; 2014), climate change was considered as a somewhat peripheral issue, remaining low down the political agenda as seemingly just one of numerous other environmental issues facing society. However, following criticisms of energy and climate change policy (*e.g.* RCEP, 2000), environmental campaigning and increasing public awareness and concern (Capstick *et al.*, 2015) the Climate Change Act was introduced in 2008 (HM Parliament, 2008). This legislation formally committed the UK to achieving an 80% reduction in greenhouse gas

emissions (from 1990 levels) by 2050. As a result, increased emphasis in the development and planning for the future operation of the UK electricity system has been placed on achieving significant reductions in Carbon Dioxide emissions from the electricity sector.

Renewable energy generation technologies are viewed as key mechanisms for decarbonising the UK electricity system (DECC, 2011). By gradually replacing fossil-based generation (such as coal or gas-fired power stations) these technologies will contribute towards the reduction in emissions from the electricity sector. However, many renewable technologies (such as wind turbines) provide intermittent, fluctuating supplies of electricity (Albadi and El-Saadany, 2010), which makes balancing supply and demand a more difficult endeavour when compared to the more manageable, schedulable and guaranteed supply provided by traditional sources. This is further compounded by the fact that currently no technology – with the exception of pumped hydro-power, which has limited scope for capacity expansion – exists that enables electricity to be economically stored in significant capacity (Patterson, 2007), effectively meaning that whenever it is generated it needs to be distributed and used instantly. For this reason, there will need to be a shift in the emphasis of how the electricity system is managed. Currently, electricity demand is relatively predictable, and generation can be scheduled to meet this demand as the output from coal and gas-fired power stations are altered when necessary. However, with a potentially less predictable, more fluctuating supply of electricity within a future network incorporating a higher proportion of renewable generation technologies, meeting this demand will become much more complex from a systems operation perspective. As such, many visions of future electricity systems involve the ambition for electricity demand to become more flexible. Possible mechanisms for achieving this involve and require both technological and behavioural changes to influence how and when electricity is used.

In addition to developing lower-carbon forms of energy generation, efforts also need to focus on ways in which electricity demand can be reduced and made more flexible. Today, the domestic sector accounts for 23% of UK carbon emissions (CCC, 2010) and approximately one third of the UK's total energy consumption (DECC, 2012a). As such, households represent a significant proportion of the UK's contributions to climate change and electricity demand. For this reason, there is scope for significant change to be achieved if the ways in which electricity is used within the home can be altered. However, in order for potential policies or technological innovations to be successfully applied and adopted

within the domestic sector, it is vital that the dynamics of how and why electricity is used in the home are understood, to enable informed, appropriate strategies to be devised.

1.2 Rationale and Research Objectives

The ways in which people use energy in the home is an extensively researched area, with scholars approaching the topic from a range of disciplines and perspectives including sociology, psychology, economics, engineering and geography. Chapter 2 discusses how the thesis draws primarily upon insights and perspectives from sociology and psychology to portray the dynamics of how and why electricity is used in the home. By understanding public perceptions towards – and understandings of – components of possible electricity system change, meaningful insights that can identify possible opportunities for – or barriers against – change can be obtained. In addition to aiming to understand the meaning that underlies the reasons for how people think about and currently use electricity, a central tenet of this thesis involves investigating public and expert imaginations of how the electricity system may change in the future, as well as the aim of understanding the implications these may have for electricity use in the home. Little existing research has combined expert and public visions of future change to how electricity may be used in the home. Visions of possible change involve a range of assumptions, hopes and concerns with technological, economic, social and psychological components. As such, investigating these visions can provide wide-ranging insights that highlight potential implications for policy makers, electricity users and designers of associated technologies to name but a few.

The aims of this thesis are thus to identify and understand how people use and relate to electricity in the home; what future change to the UK electricity system public and expert participants expect (and hope) to occur; and how possible change may impact upon how electricity is used in the home. In order to achieve this, and to provide a focus to more explicitly steer the research to ensure that the aims of the thesis could be achieved, the following research questions were devised:

1) How do people understand and interact with their existing electricity supply system in the home?
2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

Based on an interpretive qualitative design, the research adopted an iterative, grounded approach, and aimed to answer these questions through three stages of empirical research:

- **Phase 1:** Involved focus groups with members of the public to investigate how people think about electricity, perceptions towards components of the electricity system, consumption-related behaviour and practices, and to understand the underlying meaning behind reasons for how and why people use electricity in the home.
- **Phase 2:** Involved interviews with experts to identify possible future changes to the UK electricity system and to investigate the hopes, concerns and motivations within expert visions to understand and highlight the perceived need for, and mechanisms to achieve, change.
- **Phase 3:** Involved follow-up interviews with focus group participants to further investigate people's relationships with electricity in the home and build upon insights drawn from the focus groups. Participants were also presented with resources that described and presented representations of possible future change to enable perceptions and views towards possible future change to be identified, enabling an understanding of possible perceived opportunities for, and barriers to, change to be obtained.

1.3 Structure of the Thesis

Chapter 1, Introducing the Thesis: Domestic Electricity Use in a Changing Sociotechnical System provides an introduction to the thesis, presenting the rationale and aims of the research, in addition to defining a number of key terms used throughout the thesis. With political obligations for transitioning towards a lower-carbon electricity system ensuring a secure and affordable supply, significant changes to the system need to be adopted. This thesis thus presents how and why people use electricity in the home, and explores visions of (and perceptions towards) possible future change and the possible implications this may have for domestic electricity use.

Chapter 2, Literature Review presents a detailed review of existing literature that informs and supports the thesis. Relevant research into sociological, psychological and economic models of behaviour relating to energy use are discussed and critiqued, enabling the approach adopted within the thesis to be defined. Literature relating to the study of visions and expectations of the future is also discussed, along with the rationale for how sociotechnical imaginaries may be practically identified and investigated. This chapter highlights gaps in and limitations to existing literature and presents how the aims of the research were defined, in addition to how the rationale was developed (discussed in greater depth in Chapter 3).

Chapter 3, Methodology discusses the epistemological and methodological underpinnings of the thesis. Detailed justifications for, and descriptions of, the interpretive qualitative approach are presented. Specific explanations of the ethical considerations and methodologies employed within the three research phases are provided, followed by an extensive overview of the grounded data analysis process undertaken. Finally, a reflexive account of the entire research process (and the inevitable role that the researcher played within this) concludes the chapter.

Chapter 4, Empirical Findings 1 - Electricity in the Home: How do People Think About, Talk About and Use It? addresses research questions 1) and 4) and focuses on the way people relate to, think about and use electricity in the home. As such, these findings are drawn primarily from the Phase 1 public focus groups, with extra insights that were obtained in the clarification of themes during the Phase 3 follow-up interviews. Findings include insights relating to the awareness of electricity use; the meaning associated with practices or routines in the home that rely upon electricity; financial considerations of

electricity consumption; and biographical reflections upon the changing use of energy over time.

Chapter 5, Empirical Findings 2 – Expert Understandings of Domestic Electricity Use and Expectations for Future Change focuses on expert understandings of domestic electricity use and their expectations for future changes to the electricity system, with the aim of answering research questions 2) and 3). Findings include a discussion on the expectations of future change identified within participants' discourse, and as such are drawn primarily from the Phase 2 expert interviews. Participants' motivations for the need for change in the UK electricity system are explored, as well as how they expect this may – and should – be achieved. Implications of these possible changes are highlighted along with a reflection on the assumptions and contradictions identified.

Chapter 6, Empirical Findings 3 – Imagining and Responding to Change: Public Visions of Possible Change to Electricity in the Home explores public understandings of components of the electricity system and how electricity is used in the home, with particular focus on expectations of how this may change in the context of emerging policies and technological developments. As such, findings presented in this chapter help to answer research questions 2), 3) and 4). Various concerns, assumptions and contradictions relating to possible change are identified, along with a reflection on the impacts this may have for future strategies to achieving change.

Chapter 7, Conclusions synthesises the empirical findings presented in the thesis. Key findings are discussed in relation to how they answer the research questions and help to achieve the aims and objectives of the thesis. Novel contributions of the work are highlighted, in addition to a reflection upon the possible limitations of the research. Finally, the chapter concludes by providing a discussion on the implications that the findings have for policy design, technological innovation and further research.

1.4 Definitions

It is important to clarify and briefly define a number of key terms that are used throughout the thesis. Whilst it is acknowledged that for some of the terms used there are multiple possible definitions, the definitions provided in Table 1 refer to all uses of the terms throughout the thesis, unless explicitly stated elsewhere.

Table 1: Definitions of commonly used terms and concepts within the thesis

Term	Definition
House/House-hold/Home	Whilst it is acknowledged that terms such as house/household/home are often used interchangeably, the meaning of these terms do differ (even if they are closely related) and as such need to be differentiated (Blunt and Dowling, 2006). Within this thesis, 'house' is taken to mean the physical structure of a dwelling, and refers to material or technical elements of the building itself. 'Household' may also simply refer to the material or technical elements of the house, and may additionally incorporate references to other people in the 'house' (*i.e.* other members of the household). In contrast, the concept of 'home' is broader, and is understood as being multidimensional. It incorporates personal and social meanings that connect the material with the emotional, as well as with identity and culture. These terms are used differently within this thesis to refer either to the material property and make up of a house or household, or more broadly to portray the deeper meanings associated with creating and maintaining 'home'.
The Public	This thesis recognises the existence of multiple 'publics' rather than a single homogeneous 'public', which emerge in relation to specific issues and are inseparable from their contexts. Indeed, care is taken to ensure that discussion and interpretation of findings maintains this awareness of multiple publics, and that findings from public interviews are not necessarily representative of the wider public. However, for brevity and to avoid the repetitive use of the unwieldy term 'publics', discussions of findings from public participants in the research refer simply to 'public', (*i.e.* in convention with terminology often used in public perception research; Whitmarsh and O'Neill, 2011).
Experts	Lowe and Lorenzoni (2007) state that there is no universally agreed definition of what an 'expert' actually is. Furthermore, STS scholars have argued that with increasing public engagement and participation in science, the boundary between experts and the public has often tended to blur, with 'lay' expertise often holding equal – or more – validity in some contexts than more traditional notions of expertise. Whilst acknowledging this debate, practical considerations have also influenced the use of the term 'expert' throughout this thesis. The range of Phase 2 interview participants from different academic backgrounds (including economics, sociology and various disciplines within engineering) makes a 'catch-all' term to describe this participant sample difficult to devise. For this reason, the term 'expert' is used throughout the thesis to refer to Phase 2 expert interviewees. A more in-depth description is provided in Chapter 3.

Smart Meters	Definitions of smart meters and visions of their possible role in transitioning towards a 'smarter' grid incorporating more renewable generation vary. Indeed, obtaining official definitions of what domestic electricity smart meters are and the role they will perform is a seemingly impossible task. Nevertheless, DECC (2014b) have published a specification of the minimum physical and functional requirements for smart meters that will eventually be rolled-out to all homes in the UK (Roscoe and Ault, 2010). Aspects of these (*e.g.* the ability to measure electricity consumption and display feedback on this) are already found in commonly available energy monitors. However, most definitions of smart meters move beyond the basic functions of energy monitors. Indeed, a key aspect of smart meters is defined by many as the ability of two-way communication between users and suppliers to enable smoother operational efficiency by the provision of more accurate, real-time data. Expert interviewees referred to and explained their understandings of smart meters, with some aspects of these common to all descriptions. As such, whilst acknowledging that many other aspects, definitions and functions relating to smart meters exist (such as the ability to manage and automate demand), unless stated elsewhere, the basic term 'smart meter' used throughout the thesis refers to a device that: measures electricity consumption; can read data remotely via a device in the home (*i.e.* does not require meter readers to inspect readings), provides information to users on their electricity use (via an in-home display attached to the smart meter), and is capable of two-way communication between the user and system operators.

2 Literature Review

This chapter provides the rationale for the structure and approach employed in the thesis and is supported by and based upon a review of relevant literature. It aims to provide reasons for using the chosen methods (discussed in Chapter 3) and how these enable the research questions to be answered. Whilst the thesis does not draw upon a set theoretical framework for analysis – instead adopting a pragmatic, grounded theory approach that aims to draw upon a range of social-scientific literature to inform both the design and analysis – it does incorporate insights that are informed by a broad body of literature. Existing research encompassing expectations and imaginations of the future; public perceptions of risk; and differing social-scientific and economic approaches to investigating energy use in the home will be discussed, with particular shortcomings or gaps that provide an opportunity for further examination being highlighted. In summary, the chapter aims to discuss how the research conducted for this thesis has drawn upon and been influenced by existing literature, and how this thesis will further contribute to the literature.

2.1 Researching the Future

A central aim of the thesis is to investigate visions of possible future changes to the UK electricity system and how this may influence electricity use in the home. As such, the thesis draws upon a range of literature that focuses on future-oriented research, including: sociotechnical imaginaries; promissory narratives, the sociology of expectations and public perceptions. This section aims to critically review and demonstrate how the research undertaken for this project has drawn upon this literature, as well as identifying gaps that contributions from this thesis can attempt to fill.

2.1.1 Researching the Future: Sociotechnical Imaginaries

The term 'sociotechnical imaginaries' refers to a concept that is emerging from recent Science and Technology Studies (STS) research. Broadly, it refers to the ways in which scientific, technical projects develop and how visions of these simultaneously describe attainable societal futures and prescribe the kinds of futures that ought to be attained. The

concept has been applied to help investigate the development of particular scientific fields and the way in which products and outcomes of these research areas have been incorporated in society. Notable examples include Jasanoff and Kim's (2009) analysis of national nuclear policies, and Pickersgill's (2011) exploration of the evolving relationship between neuroscience and law.

To understand how the concept can be applied to this thesis, electricity cannot be considered purely as a scientific phenomenon or technology. Electricity and the means through which it is produced, distributed and used, exists within a sociotechnical system, as changes in the technical properties of electricity provision ultimately impact upon society and actors who use this commodity. For this reason an STS approach to studying electricity systems is perhaps the most appropriate method of understanding the intricacies of system evolution, as attention is given to the co-evolution of technological developments and behaviour. Jasanoff (2005) posits that the ways in which social order is created around science and technology involve more than simply producing scientific knowledge as an end in itself. Furthermore, public interest stems from questions referring to how science and technology should constitute lives and future society, and that answers to these questions help form imagined futures which feed back into shaping the focus, aims and approaches of further scientific endeavours.

The ability to imagine futures is deemed to be an important element of socio-political development (Sarewitz, 1996) that enables positive goals to be identified and realised. Castoriadis (1987) argues that imagination can be considered to take on more complex, significant roles than simple aesthetic visions in individuals' minds. Indeed, Anderson (1991) suggests that imagination forms the basis for collective viewpoints and attachments to particular political communities. Jasanoff and Kim (2009) summarise imagination as an organised field of social practices that acts as a crucial factor in creating social order. In contrast to the perhaps commonly held assumption that historical scientific and technological developments have been primarily achieved as a result of the creative imagination of individual engineers, designers and scientists, Jasanoff and Kim argue that these are the products of shared visions and promises embedded within scientific practices shaped by social organisation. They suggest these 'technoscientific imaginaries' – coined by Marcus (1995) – have been so deeply embedded that they have informed and shaped research trajectories and heavily influenced scientific endeavour and development. A key consideration of their argument involves the emphasis on desired, attainable futures –

where possible trajectories of science and technology do not rely solely on technological practices, as they are channelled to meet public needs. This consideration of the role of technology in meeting public, societal requirements accounts for the term 'sociotechnical imaginaries' and helps identify and define the concept, enabling it to be applied to specific sociotechnical systems. When attempting to unpick and illuminate differences in national nuclear policies, Jasanoff and Kim (2009: 120) define sociotechnical imaginaries as:

> "C*ollectively imagined forms of social life and social order reflected in the design and fulfilment of specific scientific and/or technological projects."*

These imaginaries differ from policy agendas, which are much more specific and directed towards achieving targeted goals. They exist in the background of the public psyche and project visions of worthy, feasible futures. Jasanoff (2005) also states that imaginaries are different from narratives of the future which arguably involve much broader mind-sets and visions of the wider roles of science – such as the narrative prevalent in modern, western society that purveys science as 'progress'. Attempting to investigate and identify imaginaries provides the researcher with interesting methodological challenges. As they exist and operate in the background – and in the unstated, implied gaps between and within more overt political discussions – it can be difficult to identify specific imaginaries and the role that these have had in the development of socio-technical systems. Furthermore, whilst Jasanoff argues that imaginaries differ from narratives, they remain closely linked and operate within similar spheres of discourse. Indeed, Macnaghten's (2010) analysis of the use of narratives in technoscientific concerns towards emerging nanotechnologies identified dominant frames that promised and reflected varying visions of what impacts future nanotechnologies could have. These included one that promised revolutionary changes to human capacities and capabilities that would enable people to transcend and overcome natural constraints; one that identified nanotechnology as a new science that would contribute to cross-sector breakthroughs in scientific research endeavours; and one that focused on the risks and uncertainties of nanotechnology running out of control and affecting human health and the environment. Macnaghten suggested that these frames involved more than purely a discussion of what nanotechnology is, moreover they depicted what nanotechnology can explain and what it can represent. This argument echoes Jasanoff's definition of imaginaries that describe and prescribe attainable societal futures.

Through comparing the case studies of the USA and South Korea, Jasanoff and Kim (2009) were able to identify significant differences in their respective nuclear policies. By analysing the development of nuclear technology through time and how this technology was embraced by the two nations, they unpicked and identified imaginaries that lay beneath the surface and helped explain the differences in uptake and application of the technology. Both imaginaries of the role of nuclear energy were found to be closely linked to the relationship between the state and society as well as changing interpretations and ideas towards democracy. The USA, as one of the pioneers of the technology itself and the only nation to have used atomic weaponry in war to date, imagined the role of nuclear technology as a peacekeeping tool, and as such, nuclear policies were tailored to reduce risk and achieve and maintain peace. In contrast, South Korea saw socio-economic development as a crucial target, and identified nuclear power as a key mechanism for this development. Indeed the motivation for the state to promote indigenous nuclear capability and become a figurehead of economic development was so powerful that the benefits of nuclear power to society were often considered to outweigh the potential safety and risk issues – much more so than in many western states like the USA. Whilst Jasanoff and Kim were able to identify the ways in which differing national imaginaries of nuclear technology manifested themselves in state policy, it is difficult immediately to consider how this wide-scale, national-level approach could be usefully applied to electricity system evolution in the context of understanding the dynamics of how and why people use electricity in the home and how they expect this to change in the future.

It could perhaps be assumed that imaginaries are more readily identifiable on larger, national (as opposed to sub-national) scales because magnified disparities between policies towards specific technologies and their roles in society may be more easily recognised. Despite this consideration, it could be argued that attempting to delve deeper into sub-national psyches, visions and policies may be a fruitful way of understanding how imaginaries interact with and influence the development of different technologies within society, and could perhaps be a more appropriate angle of approach for the PhD research. Indeed, there has been little research to date on imaginaries of energy within domestic contexts. This thesis aims to contribute towards addressing this research gap and demonstrate how visions portray imagined hopes and concerns that relate to possible technological innovations and the expected role that they may play in domestic life (for example enabling more control of demand for different imagined users). Pickersgill (2011) investigated the role of imaginaries in the rapidly-evolving relationship between

neuroscience and the law. By studying scientific literature, conventional media coverage and new media platforms such as blog posts Pickersgill conducted a critical discourse analysis. Additionally, participant observation at conferences, workshops and other events was employed to gain an understanding of dominant and emerging neuroscience discourse. This design was adapted from Jasanoff and Kim's (2009) historical approach to build upon recent sociological research on expectations (Hedgecoe and Martin, 2003; Nerlich and Halliday, 2007; and Wilkie and Michael, 2009) to inform how sociotechnical imaginaries influenced practice and discourse and prescribed roles of neuroscience in existing and future laws.

Pickersgill (2011) identified debates on lie detection and free will – which are commonplace in neuroscience discourse – and found emerging visions, disagreements and debates on the ways in which these new 'tools' could, and perhaps should, be embedded within law. Perhaps the most contentious debate revolved around the idea of free will, which forms the basis of our legal system. Research into decision making undermines support for the concept of free will (stemming from Libet's (1985) pioneering work on pre-emptive subconscious decision making), which ultimately questions the validity of this aspect of the legal system itself. Littlefield (2009) discovered that much of the literature surrounding these debates contains assumptions about the brain and the differing ways in which it can be perceived to impact upon the notion of 'self'. It is this ability to identify the underlying, implicit assumptions within imaginaries that makes this approach valuable in STS research. As such, this perspective was adopted in the development of the research strategy (see methodology and data analysis sections in Chapter 3) because it was hoped that providing participants with opportunities to talk at length about their imagined futures would enable the underlying assumptions in their responses to be identified (thus contributing towards answering research questions 2, 3 and 4).Building on this, Pickersgill argued that imaginaries that shaped the discourse could be identified to highlight how different future legal scenarios could be borne through the adoption of neuroscience breakthroughs. In common with much research on energy use, there is an emerging emphasis on inter-disciplinary collaboration in the field (Barry *et al.*, 2008), with neuroscientists working alongside economists, lawyers, politicians and educational specialists to forge new connections. This process has helped shape particular imagined visions towards how law should adapt to emerging insights from neuroscience, and Pickersgill argues that this collaboration has helped strengthen the shared imaginaries by producing "stickiness through being able to bring together the main players in the field" (Molyneux-Hodgson

and Meyer, 2009: 141). Parallels can be drawn with Stephens' (2010) work on 'promissory languages' of In-Vitro meat (IVM), where scientists and other stakeholders 'promise' the benefits of this innovative production method to attempt to garner financial, political and moral support for their research. This collaborative support is a key driving force in invoking imaginaries related to the future adoption of neuroscience findings into law. As a controversial, contested field, strong opposition to potential future 'neuro-law' exists. These provide what Pickersgill terms 'counter-imaginaries' that provoke images of negative expectations as a result of neuroscience being granted greater significance in legal policy. However, Nerlich and Halliday (2007) argue that the majority-view 'pro' neuro-law imaginaries prevail over the 'counter-imaginaries' and suggest that rather than dampening efforts to embed neuroscience more firmly in law, the increased debate helps generate more interest in the field as a whole, which prompts further investment and research in neuroscience, thus moving anticipatory discourse further upstream and embedding the 'pro' neuro-law imaginaries more deeply. Similar sentiments have been identified in Macnaghten's (2010) research into technoscientific concerns surrounding nanotechnologies, where fears over adverse public relations and an image backlash – similar to those surrounding genetically modified (GM) food – have highlighted the need for social science and public engagement to be incorporated into research projects. Whilst Stephens' analysis is more focused on a narrower group of scientists and other interested parties, (compared to the wider focus of Pickersgill's approach) both investigations have found that by working together to promote the imagined future developments of their fields, the two case studies have created 'important incubators' (Pickersgill, 2011: 36) for the emerging sociotechnical trajectories. As such, the research approach adopted within the thesis draws upon theoretical insights and considers the methodological approaches employed by Pickersgill (2011) and Stephens (2010) to aim to identify the ways in which visions of the future are portrayed and how this may impact the development of the UK electricity system.

2.1.2 Researching the Future: Sociology of Expectations

As discussed above, investigating imaginaries and promissory narratives can help to provide insights into how visions of the future impact upon the development of sociotechnical systems. However, these approaches – often centring on discourse analyses

– target broad phenomena such as national nuclear policies, and are arguably not able to identify the dynamics and individual differences that exist in people's individual understandings of and relationships with their electricity supply, as well as the hopes and concerns embedded within their imaginations of the future. For this reason a methodology drawing upon approaches from literature on the sociology of expectations – involving interviewing public and expert participants and asking about their expectations of the future (see Chapter 3) – was decided to be the most appropriate way to obtain deep and meaningful data to illuminate how public and expert interviewees imagine possible future change. Additionally, by attending relevant academic events and conferences, keeping abreast of policy developments and literature (*e.g.* academic and professional) and considering how the UK electricity system has developed over time (*e.g.* Hughes, 1983) and may change in the future – mirroring aspects of Pickersgill's (2011) approach – it was anticipated that further insights could be obtained to assist the analysis.

Expectations are '*real time representations of future technical situations and capabilities*' (Borup *et al.*, 2006: 285) and are '*wishful enactments of a desired future'* (*ibid.*: 286). As such, expectations are generative and performative in the sense that they help to mobilise interest and resources relating to emerging technologies or fields, which van Lente (1993) describes as 'forceful fictions' that drive the evolution and development of sociotechnical systems. Work into the sociology of expectations adopts a constructivist position because the emphasis is placed on the construction and enactment of futures past, present and yet to come. However, Borup *et al.* (2006: 289) argue that investigating the role of expectations is problematic from a constructivist stance given that anticipation is constitutive of value. Indeed, they suggest that '*we cannot logically differentiate between the expectation of things and what those things actually are*'. In other words, as future visions work back on and play an active role in the formation of the present, it is logistically difficult to differentiate between the present and the future. Brown and Michael (2003) refer to how people reflect upon memories of past futures to help to manage or engage with the future. They argue that this relationship between 'retrospecting prospects' (*i.e.* recollecting past expectations and representations of the future) and 'prospecting retrospects' (drawing upon these recollections to inform how they imagine the future) can influence people's expectations and how they perceive 'real life' to be influenced by these. Furthermore, Borup *et al.* (2006) suggest that the role expectations play in sociotechnical system development almost inevitably results in disappointment because imagined futures rarely come to fruition. However, despite this, van Lente (1993) maintains that expectations play a vital role in creating a 'protective space' for emerging

technologies. This echoes similar notions from the imaginaries literature (*e.g.* Pickersgill, 2011) and fits with Geels' (2002) assertion that novel technologies need to be protected in these 'incubating' niches to enable them to develop, improve and diversify.

Asking people how they imagine the future can be a useful way to understand the dynamics that influence their expectations (Coveney, 2010). Visions of the future function as rhetorical devices for participants to explore hopes, promises and concerns. As such, it was anticipated that asking participants about their visions relating to the electricity system and possible future changes in domestic electricity use would help to identify relevant components that influenced their views towards and expectations of future change. Research into sociotechnical imaginaries and the role of expectations in the development of sociotechnical systems has often focused on emerging technologies. However, a novel aspect of this thesis is the focus on investigating an existing sociotechnical system – the UK electricity system – and how this may change in the future. As such there is a range of different dynamics which make this research novel and ensure that the work addresses gaps and contributes towards the growing literature in this field. A key aspect of this is the aim of policy makers and network planners to transition towards a lower-carbon electricity network, whilst ensuring electricity supplies remain both secure and affordable. This involves an interesting dynamic where significant change needs to occur in how electricity is used in the home (including reducing and shifting electricity demand, which may involve novel technologies such as smart meters and automation) (Jamasb and Pollitt, 2011), yet at the same time many imagined visions involve striving to maintain the existing 'status quo' and expectations relating to how people use and rely upon electricity in their everyday lives. For this reason it was deemed valuable to probe both public and expert imaginations of the future to identify the hopes, concerns and assumptions that influence and make up these visions.

2.1.3 Researching the Future: Public Perceptions of Energy System Change

Energy system change incorporates an interconnected set of transformations in supply, demand, wider infrastructure and behaviour. As such there are a whole range of factors that need to be considered from the perspective of public attitudes and perceptions. For this reason there are numerous components of the wider energy system that have been the focus of sociological and psychological research – amongst other disciplines. It is outside

the aims and scope of this section to include an extensive review of literature on public perceptions relating to the myriad components of the energy system, however, this section aims to provide a brief overview of the literature directly relevant to this thesis, and how it has informed the approach.

Research into public attitudes and perceptions towards aspects of the energy system is well established. Indeed, Demski *et al.* (In Press) note that public acceptability is recognised as being 'critically important' in processes of energy system change, which presents both challenges and opportunities for the development of energy policy. Research has been undertaken to investigate public perceptions towards – and values that influence opinions of – topics including, but not limited to, Shale Gas (*e.g.* Whitmarsh *et al.,* 2014); Energy Security (*e.g.* Demski *et al.,* 2014); Nuclear Power (*e.g.* Corner *et al.,* 2011); Demand-Side Management (*e.g.* Spence *et al.*, 2015) and Geoengineering (*e.g.* Corner *et al.,* 2012; Corner and Pidgeon, 2014). However, Butler and Demski (2013) highlight a gap in the literature relating to research on perceptions towards wider energy system change.

This is particularly important in relation to this thesis as perceptions towards specific technologies, developments or other components of energy systems can arguably not be fully understood without taking attitudes and opinions towards other technologies or system components – coupled with environmental, financial and other concerns – into account (Whitmarsh *et al.*, 2011). Wang (2010) suggests that this may perhaps be a result of much 'interdisciplinary' research undertaken in the UK still being confined to some extent within disciplinary boundaries, which inevitably makes 'whole-system' approaches both theoretically and logistically more difficult. Another explanation may be the paucity of resources available to assist the development of scenarios to be used for public engagement. Indeed, Mackay (2008) suggests that this has resulted in those quantitative scenarios that have attempted to engage participants with energy system change being needlessly obscure and technically demanding, thus limiting their intended use as a research tool. For this reason, whilst a quantitative approach was not considered, it was deemed to be a useful endeavour to attempt to develop scenario-type resources for this thesis, in the form of vignettes, videos or other materials (discussed in Chapter 3). In addition to directly influencing the methodological approach, the fact that energy systems involve a complex network of technologies, infrastructures, resources, behaviours, actors, policies and institutions (Demski *et al.,* In Press) was considered important in the development of the research aims – as it was deemed important to both understand perceptions towards

individual components of the system, as well as 'wider-system' changes and insights that relate directly to visions of possible future change.

Public concerns about energy system change are not only influenced by technological and ecological aspects, but also social and cultural considerations. For example, financial concerns or aspects that threaten personal identity may influence perceptions towards change. Power relations between different actors and issues of trust are similarly important, particularly in terms of the actors that are (or are perceived to be) driving change (Demski *et al.,* In Press). For this reason, how change is realised is as important as what is actually undertaken. Similarly, perceptions towards energy system change are influenced by wider social ideas and experiences that are not directly related to energy per se but refer to broader concerns about society (Butler *et al.,* 2015).

Media coverage and statements made by public figures and institutions are perceived to be important in influencing public perceptions (Parkhill *et al.,* 2013). However, whilst acknowledging that these do inevitably play a role, Parkhill *et al.* build on Gamson and Modigliani's (1989) assertion that people seek out and pay attention to media that confirm their existing beliefs or views. This suggests that this selection bias perhaps reduces the level of importance of the framing and content of specific media in shaping perceptions. Indeed, there is a wealth of literature providing evidence that people's values, worldviews and interpretative frames (*e.g.* Moscovici, 1984; Douglas, 1992; Jasanoff and Wynne, 1998; and Miller, 2000) influence the way they make sense of the world. As such, this literature demonstrates how new information does not simply 'fill holes' in understanding, but instead gets incorporated within existing frames. For this reason public perceptions towards novel developments may be anchored within – and in relation to – their existing cultural values and knowledge, which can in part help to explain the wide range of individual perceptions towards energy system change. Whilst this makes understanding – and predicting – perceptions a complex task, particularly at an individual level, it is possible to study perceptions and understand general trends to identify important aspects of change that influence perceptions. For this reason it was considered appropriate to mirror Parkhill *et al.*'s approach to studying perceptions towards both individual components of energy system change, and a wider, system view, which would also help to contribute towards filling the research gap in this area.

Perhaps the largest study to date of public attitudes and values relating to energy system change was conducted by Cardiff University researchers for a UKERC report entitled

'Transforming the UK Energy System: Public Values, Attitudes and Acceptability' (Parkhill *et al.*, 2013). This combined both deliberative, qualitative workshops and a large (n=2,441) nationally representative survey. This mixed-methods approach aimed to identify how and why people's attitudes towards energy system change were formed, and what the potential policy implications of these were. Values that were identified and considered to be important in the formulation of public views towards energy system change included: the desire for the energy system to be efficient and not wasteful; nature and the environment to be protected; energy security and stability to be ensured; the importance of autonomy and freedom for individuals within the system; a socially 'just' system that ensures change is open, transparent and fair; and the importance of improvement - where change represents improvements in the quality of life (Butler *et al.*, 2015). These findings represent a range of values that underpin people's perceptions towards change and provide an insight into how publics think change should be achieve in relation to developments of the wider energy system. As such, these theoretical insights influenced the way the analysis was undertaken in this thesis, as the researcher remained mindful of these values that could help to identify and explain participants' understandings of and opinions towards the components of visions of change being discussed.

In addition to Parkhill *et al.*'s (2013) large-scale study, the thesis has drawn upon theoretical insights from investigations of perceptions towards individual technologies that may play an important role in the future UK energy system. For example, Spence *et al.*'s (2015) investigation of public perceptions of Demand-Side Management identified a range of acceptance depending on the design and operation of the technologies being discussed. Mirroring Butler *et al.*'s (2015) findings, acceptance was generally high if living standards were perceived to increase as a result of the technology. However, concerns around comfort and health explained a lower acceptance for changes in the management of fridge-freezers and heating in the home. Additionally, findings relating to concerns over data privacy were also found, but discussions concluded that more research is required to better understand if – and how – publics are concerned over data privacy and security in the context of Demand-Side Management. For this reason it was decided that the research undertaken for this thesis would incorporate discussions of Demand-Side Management (including smart meters, automation and other components) to contribute towards this growing literature.

In addition to the literatures discussed above, public perceptions of energy system change are also influenced by perceptions of risk. Some aspects of risk perceptions are broadly generalizable: for example, in the context of perceived risks from new technologies, factors that may result in lower levels of acceptability include a technology's novelty, how poorly (or well) the technology is understood, whether the innovation is involuntary or forced upon people and if there is uncertainty surrounding the possible time delay that adverse effects may take to come to fruition (Fischhoff *et al.*, 1990; Pidgeon *et al.*, 1992). In the context of this thesis these aspects resonate with possible concerns relating to the perceived risk of power cuts in a future electricity system and how novel technologies such as smart meters and home automation may be governed, as well as broader risks such as climate change and the role that the electricity system may play in mitigating or exacerbating this risk.. Furthermore, Gregory *et al.* (1995) suggest that technologies (*e.g.* nuclear power) may become stigmatised and be associated with negative images (*e.g.* a nuclear accident). This is particularly suggested to be more likely if the public – or sections of the public – have concerns regarding the competence, values and trustworthiness of authorities (Poortinga and Pidgeon, 2003), which has specific relevance to this thesis in the context of the governance of new technologies and how communication and engagement relating to these may be conducted. As such, whilst 'risk' was not a topic central to the aims of the thesis, because perceptions relating to energy system change are inevitable entwined with perceived risk, analysis of participant responses was conducted whilst being mindful of the importance of risk, and findings that demonstrate this relationship are presented later in the thesis.

2.1.4 Researching the Future: How to Study Imagined Futures

Imagining the future is a difficult task, and therefore studying imagined futures is both theoretically and methodologically complex. In their biographical approaches to studying imagined futures relating to energy use in the home, Shirani *et al.* (2015) discuss the difficulties that people have in imagining change, particularly in terms of picturing social change.

Adam (2009) discusses the importance of opening up futurity and contemporary social extension into the long-term future as issues to be considered amongst social scientists.

Rosenberg and Harding (2005) argue that the future does not exist as an 'empty category', but instead involves anticipatory hopes and fears. Given this assertion that anticipated futures can situate and influence present action and experiences, a range of approaches have been developed to probe and understand how people think and talk about the future. Structured techniques – such as questionnaires and surveys – have been employed (*e.g.* Pidgeon *et al.*, 2014) to investigate respondents' future plans relating to energy use. Other qualitative approaches, such as using timelines and writing tasks (*e.g.* Henwood and Shirani, 2013); ethnography and observation (*e.g.* Strengers, 2013), narrative interviews (*e.g.* Groves *et al.*, 2016) and biographical interviews (*e.g.* Shirani *et al.*, 2015) have also been adopted with the aim of understanding how people imagine future change to the energy system and how this may affect how energy is used. Whilst these techniques provide different opportunities for discussing and investigating the future, there are also challenges that need to be overcome. Henwood and Shirani (2012) highlight the challenge of written tasks being overly complex for participants to complete, whilst their 2015 discussion of the challenges that researchers face when asking older people about imagining longer-term, future (*i.e.* beyond their expected lifetime) highlights the importance of ethical research practice in relation to how participants are positioned in the future.

In addition to the methods described above, other novel techniques have been employed to try to investigate visions of the future, with different methods providing different challenges and opportunities. Stouffer, Jeffrey and Oliva (2004) suggest that creative and non-language-based approaches can help to make routine energy use more alien, which in turn can open up new insights relating to thinking about current and future use. Furthermore, Mannay (2010) argues that researchers can often be constrained by their familiarity with the area they are trying to investigate. By using techniques that involve more participation from interviewees this constraint can be overcome as the direction is less guided by the interviewer. For this reason, it was decided that the methods employed for this thesis should incorporate some form of participatory approach that enables interviewees to dictate the direction of discussion. This is discussed in more detail in Chapter 3.

In their attempt to understand how people make sense of the future, Shirani *et al.* (2015) provided participants with cameras and asked them to take photographs of their energy use as a tool to help them engage in discussions of energy change – and to help to capture the

complexity of the mundane (Phoenix and Brannen, 2014). Employing a similar approach was considered for this thesis, but logistical and cost constraints prevented this. However, whilst this was not feasible, it was considered important to try to find novel ways of engaging participants with the future, and for this reason the researcher explored using visual methods to present information in a multi-modal way. In particular, video is argued by some to be a powerful tool, as it not only involves images and sound, but also is capable of capturing and representing other senses (Pink, 2003) and generating emotional reactions. Despite the potential advantages that video can offer social researchers who are investigating the future, there are surprisingly (very) few published studies that have used videos as a tool to stimulate discussion (Shirani *et al.*, 2015). For this reason it was hoped that using videos as a multi-modal tool within the collection of data during interviews would be a novel approach that could help to generate novel findings, and also contribute to the small selection of published research that has used this approach. By combining the videos with targeted (and open-ended) questions it was hoped that participants would be provided with a range of stimuli and opportunities to imagine and talk about the future. These questions were influenced by and built upon Shirani *et al.*'s (2015) approach, and included asking participants about their initial reactions to the visions of the future being portrayed, what they did or did not like about these visions, and what alternative visions they would prefer instead.

This section has aimed to present and review relevant literature that has, along with the approaches discussed in Sections 2.1.1 and 2.1.2, informed the theoretical and methodological approach undertaken for this thesis in the context of researching the future. A more in-depth explanation of the methods employed at each stage of the research process is included in Chapter 3.

2.2 Technology Transitions

The study of technological transitions can help to identify the ways in which specific technologies develop and become adopted into both the physical infrastructure and social fabric of society. Geels (2002:1257) defines technological transitions as:

> "*Major technical transformations in the way societal functions such as transportation, communication, housing and feeding are fulfilled. They not only involve technological changes, but*

> *also changes in elements such as user practices, regulation, industrial networks, infrastructure and symbolic meaning."*

Electricity networks are vast sociotechnical systems that have evolved over time and have incorporated emerging technologies to meet changing social and technical demands. By investigating technological transitions that have been associated with the development of electricity systems, an understanding of the dynamics that have influenced these transitions can be obtained. This could potentially identify important aspects that may need to be considered when designing the ways in which new technologies may interact with and become incorporated within existing electricity systems.

In 2002 Geels proposed a 'Multi Level Perspective' (MLP) model that can be applied to help map out the trajectories (which are influenced by engineers, consumers, policy makers, societal groups, scientists and investors) (*ibid.*, 1260) of technology transitions over time. This model has been critiqued as being over-simplistic by some, however, in the context of this thesis the broad descriptions and definitions of levels within the model provide a simplistic and easily-visualised approach to considering the development of technologies.. For this reason it was anticipated that interpretation of some responses would be undertaken using the model as a reference point – whilst also drawing upon other sociological and STS literature – to portray how the findings could perhaps influence the development of the technologies being discussed by participants (*e.g.* solar photovoltaic panels and smart meters).The MLP demonstrates the ways in which novel, niche technologies develop into becoming important aspects and landmarks within sociotechnical landscapes. The term landscapes can refer to both the networked, material infrastructure that exists (*e.g.* Harrison and Popke, 2011) as well as the sociotechnical arrangements and links between consumers and technology (*e.g.* Zimmerer, 2011). Building upon Nelson and Winter's (1982) 'technological regimes' concept, Geels' MLP identifies nested levels of the model, with regimes being embedded within landscapes, and niches embedded within regimes. Van den Ende and Kemp (1999) suggest that new regimes '*gradually grow out of* [and replace] *old ones'*, and as emerging 'niche' technologies develop they become dominant designs embedded within these evolving regimes. As the transition continues through the hierarchy of multiple levels, processes at landscape level create windows of opportunity for the 'patchwork' of regimes to become more dominant and important within the landscape itself, further creating space for existing and developing regimes and niches to evolve. Parallels can be drawn between this approach to understanding technology transitions and

literature on sociotechnical imaginaries and expectations of the future, where support – which can come in a variety of forms such as legislation, funding and promissory narratives – can help to cultivate and protect 'niche' technologies, thereby enabling them to develop and take on a more prominent role in society. Findings from the research undertaken for this thesis will aim to discuss how both public and expert participants talk about possible technological innovations in the context of whether discourse surrounding these technologies is 'promissory' in nature or, conversely, whether their visions involve concerns that arguably counter the 'protective niche' that some innovations are afforded. Discussion of these findings relating to specific technological components of participants' visions (*e.g.* solar photovoltaic panels) will also aim to tie together various STS literature (spanning imaginaries, technological transitions and social practice theory) in a novel way, thus further contributing to the wider literature. Schatzki (2009) stated that designers and producers who make and lay out the material arrangement of people's lives have a 'special hand' in people's practice (as they limit the possible dynamics of practices), which ultimately influences their electricity consumption. For this reason it was decided that the 'expert' sample would comprise individuals involved in researching and designing technological innovations that could have an impact on the wider electricity system and influence how people are able to use electricity in the home. Furthermore, Lie and Sorensen (1996) suggest that for new technologies to be successful, users have to integrate them into their routines and practices. This appreciation highlights the feedback loops that can influence technological transitions. As Schatzki argues, designers influence people's consumptive practices, and as these evolve over time, space may be created for new products to be developed, completing the feedback loop. Ingram *et al.*'s (2007) analysis of the relationship between products and practices illustrates how consumer practices stimulate design, and how the design of new, 'niche' products (which, in the context of this thesis, could include technologies such as smart meters or solar Photo-Voltaic (PV) panels) can stimulate new practices (Figure 1).

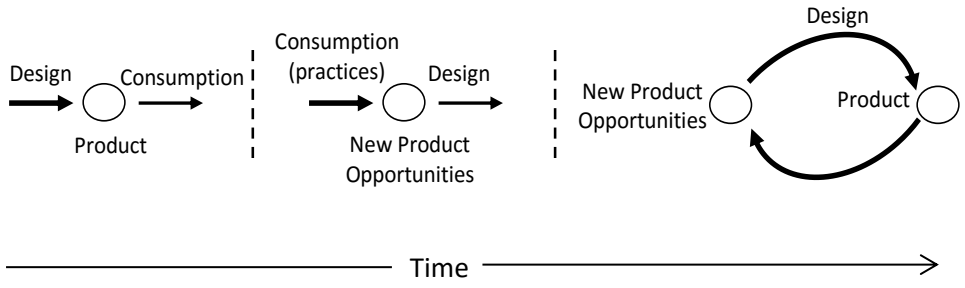

Figure 1. Design-consumption feedback loop (Ingram *et al.*, 2007)

Hand *et al.* (2005) discussed the influence that technological innovations have had on the practice of showering. By applying concepts from Geels' MLP approach to their historical discussion of the development of showering as a practice, a deeper understanding of the dynamics that have influenced this technological transition can be obtained. Despite public bathing houses existing since the Roman era (Webb and Suggitt, 2000), showers as we may define them today ('*consisting of a cascade of water falling from an overhead outlet*') (*ibid.,* 2) emerged as a niche technology in the eighteenth century. These became sought-after, luxury items in Victorian households, and as a result remained as a very rare, niche technology. This slow uptake of showers is also due to the reliance upon piped hot and cold water supplies to private houses, which limited the technology's application to wealthy households. As these required water supply developments came to fruition through the middle of the twentieth century, showers became more popular. However, they were still relatively uncommon in households and could be described as occupying a technological regime as opposed to being a key part of the landscape. Hand *et al.* (2005) also suggest that the development of showers into becoming mainstream, dominant technologies has also been influenced by social factors as well as purely technical innovations. They argue that until the 1970s, showering remained a largely collective, communal activity (in institutions such as the army). The electrification of UK homes and improvements in domestic plumbing increased the safety and convenience of showering, and these developments, they argue, combined with societal requirements for improved cleanliness and personal hygiene, contributed to increased uptake of showers in UK households. In more recent history, the 'time squeeze' that has occurred in modern lifestyles (Demos, 1995) – where time has become an increasingly precious commodity – has made quick, convenient showers more desirable than more time-consuming baths. As a result, power showers, that are often marketed as luxury items offering consumers opportunities for relaxation (which as a concept could perhaps be interpreted as being borne through dominant public discourses and framed as a desirable aspect of a product or practice) have become increasingly popular. This can be seen as an example of the feedback relationship between design and consumption practices, as the growing popularity of showering increased the number of people who showered, which created a larger and more diverse market for shower products. This transition can also be considered from Shove and Warde's (2002) approach (discussed later in this chapter), with sociotechnical requirements and the specialisation of commodity production influencing individual and household consumption.

In the context of this thesis it is useful to consider technological transitions within electricity systems. The thesis aimed to identify some of the perceptions, practices, behaviours and visions of the future that may influence possible changes to the UK electricity system. For example, solar PV panels are becoming increasingly common on homeowners' properties, enabling them to generate their own electricity. As the technology has developed, coupled with government policies that have encouraged investment to increase the capacity and diversity of the UK's electricity supply, it has been embraced by consumers, and numerous companies have been formed to manufacture, sell and install solar PV panels to UK homeowners. These factors, in addition to public discourses and government efforts that promote renewable energy and technologies to help mitigate the effects of climate change, have helped this niche technology to develop into what could perhaps be described as a sociotechnical regime. Furthermore, if solar PV panels continue to be adopted this could perhaps have longer-term, wider-ranging impacts on the provision and distribution of electricity in the UK. Conversely, electric vehicles arguably remain situated within a niche. As the technology continues to be developed, concerns over the cost and usability of vehicles (*e.g.* Egbue and Long, 2012; Sierzchula *et al.*, 2014), coupled with uncertainties surrounding design and system requirements, and the possible implications this may have for the electricity network make it difficult to predict how, if at all, this niche technology will succeed in becoming a more mainstream, dominant regime within the wider sociotechnical landscape of the UK's electricity system. By investigating the concerns, hopes and assumptions embedded with visions of the future that public and expert interview participants had towards a range of possible technological innovations, it was anticipated that a consideration of how these may interact with and fit within the context of technological transitions – and wider STS literature - would be obtained.

2.3 Ecological Modernisation and Technological Solutions

Ecological modernisation is an evolving field that encompasses a range of aspects and definitions. Originating in the 1980s within political science and sociology, it has developed into what Mol and Sonnenfeld (2000) describe as both a theory on social continuity and transformation, and as a political programme for and discourse about environment-inspired change (Hajer, 1995; Mol, 1997). The term has been used to refer to many different technological-political-environmental debates, but broadly involves the

assumption that technological progress and economic growth can deliver sustainable development. In other words, ecological modernisation can be understood as the "*ability of financial markets and technology to solve environmental issues"* (Backstrand and Lovbrand, 2007). This assumption in effect means that environmental degradation can be decoupled from economic growth (Bernstein, 2001), essentially suggesting that industrialisation and capitalism can be made more environmentally friendly through regulation, investment and trade (Hajer, 1995). Within this lies the premise that technological innovation is the key to boosting 'environmental productivity' (Eckersley, 2004) by achieving cost-effective, eco-efficient technological developments which simultaneously help to drive growth and reduce adverse environmental impacts, thus delivering sustainable growth. As such, technological solutions to environmental challenges are often preferred to other approaches. Assumptions about the difficulty, political attractiveness and scope of interventions promoting behaviour change are suggested by some to have resulted in many decarbonisation strategies favouring technological solutions (Spence and Pidgeon, 2009). For this reason, whilst developing questions for the interview and focus group protocols, the author considered the role that political impacts may have on the perceived political attractiveness of possible future interventions and tried to ask open-ended questions (and if necessary use further prompts) to probe this. Furthermore, Walker *et al.* (2010) discuss how assumptions about imagined public subjectivities in the context of future change (in particular imagined hostilities to change) can impact upon the development of technologies, along with associated policies and public engagement strategies. Other research has found that uncritical assumptions of ecological modernisation are embedded within media coverage and dominant discourses of decarbonisation in the domestic sector (Cherry *et al.*, 2013).

This dominant discourse of ecological modernisation has been critiqued because some scholars have suggested that technology and markets acting in isolation will not be able to deliver the radical changes in society that are required to meet climate change targets and legislation on decarbonisation. Indeed, Erhlich and Erhlich (2012) suggest that technological optimism and uncritical acceptance of technologies – and the assumption that 'value-free' technologies can solve environmental challenges – amongst the general public, politicians and economists is a central issue that needs to be challenged. Stating that "*solutions to the predicament lie primarily in the domain of human behaviour"*, they argue that there needs to be a change in emphasis from the existing reliance upon "techno-fixes"

(Spaargaren, 2010), which would involve technological innovation being redirected to help solve, rather than contribute to environmental issues (Huesemann and Huesemann, 2012). They suggest that, whilst not dismissing the role that technology can have (*e.g.* efficiency improvements), attempts should focus on influencing how people act – both individually and at broader social or institutional levels. For this reason, we need to investigate the assumptions that a range of actors have towards technology and its role in both contributing to and solving societal and environmental challenges. This – they suggest – may help to identify ways of reducing the reliance upon techno-fixes that ignore or marginalise social-scientific considerations and moving the emphasis towards solutions involving technological innovations that encourage and facilitate pro-environmental behaviour. As such, this consideration was taken into account during the research design and development of the methodological approach (see Chapter 3). Care was also taken to try to avoid inappropriately referring to 'techno-fixes' – which could perhaps be argued to be a 'loaded' term – unless this reflected an interpretation of specific responses or analytical findings.

2.4. Researching Energy Use in the Home

2.4.1 Economic Approaches, Rationality and Information-Deficit Model

Wilson and Dowlatabadi (2007) state that economic theories of consumer choice assume that people aim to maximise 'utility' given their budget constraints, where decisions that lead to higher utility will consistently be preferred to decision outcomes with lower utility. In this context, Clemen and Reilly (2001) describe utility as a construct measuring expressed preferences for different outcomes, which is often regarded as a proxy for well-being or personal benefit obtained through an outcome (Kahneman *et al.*, 1999). Within utility theory is the assumption that consumers are rational actors (Tversky and Kahneman, 1981) in a normative sense of having preferences that are known, invariant, ordered and consistent (Wilson and Dowlatabadi, 2007). As such, rational decisions are based upon the evaluation of outcomes and therefore are essentially instrumental and self-interested (Jackson, 2005). In essence, rational economic models assume that an individual's engagement in a specific behaviour is primarily determined by whether or not it is in their financial interests to do so (Kurz, 2002). This assumption of rationality forms the framework for a range of economic theories (Starmer, 2000) that are applied to researching

domestic energy use. For example, discrete choice modelling has been applied through conducting surveys and analysing purchasing behaviour to investigate aspects such as people's willingness to invest in energy-efficient products based on weighing up the up-front investment costs and payback time through lower operating costs (Train, 1985; Ruderman *et al.*, 1987). However, there is a wealth of literature and evidence that shows people do not consistently act rationally and make economically-rational decisions (Camerer and Loewenstein, 2004). For example, Wilson and Dowlatabadi (2007) suggest that people often make decisions that are inconsistent over time (*i.e.* where more immediate preferences may be prioritised over aspects that are further in the future). Furthermore, the way information may be framed, obtained and understood can further influence decision making which can often result in individuals not necessarily behaving in the most 'rational' manner. As such, behavioural economics aims to incorporate psychological understandings of decision making to better inform economic models and move beyond simple rational models. Whilst behavioural economics is often applied to controlled experiments in laboratories, successful replication of findings has been achieved in some real-world conditions (Camerer, 2004), and findings are often applied to the field of consumer marketing (Hoyer and MacInnis, 2004), such as aiming to influence people's decision making through providing inferior products within a range to increase people's preferences for more superior alternatives (Simonson, 1993). Peter and Olsen (2005) suggest that consumption is often not the result of rational deliberation, but from cognitive or affective responses to certain stimuli. Furthermore, Knight *et al.* (2006) argue that highlighting aspects that may be more emotional or meaningful can be a better approach to influencing decision making than simply providing people with information on all factors relevant to the decision. For example, they suggest that promoting 'comfort' can be more successful in selling products and getting people to retro-fit or renovate their houses than by promoting energy-efficiency in isolation. For this reason the researcher was mindful of providing participants with the opportunity to discuss and reflect upon the perceived reasons that influence their (and others) decision making in relation to electricity use in the home throughout the collection and interpretation of interview and focus group data. Other findings with relevance to investigating (and influencing) domestic energy use include McCalley's (2006) discussion of the energy savings that can be achieved by removing default temperature settings on washing machines, which can influence the temperature set by users as they start from a new anchor point of zero. Whilst behavioural economics and theories based upon the assumption of rationality have useful application in some contexts,

these approaches are arguably over-simplistic in the context of understanding people's relationships with and perception of their electricity use in the home. Furthermore, as this thesis involves an investigation into the hopes, concerns and assumptions associated with both public and expert visions of the future electricity system, these models do not form a central part of the thesis. However, as energy use is closely connected to and often associated with cost (Simcock *et al.*, 2014), relevant findings will be considered and discussed within the context of economic approaches. As such, discussions will aim to portray how some of the findings from this research have been influenced by and can build upon and contribute to this literature.

According to the rational choice and decision making model, people are viewed as 'rational actors' whose behaviour is responsive to the provision of information, incentives and education (Southerton *et al.*, 2004). However, this model has been critiqued (*e.g.* Heiskanen *et al.*, 2009; Jackson, 2005) as it focuses on 'methodological individualism' (Hinton, 2010) and ignores other influences that impact upon how people make decisions, such as societal structures and institutional constraints. Despite such critiques, this approach has taken on an influential role in both academic research and in informing policy making that aims to encourage pro-environmental behaviour. This has in part contributed to approaches being developed that fall within the critiqued information-deficit model, where Wilhite and Ling (1995) suggest policy makers aim to devise strategies to fill 'information vacuums', based on the assumption that if people are provided with sufficient information then they will make rational decisions and behave in a predictable manner. Criticisms often focus on the simplistic notion that increasing awareness or knowledge will not necessarily result in anticipated change or actions, with behaviour in the home instead being influenced more strongly by factors such as household dynamics (*e.g.* Gram-Hanssen and Bech-Danielsen, 2004) and the prioritisation of ensuring comfort (*e.g.* Fudge and Peters, 2011). Devine-Wright and Devine-Wright (2005) suggest instead that emphasis should be placed on exploring what people *do know* and how they *do process* information relating to their energy use (*e.g.* Kempton, 1987; Kempton and Layne, 1994). The researcher aimed to keep this idea central to the approach adopted in the development of interview and focus group protocols, as well as the interpretation and presentation of data. Hobson (2002) highlights policy discourses that put emphasis on raising awareness through a number of approaches such as the provision of feedback on energy use (*e.g.* through smart meters or detailed billing information) and educational campaigns with the ambition of providing people with the information – and anticipated motivation – to change how they use energy in the

home. Whilst these approaches are sometimes critiqued as being over-simplistic and failing to take account of the myriad factors that influence attitudes and behaviours, there is evidence that providing information can have useful value in influencing change. For example, Burgess and Nye (2008) argue that providing energy feedback can help to make energy use more visible (discussed later in this chapter) and more salient, which Hargreaves *et al.* (2010) found can empower residents and provide people with more of a sense of control over their energy use. Additionally, evidence suggests (*e.g.* Brandon and Lewis, 1999; and Mansouri *et al.*, 1996) that individuals are often open minded and positive about receiving information on their energy use, and indeed often act upon and change their behaviour in response to these interventions. For this reason it is argued that whilst there are notable limitations to approaches based upon the rational actor model - most notably in terms of information-deficit approaches - there is evidence of how these can be employed successfully. As such, whilst being mindful of potential pitfalls, a consideration of how these approaches relate to findings is thus important in the context of interpreting and presenting data in this thesis.

2.4.2 Energy Use in the Home: Sociological and Psychological Perspectives

In addition to the models discussed above, energy use as a topic can be investigated and approached in a variety of ways. Psychological approaches treat individuals as the units of study, and attempt to identify personal attitudes and values and explain the reasons for an individual's behaviour that influences how they use electricity. Another approach, stemming from cultural and environmental sociology, involves social practice theory, which treats the consumptive practice itself – as opposed to the individual performing the practice – as the unit of study. Despite the differences that exist between these, and other, approaches and perspectives, there are common ideas and concepts that have been employed to help better understand energy use, with the ultimate aim of discovering mechanisms to change – and indeed reduce – electricity demand in the domestic sector. This section discusses differences and commonalities between sociological and psychological approaches to investigating energy use. The ways in which the research has drawn upon and been influenced by this literature - in the formation of the research strategy, methodology, data analysis, interpretation and presentation – is also discussed.

2.5 Inconspicuous Consumption and Social Practice Theory

Until recently, sociological studies of consumption traditionally focused on conspicuous and symbolic aspects of consumption (Gram-Hanssen, 2011). However, contemporary approaches have moved towards understanding everyday, routine consumption (Gronow and Warde, 2001) that adopt a practice theory (as formulated by Schatzki, 1996) approach to investigate how energy is used on a more routine, mundane basis (Reckwitz, 2002a). Indeed, Jackson (2005) suggests that everyday repetitive actions involve minimal conscious consideration, and are instead influenced by convenience, habit, social norms and other contextual factors. Furthermore, electricity in particular is argued to be an abstract 'thing' that exists in the background of everyday life and is hidden in walls and wired networks within the home (Hargreaves *et al.*, 2010). For this reason Burgess and Nye (2008) posit that energy is 'doubly invisible' because it is an abstract force and is often used as part of habitual, unconscious practices, which poses challenges for approaches that aim to influence how people think about energy use and achieve changes in people's lifestyles and behaviour. This, they suggest, makes it more difficult for people to connect energy use to everyday actions, and as such, energy is difficult to relate to, visualise and quantify. Exceptions can be found, with smoke billowing out of a chimney and lights illuminating an otherwise dark building being more 'visible' examples. However, as electricity is available at the flick of a switch and simply acts as a means for providing power to domestic appliances that enable specific consumptive practices to be performed, it can be difficult to picture electricity as a commodity that is being consumed (Hargreaves *et al.*, 2013). They argue that this inconspicuous consumption needs to be made more meaningful and conspicuous to enable individuals to better understand the amount of electricity that is being used. For this reason, mechanisms that provide people with feedback and information on their electricity consumption are the focus of much research, with the effectiveness of in-depth, detailed bills (Wilhite and Ling, 1995); personal, face-to-face guidance and advice (Darby, 2003); and 'smart' meters (Faruqui *et al.*, 2010) being investigated. Furthermore, the UK government aims to develop and rollout smart meters to all domestic properties by 2019 (DECC, 2012b) to enable these feedback technologies to become an integral component of a future, 'smarter' grid. The issue of visibility and awareness of energy was considered to be a key topic to investigate in focus groups. As such, the literature reviewed above provided the inspiration for asking participants how they thought about energy, their experiences of energy monitors and interactions with feedback from other devices. Furthermore, it was hoped that findings relating to interactions with feedback from solar photovoltaic panel

system inverters would provide a novel contribution towards filling a research gap, as to the author's knowledge there is no published research specifically focusing on this. In addition to this literature informing some questions, it was also considered in the recruitment and design of participants. One focus group (consisting of students in a shared house – see Chapter 3) also enabled participants to be quizzed on their use of a pre-payment electricity meter, allowing different perspectives towards awareness of energy in the home to be probed.

In Shove and Warde's (2002) examination of consumption they identify six mechanisms that support and contribute to escalating consumption in modern lifestyles. The first mechanism they describe is social comparison, where consumers compare themselves to others and attempt to display and express different cultural tastes. They suggest that this comparison, coupled with what Peterson and Kern (1996) describe as 'omnivorousness' – the need for people to appear open to appreciating everything – leads to the replacement of items with new, different ones, thereby increasing the overall number of items being used. Linked with this social comparison, the creation of self-identity, where homeowners design houses to transmit an identity that they want to portray to others, can have important impacts on a household's consumption footprint. In the context of domestic electricity this could relate to the number of electrical appliances in the home, and could also influence the efficiency of appliances in the home, because the replacement of inefficient appliances with less energy-intensive products could contribute to a reduction in domestic consumption (Mansouri, Newborough and Probert, 1996) (although overall lifecycle consumption of the products themselves could remain high if energy-intensive, inefficient production processes are used).

In addition to social comparison and identity creation, the desire to receive mental stimulation and satisfaction through the acquisition of new products is identified as one of Shove and Warde's (2002) mechanisms of increasing consumption. This desire could also be argued to be an important factor in influencing their fourth mechanism, which they describe as aesthetic matching. Termed the Diderot effect (in reference to the philosopher who slowly changed the contents of his room to aesthetically match a new robe) by McCracken (1998), this concept relates to a desire for items to match one another. As one novel item is acquired, other items may, over time, be replaced with ones that are deemed to be a more appropriate match. Whilst this effect can be viewed as a mechanism to increase consumption, a counter argument can also be made to explain the effect's possible

role on demand reduction. For example, green consumerism, which champions aspects such as local produce, recycling and the use of more durable products, could motivate a person to slowly amass a collection of domestic products that fit together in a way that helps to reduce overall consumption. An example relevant to domestic electricity consumption could be consumers who want to transmit a 'green' image identity acquiring energy-efficient electrical appliances or using products that enable them to consume less electricity than other options available to them.

Shove and Warde's (2002) four mechanisms identified so far, centre primarily on the individual wants, needs and desires of domestic consumers, and could be considered as social-psychological mechanisms. In addition to these mechanisms they suggest two further external, more technical, material factors that influence consumer choice on a wider scale. The first involves the specialisation of commodity production, where evolving markets create niches that enable an increasing number of similar products to exist in spaces where just one product may have previously existed. The second external factor is the requirements of sociotechnical systems. As sociotechnical systems – such as electrical power supply networks – have developed they have imposed certain design criteria and limits upon electrical domestic appliances, which have in turn influenced the types of behaviour and levels of electricity consumption possible within the home.

By applying Shove and Warde's (2002) lens to the analysis of specific products that enable consumers to perform certain practices, the relationship between these six mechanisms, and the impact this can have upon domestic electricity consumption can be understood. For example, electric coffee machines, which enable people to perform the practice of coffee making, are becoming more common items in people's homes. Today coffee machines can be bought in a range of styles, materials and colours, and vary greatly in price and complexity, yet even the most sophisticated coffee machine relies upon a source of water and electricity, both of which are supplied to houses through complex sociotechnical systems. This vast range of products that perform the same role is a result of the specialisation of commodity production. It is conceivable to see how a consumer, who wants to portray that they have the desire and means to invest in a coffee machine, may be motivated to replace an existing kettle, filter machine or other older coffee making product with a novel machine. In addition to the new coffee machine being more, or less, energy-efficient than the replaced products (therefore influencing the total consumption of the coffee making practice) the consumer may possibly choose to slowly replace other

products in the kitchen or household to form a collection of products that match each other, which may further influence electricity demand and use within the home.

As products develop that support people in performing a wide range of practices within a home, certain practices become absorbed into routines (Southerton, 2006). These routines and ways of organising practices into daily life are dynamic and can be influenced by a range of factors. For example, through undertaking a series of in-depth semi-structured household interviews, Southerton identified practices that held a fixed place in daily life (such as meal preparation and cooking). Other practices therefore had to be organised around these fixed nodes. Sequences of practices were also identified, where a range of smaller practices had to be performed in order to enable a wider, overall practice to be completed, and these were often found to be synchronised temporally with practices and activities that other members of the household were performing. This can be demonstrated by the need to buy, prepare and cook food for a family meal, which has to happen in a certain order, and may need to occur around other fixed events such as work routines or social arrangements. Southerton argues that this approach enables the relationships between practices to be better understood, which can provide deeper, more meaningful information than other approaches such as diary data (*e.g.* Gershuny, 2000) and time-use studies (*e.g.* Adam, 2000). This idea has been built upon in Higginson, Richardson and Thomson's (2012) discussion of the challenges faced by researchers attempting to model flexible electricity demand in the domestic sector. They argue that understanding the links between practices and the dynamics of the practices themselves can help produce more accurate outputs than those based upon time-use or occupancy data. For example, they suggest that conventional models may incorporate the practice of ironing into models by simulating the average power demand for an average iron operated for a standard length of time. However, ironing is often performed whilst watching the television or listening to the radio, which could result in more electricity being consumed than a conventional model output would depict. This correlated use of electrical appliances for different, related, simultaneous practices makes it difficult to model demand, and these challenges, they argue, need to be overcome to help inform ways of shifting demand and influencing how much electricity people use in the home, as well as when they use it.

Social practice theory provides a useful lens through which to study aspects of mundane domestic consumption. Indeed, the literature reviewed in this section influenced the ways in which data analysis was approached in this thesis. In particular, a practice theory lens was

applied to the analysis of changing energy-use practices in response to the installation and interaction with solar photovoltaic arrays in people's homes. This novel finding (discussed in Chapters 4 and 7) further contributes to the growing body of research that draws together theories of practice and behaviour within evolving sociotechnical systems.

2.6 Psychological Models of Behaviour Change

Other, more psychological, approaches to studying energy use in the home consider individual users to have more agency than a social practice theory approach, and attempt to analyse the motivations and reasons that people have to undertake specific behaviours. Nye *et al.* (2010) identify two dominant psychological approaches. The first is the 'expectancy-value' approach, which works on the assumption that a person's intentions to act are based upon a consideration of the expected costs or rewards that a particular behaviour will have (Ajzen, 1999). Secondly, they identify norm-based approaches which focus more on what Axelrod and Lehman (1993) describe as 'internal' rewards that are associated with people's personal values. Additionally, research has also aimed to identify and explain the role that unconscious processes such as habit have on behaviour relating to how and why people use energy (*e.g.* Verplanken *et al.*, 1998). Various models have evolved to attempt to explain behaviour. Chatterton (2011) argues that most individualist models of behaviour follow the basic linear ABC structure, which Wilson and Dowlatabadi (2007) state originally stood for attitude-behaviour-external conditions, but is also referred to by some as standing for attitude-behaviour-choice (*e.g.* Shove, 2010) or indeed attitude-behaviour-context (*e.g.* Zepeda and Deal, 2009). Furthermore, as these models are grounded to some extent in assumptions of economic rationality, they have been readily and extensively adopted by policy makers (Chatterton, 2011). Fishbein and Ajzen's (1975) Theory of Reasoned Action aimed to explain how attitudes, norms and behavioural intentions could predict behaviour. Haiskanen *et al.* (2009) suggest this model is commonly applied to health research, but that its applicability to the environmental and energy domain is limited by more mixed results (Kurz, 2002). By combining this with an additional variable – 'perceived behavioural control' (*i.e.* the extent to which a behaviour is easy or complex to perform) – Ajzen (1991) developed the Theory of Planned Behaviour, which resulted in the model becoming more accurate at predicting behaviour. A yet-more-complex extension of this model is the Theory of Interpersonal Behaviour (Triandis, 1977). This takes into account social factors (such as social norms and perceived self-identity) and affective components (such as values,

emotion and mood), as well as a consideration of the role of past behaviour and habits, which Macey and Brown (1983) suggest are key components of improving the ability to predict future behaviour. Furthermore, the model also incorporates 'facilitating conditions' - which can refer to any external factors that may help, hinder or prevent an individual from acting upon their intentions (for example, in the context of decisions over energy conservation in the home, this could perhaps include whether an individual rents their home or whether or not they have cavity walls that could be insulated *etc.*). Chatterton suggests that policy makers could benefit from using Triandis' Theory of Interpersonal Behaviour because this 'facilitating conditions' component can be considered in the context of barriers or enablers, which opens up the possibility for emphasis to be put on positive, enabling aspects as opposed to simply aiming to remove barriers. Whilst this thesis is not aiming to apply or test any particular psychological models (such as those discussed above), it was important and useful in the initial design phase of the research that an understanding of the historical development of the field was obtained. Furthermore, the discussion of findings draws upon concepts within wider psychological research that contribute to and form components of these models (*i.e.* attitudes, habits, and identifying potential enablers or barriers to change *etc.*).

Much research has been undertaken to investigate the role of people's attitudes – which are defined by Nye *et al.* (2010) as "*an individual's evaluation of, or orientation towards, an attitude object (i.e. a thing, idea, person, action, self etc.)"* - in behaviour change. The intensity and direction of specific attitudes may be influenced by a range of factors including involvement, emotional intensity, certainty, underlying values and ambivalence (*e.g.* Maio *et al.*, 2001; Verplanken and Holland, 2002). Furthermore, differences or contradictions between people's explicit and implicit attitudes may sometimes exist - particularly if investigating attitudes towards controversial topics - for example, as a result of subjects outwardly providing what they perceive to be socially desirable responses (*e.g.* Spence, 2005). As such, whilst there are experimental ways of attempting to unpick implicit attitudes (such as the Implicit Association Test (Greenwald *et al.*, 1998) – which often have a bigger impact on behaviour than explicit attitudes (*e.g.* Maio *et al.*, 2007) – it can be difficult to accurately identify and explain the exact role that attitudes play. This is particularly the case in complex, dynamic contexts such as investigating attitudes towards energy use in the home, where myriad factors may have an influence. Indeed, approaches that aim to identify relevant attitudes and successfully control for the vast amount of potential variables often require specific issues to be isolated so that they can be used to elicit expressions of opposition or support

(*e.g.* through using questionnaires). It is neither in the aims or scope of this thesis to specifically identify participants' attitudes. Instead the thesis adopts a qualitative approach to obtain more nuanced understandings of the range of factors that contribute towards how and why energy is used. However, as domestic electricity consumption is related to controversial issues such as energy security and climate change, as well as touching upon issues including identity and governance, interpretation of findings – where relevant – has been influenced by and drawn upon attitudinal literature. Whilst many of the psychological concepts and theories discussed above have only peripheral – yet important – relevance to specific aspects and findings discussed later in the thesis, others take on a more prominent role, and are discussed below. In the context of electricity use in the home, the rebound effect refers to consumer responses that limit the expected reductions in consumption following the use and integration of energy-efficiency measures. Rooted in economic theory, the concept is contested and considered by some as difficult to identify, understand and predict. Greening *et al.* (2000) state that the size of rebound effects can be insignificant – depending on the definition of rebound being used – or can at the other extreme result in an overall increase in consumption. Discussed simply, homeowners may, via a range of possible mechanisms, benefit financially from improved energy efficiency measures and then 'rebound' by using the rewards of these benefits to instigate behaviour that increases electricity use through other means or increased intensity or repetition of the original behaviour. Sorrell and Dimitripoulos (2008) make the economic case for rebound effects, presenting the idea that replacing appliances with more energy-efficient models could be expected to reduce overall electricity consumption. However, by drawing on Greening *et al.*'s (2000) direct and indirect rebound effects they explain how responses counteract this reduction. Direct effects may occur for example when efficient appliances effectively become cheaper to run, which could lead to the appliance being used more often, therefore reducing the energy savings achieved through efficiency improvements. Indirect effects may result from financial savings accrued through efficiency improvements being used to invest in other consumption-intensive activities or products. This can be demonstrated, for example, by cost savings gained through insulation or heating system improvements, which may then be used to buy newer, more energy-intensive appliances for the home. However, others suggest that this rebound effect is oversimplified, particularly if the investigation of electricity consumption stems from an industrial ecological approach. Hertwich (2005) suggests that additional mechanisms have an impact, and that a more accurate and neutral description – that avoids the negative attention sometimes afforded to what can be positive

secondary or indirect environmental effects – such as 'ripple effects' should be used. Despite these effects being contested and notoriously difficult to identify, it was decided that interviews and focus groups should include questions and prompts to explore the opportunity of identifying possible rebound effects, and therefore contribute novel findings to this well-known but poorly-evidenced theory. This would be achieved by asking participants about their experiences of change in how they use electricity in the home, as well as investigating reported interactions with technologies or other changes in the material property of the home.

Many attempts to foster more environmentally friendly behaviour have focused on narrow sectors and isolated habits within people's lives (for example, water saving initiatives) (Olander and Thogersen, 1995). However, Thogersen and Olander (2003) argue that it can also be beneficial to investigate whether these environmentally friendly behaviours can spread to other areas, impacting people's overall consumption, in what they term a 'virtuous circle'. This could, perhaps crudely, be almost considered as an indirect extension of a positive 'rebound', where perceived rewards from reducing electricity consumption in one context spill over to others. However, research has often found that successfully encouraging consumers to adopt one environmentally friendly behaviour (such as recycling) does not necessarily result in getting people to take further actions beyond this (DEFRA, 2007; Whitmarsh, 2009). Thogersen and Olander (2003) suggest that the ability to achieve intended behavioural spillover depends upon people's beliefs and attitudes (reflecting other psychological theories such as Balance and Dissonance Theory). Despite these limitations and challenges to achieving spillover, Thogersen and Crompton (2009) suggest that environmental campaigns (including encouraging people to switch off lights in their homes) often have implicit assumptions that these small behavioural changes may magnify and spread into larger-scale changes. Furthermore, as new technologies for electricity demand reduction and efficiency improvements become available to consumers, on top of micro-generation schemes (*e.g.* solar PV) that enable consumers to take more control over their domestic electricity supply and consumption, it is conceivable that more opportunities for possible spillover effects will arise. There is currently a gap in the research investigating behavioural spillover responses to domestic micro-generation schemes. For this reason, homeowners with solar PV installed on their properties took part in a focus group and interviews (discussed in Chapter 3), in the hope of obtaining novel findings to help fill this gap in the research and contribute evidence to a contested and sparsely researched area.

2.7 Chapter Summary

Many of the approaches discussed in this chapter form a central part of the analysis undertaken within this thesis. Reviewing the literature enabled the aims and research questions to be devised and provided a rationale for the methodological approach (discussed in Chapter 3). By critiquing theories, models, and specific studies, an understanding of the research gaps was obtained, enabling an approach to be devised with the aim of building upon and improving existing empirical research. For example, much existing literature on imagination and expectations of the future could be critiqued as being overly theoretical with a limited amount of empirical research. By investigating how and why people imagine future changes to the electricity system – and how they expect this may affect the way they use electricity in the future – findings simultaneously draw upon insights from the field and contribute to filling gaps in the literature. Insights from other literature take on more peripheral roles within the thesis. Nevertheless, reviewing these played a crucial role in informing the initial research strategy, and also helped to provide important insights for the analysis of data, enabling different findings to be interpreted and discussed from a range of different theoretical angles (for example the interpretation of participants' interactions with solar PV using psychological approaches and adopting a more social practice-based lens.

In addition to critiquing existing literature and attempting to identify any research gaps or other limitations to existing bodies of work, this chapter aimed to present how and why the work undertaken in this thesis has drawn upon the reviewed literature. In some cases this was a relatively simple task (such as describing the value of investigating expectations of the future). Other theories or approaches were more problematic to bring together in a cohesive, coherent way. For example, some scholars (*e.g.* Shove, 2010; 2011; Kuijer and Bakker, 2015) suggest that social practice theory approaches are incompatible with psychological approaches to investigating behaviour change. They argue that as the units of study (namely practices or individuals) are different (like "chalk and cheese") (Shove, 2011), employing a theoretical framework encompassing both approaches is impossible. Others (*e.g.* Whitmarsh *et al.*, 2011; Wilson and Chatterton, 2011) suggest that drawing upon a range of theoretical influences and perspectives can help to gather different insights that can be meaningful and contribute towards a more informed, interdisciplinary analysis. An example could be investigating electricity demand in the home from a washing machine. Understanding how someone uses energy in their washing practices could provide insights

into the temporal and routine factors that contribute to this aspect of their electricity use, which may contribute to academic literature and perhaps inform policy makers. However, by also asking individuals about their perceptions towards possible changes in future electricity provision (and aspects such as the automation of some demand, or dynamic pricing), and how they imagine this may impact on their behaviour – and specific routines or washing practices within this – this can enable participants to delve into their own understandings and personal reflections to generate further meaningful insights. Wilson and Dowlatabadi (2007) go further in their appeal for integration, suggesting that a model integrating wider sociological and psychological approaches is crucial in overcoming the limitations created by the theoretical approaches of different disciplines. Additionally, Kurz *et al.* (2015) discuss the need for psychological approaches to achieve the more nuanced insights into 'context' and habitual behaviour that social practice approaches can deliver, whilst also highlighting the need for social practice approaches to more successfully translate findings into policy-relevant conclusions. This argument has been considered in the thesis, and a range of findings are interpreted from these different perspectives and presented in a way that portrays how findings contribute to a range of academic and policy fields. As some scholars would contest the fact that social practice and psychological approaches can be used together, it is perhaps appropriate to explicitly state the researcher's position on this debate, and how the research undertaken for this thesis influenced this stance. Throughout the collection and analysis of data it became clear that people talk about their experiences of using electricity in the home in complex, inconsistent ways. For example, many often referred to affective components of behaviour and decision making, whilst also at other times referring to habitual, mundane and almost-unconscious behaviours. In addition to this, participants would sometimes refer to specific practices they performed that were more 'distant' to their own individual 'agency' and actions, where they seemingly carried or undertook practices without really interrogating their own understandings of how or why they were doing them. This suggests that these routine aspects of their lifestyles are almost viewed from a more detached position that aligns with social practice approaches and also resonates with literature on habitual behaviour. For this reason, the researcher argues that it is perfectly acceptable and appropriate in the context of this thesis to draw upon theoretical insights from both psychological and social-practice approaches, and rejects the notion that these approaches are incompatible.

Research undertaken for this thesis has adopted a grounded theory approach (see Chapter 3) and does not draw upon a specific theoretical framework for analysis. Instead insights

from a range of literature were used to inform both the research design and analysis. As such – whilst it has not been within the aims or scope of the thesis to develop a model to be applied to domestic electricity use – the research has attempted to take account of both individual and wider societal impacts enabling literature from a range of social-scientific perspectives to inform the analysis and unearth the nuanced meanings that exist in people's understandings of and relationships with electricity in the home. In summary, this chapter has aimed to portray how considerations from a diverse body of literature have informed the approach adopted within this thesis, with the aim of enabling the research questions to be answered and meaningful data to be obtained and interpreted to provide insights into how and why people use electricity in the home, as well as how experts and publics imagine this may change in the future.

3 Methodology

This chapter provides an account of the methods employed to obtain and analyse data. A range of innovative and qualitative methodologies were employed to obtain a broad understanding of the behaviours, perceptions and lifestyles associated with electricity use in the home, as well as insights into how and why expert and public participants imagine future change may occur. A detailed overview is provided that describes and provides justification for the design of the three research phases, ethical considerations, recruitment and sampling strategies. Explanation of the analytical process and approach is also provided, along with a reflexive critique and account of the overall research process.

3.1 Rationale for research design and epistemological considerations

Today there is an increasing trend for academic research to span across individual research areas and employ interdisciplinary approaches (Pace *et al.*, 2012). This is particularly evident in research fields that directly relate to and inform policy design, with energy policy – drawing upon insights from economists, natural scientists, engineers, geographers and psychologists to name but a few – being a prime example (Vaclav, 2009). This focus on interdisciplinarity, and the resultant uptake of mixed-methods approaches, has blurred the boundary lines between specific research fields and has made identifying ontological and epistemological positions a more complex endeavour. Indeed, these new research structures suggest that methodological approaches are not necessarily tied to specific epistemological positions, and practical and logistical considerations can often more significantly influence the ways in which researchers approach their work. It could be argued that such interdisciplinary approaches are not only desirable, but vital, for research that investigates interactions between people, society and technology (Biesiot and Noorman, 1999). However, whilst this project has benefitted from drawing upon influences from sociology, psychology, engineering and STS to inform methodological approaches and aid the interpretation of data, it is also acknowledged that interdisciplinary research is challenging, with researchers often facing personal, practical and institutional barriers in undertaking and presenting their work (Foulds *et al.*, 2013). Whilst difficulties had to be overcome in relation to situating the research into a disciplinary context, as well as maintaining epistemological consistency, the benefits obtained through being exposed to a wide breadth of literature that may otherwise have remained untouched have helped to

provide a context for how the findings fit within and further contribute to the multi-disciplinary literature.

A mixed-methods approach, making use of both quantitative and qualitative methods (Bryman, 2008), was considered through the integration of surveys, structured interviews and questionnaires together with more qualitative aspects of the research design. However, to best answer the research questions it was deemed to be more appropriate to adopt a qualitative approach, with the aim of obtaining a rich depth of data that would enable the meanings (Whittemore *et al.*, 2001) and reasons for people's consumption-related perceptions and behaviours to be investigated. Whilst this project could not be described as a mixed-methods study, as the research is purely qualitative, it does still make use of and integrate multiple methodological tools. This qualitative approach is traditionally associated with the ontological constructivist paradigm (Latour, 2005; Hammersley and Atkinson, 2007) and is borne from the epistemological interpretivist stance, which Bryman (2008; 694) defines as a position that 'requires the social scientist to grasp the subjective meaning of social action.'

In the context of this thesis it is important to clarify the epistemological position adopted, to outline how data can and should be interpreted. In particular, it is useful to state what participants' quotes show, what they can tell us and what forms of knowledge they can provide. For example, should quotes be interpreted as direct reflections of a concrete reality? Are they constructions of social reality, or are they highlighting participants' own subjective experiences? The aim of the thesis - and the research questions that were devised to achieve this aim – is to identify and understand public and expert participants' understandings and experience of electricity use in the home, and how and why they imagine this may change in the future. As such, whilst acknowledging that all qualitative interview data involves an element of co-production (see Section 3.4), quotes presented are treated as data that provides an insight into participants' own subjective experience and understanding. For this reason the author does not attempt to claim to have found data that directly describes and explains concrete reality. However, it is also acknowledged that interpreting participants' own subjective understandings and experiences enables nuanced insights that can have direct 'real-world' policy-relevant implications to be obtained and discussed.

Contemporary research into consumption spans many fields including economics, psychology and sociology. These differing fields and theoretical approaches involve a range

of methodological tools that are often used. As a result, debates exist over the most appropriate way to approach the topic of consumption. For example, psychological models treat individuals as the units of study, and attempt to explain the reasons and motivations for an individual's behaviour that influences their consumption. Another approach, stemming from cultural and environmental sociology, involves social practice theory, which treats the consumptive practice itself – as opposed to the individual performing the practice – as the unit of study (Reckwitz, 2002). Warde (2005) states that consumption occurs 'within and for the sake of practices', suggesting that individuals consume because they perform and 'carry' practices. This theoretical stance arguably reduces the agency of consumers, which has prompted debate between researchers who employ social practice theory approaches and those who adopt more psychological approaches. Shove (2010) argues that wide scale societal changes need to be adopted to foster less resource-intensive practices, and that a social practice theory approach is the most appropriate means of understanding how this can be achieved. Others have argued that aspects from both approaches can be drawn together to develop a complementary means to achieve the same research goals (Whitmarsh, O'Neill and Lorenzoni, 2011). Despite the differences that exist between the perspectives discussed above, there are common ideas and concepts that can be applied to help answer the research questions and contribute towards efforts to achieve the wider end-aim of discovering mechanisms to reduce overall domestic electricity consumption and demand. As summarised in Chapter 2, the strategy adopted for this research is based on the position that argues that aspects of both approaches can successfully be dovetailed together in a way that attempts to understand both the wider scale, social context of consumption and the more individual aspects of people's consumption-related behaviour, perceptions and lifestyles.

3.2 Research Design Overview – The Three Research Phases

The project employed a pragmatic approach with regard to the research methods used. The research was divided into three phases, as it was decided that this format would be most suitable for obtaining data that could answer the research questions (see Section 1.2 for the research question rationale). The first, Phase 1, involved focus groups with members of the public to investigate electricity consumption-related behaviour, perceptions and lifestyles. Methods employed in this phase aimed primarily to contribute towards and answer research questions 1) and 4):

1) How do people understand and interact with their existing electricity supply system in the home?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

Phase 2 involved expert interviews with fellow members of the Top and Tail network – to which the researcher was attached. The Top and Tail network is a collaborative project funded by the EPSRC Grand Challenge Network. The project focuses on the physical infrastructure change in energy networks required to move the UK to a low carbon economy, and achieve the Government's 2050 reduction in CO_2 emissions target (for more information see www.topandtail.org.uk). The main aims of these interviews were to identify possible future changes to the UK electricity system and to investigate the hopes, concerns and motivations within expert visions to understand and highlight the perceived need for, and mechanisms to achieve, change. As such, this research phase aimed to unearth findings that would help to answer research questions 2) and 3):

2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?

Phase 3 involved follow-up qualitative interviews with Phase 1 (focus group) participants to further investigate people's relationships with electricity in the home and build upon insights drawn from the focus groups. Participants were also presented with resources (such as videos and a 'tabloid' headline writing task) developed from insights obtained in Phase 2 expert interviews that described and presented representations of possible future change. It was anticipated that this approach would enable perceptions and views towards possible future change to be identified, enabling an understanding of possible perceived opportunities for, and barriers to, change to be obtained. Adopting a grounded approach throughout the research process, it was hoped that these follow-up public interviews would build upon findings from the previous two research phases. Drawing upon this iterative, grounded approach enabled a range of inter-related and contributory findings (and an understanding of their implications for policy and research) to be obtained. For this reason this research phase could be legitimately argued to be aiming to identify answers to all four

research questions, however, the aim of these interviews was particularly to answer research questions 2), 3) and 4):

2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

3.2.1 Research Phase 1 (Focus Groups)

3.2.1.1 Why Focus Groups?

Face-to-face qualitative interviews are highly appropriate ways of obtaining meaningful, descriptive data as they provide participants with the opportunity to 'open up' and talk about their ideas. As the research centred on electricity use in the home and the role that electricity plays in everyday life it was anticipated that participants would be able to personally relate to and may perhaps feel strongly about the issues being discussed. It was considered important to be able to react to and probe the varying responses provided by participants – in a way that questionnaires or structured interviews do not enable – as this could help generate further useful data by delving into the meanings and reasons for particular responses. For this reason a semi-structured, qualitative approach was considered to be the most appropriate means of obtaining data that could answer the specific research questions set out in this thesis.

Electricity consumption in the home is intrinsically linked with lifestyle (Akcura *et al.*, 2011), and as a result, changes in people's lifestyles are likely to be reflected by changes in people's electricity consumption. For this reason approaches incorporating temporal change were considered as a mechanism for obtaining insights into the effects of changing habits on electricity consumption, which could then help to identify key areas which could be targeted for further investigation. Quantitative approaches have been employed through the use of smart meters and the analysis of consumption data (Faruqui *et al.*, 2010). However, the lack of explanation and understanding of the reasons behind the dynamics of electricity consumption, combined with the effects that feedback on household electricity use provided by smart meters has on residents' behaviour, is often cited as a limitation to

these studies, and future approaches may attempt to combine quantitative aspects with longitudinal qualitative tools (Hargreaves *et al.*, 2010). The use of technology such as smart meters to adopt a mixed-method design was beyond the financial and logistical scope of this project. However, by addressing the limitations identified in existing research it was hoped that the longitudinal aspect of the design would still produce novel, meaningful insights and contribute to the growing body of literature on electricity consumption.

Limitations exist within all forms of methodological approaches. Qualitative interviews, whilst considered a useful tool in the qualitative researcher's arsenal, are often expensive and time-consuming to undertake (Tracy, 2013), and the data obtained is reliant upon the interviewee's willingness to engage with and respond to prompts and questions provided by the researcher. Furthermore, Bryman (2008) suggests that the artificial nature of interviews can influence participants' responses and ultimately affect the quality of data obtained. The research design aimed to combine a range of different qualitative methods. It was hoped that this triangulation between methods (Flick, 2008) would help reduce and overcome some of the limitations that have been identified in previous research. Focus groups were considered as they offer a more 'naturalistic' setting, enabling participants to 'collectively make sense of social phenomena and construct meanings around them' (Bryman, 2008: 476). In addition to facilitating a more natural discussion, when moderated successfully, focus groups provide the opportunity for participants to probe each other's opinions and stimulate discussion in a way that individual interviews cannot. This methodological characteristic was considered to be a key advantage that would help to generate answers to the research questions as it was hoped that natural discussions would lead in directions that were meaningful to participants – and therefore relevant to the research – yet could arguably not be foreseen or anticipated by the researcher. Barbour and Kitzinger (1999) suggest that this group interaction can potentially reveal useful information about participants' opinions that is otherwise difficult to unearth in interviews. One of the aims of Phase 1 was to explore and identify key areas and concepts that could be further investigated and built upon in the later phases of the research. For this reason it was considered important to probe participants' opinions towards certain ideas and to provide open-ended prompts to enable participants to respond in ways which were personal to themselves. As such, the protocol was designed to enable these opportunities to occur. Kitzinger (1994) also highlights the importance and benefits of interactions between group members, which enable people to orient to one another and share discourses in the process of collective sense making. Fern (2001) states that focus groups

are suitable tools for 'exploratory' research, and it was decided that by conducting focus group discussions in Phase 1 it would provide meaningful insights into the dynamics of people's electricity-related attitudes and behaviour, and identify areas that could be considered in the design of the Phase 2 resources. It was anticipated that these focus groups would set the foundations for the iterative approach adopted throughout the progression of the research project, enabling subsequent research phases to build upon and complement findings and insights obtained in this first, exploratory phase. Individual qualitative interviews undertaken in Phase 3 would then be used to follow-up and develop upon the concepts identified in Phase 1.

3.2.1.2 Recruitment and Focus Group Design

Focus group discussions can generate useful data that can help to describe and explain participants' viewpoints and opinions (Basch, 1987). These insights can be useful for policy makers as they can highlight particular areas that are important to the public and can be considered in the design of new policies. However, to ensure that the dynamics of the groups led to open discussion there were some aspects of the focus group design that needed to be considered. Stewart *et al.* (2007) suggest that there are many factors that can influence group compatibility and cohesiveness. These include - and are not limited to - physical appearance (Adams and Huston (1975), personality (Quiriconi and Durgan, 1985), gender (Deaux and Lafrance, 1998) and age (Shaw, 1981). Furthermore they argue that socio-economic status can influence group dynamics, particularly if the group is comprised of participants from a range of socio-economic backgrounds. Emerson (1964) also suggests that the perceived social power of participants can affect the ways in which group members may influence other people, which can impact upon people's responses and participation in discussion. Whilst it was impossible to accurately predict how the dynamics of focus groups would develop, by considering these factors in the design and recruitment, the researcher was able to have some control over the group effects that were likely to occur. To ensure that meaningful data was obtained the focus group protocol remained adaptive and flexible to emerging topics discussed by participants (*e.g.* Henwood *et al.*, 2008), and whenever appropriate, responsive to the conventions of normal group conversation, mirroring Parkhill *et al.*'s (2010) approach to conducting narrative interviews.

In the current study focus groups were homogeneous and comprised of participants with similar characteristics that were seen as potentially relevant to the research questions (Macnaghten, 2010). As the research focused on electricity in the home it was decided that living arrangements – more specifically the type of accommodation that participants lived in – would be a suitable factor that could be used as the 'common denominator' in each group. It was hoped that by recruiting participants from similar 'home' backgrounds, or with some similar aspects of their lifestyles, this commonality within the group would encourage discussion and in particular provide the opportunity for participants to explore the similarities and differences in each other's opinions and ideas (*e.g.* Rabiee, 2004). To attempt to obtain a range of responses from people from different backgrounds and perspectives it was important to include participants from a variety of living arrangements. In addition to these considerations, recruitment of participants had to be flexible and responsive to opportunities, and as a result, the make-up and characteristics of the groups evolved throughout the course of the project. Groups consisting of the following distinctive characteristics were conducted: young professionals living in rented accommodation; retired homeowners; students living in shared accommodation; residents who had recently had solar photo-voltaic (PV) panels installed on their properties; and mothers with young children.

Combined with the participants who made up the focus groups, the environment in which the discussions took place had to be considered, as these could have influenced the data quality (Levine and Moreland, (1998). The homogeneous focus groups, comprised of participants from a number of different households, were undertaken in a 'neutral' location (*e.g.* on university premises) to ensure that no participants were less familiar or less comfortable with the surroundings than other members of the group. Focus group size was also carefully considered within the design (Tang and Davis, 1995), as a group comprised of too many participants may not provide all members with the opportunity to air their views. Conversely, groups made up of too few members may not have enabled participants to stimulate discussion amongst themselves, potentially limiting one of the main benefits of using focus groups, and therefore potentially reducing the suitability of employing focus groups to obtain data capable of answering the research questions.. In addition to ensuring sufficient opportunities for participants to engage in discussion, Tang and Davis (1995) also suggest that focus group size determines the available time for questions and allotted time for responses, with larger groups limiting the number of questions. Six participants was deemed to be the most appropriate number for each group in this project, because this

mirrors standard research practice and falls within Kitzinger's (1995) suggested range of using between four and eight participants. This figure was kept in mind throughout the recruitment process, however, due to time constraints and obstacles involved in recruiting sufficient participants who were available at the same time, focus groups of varying sizes were conducted (see Table 2, next page).

The initial aim for Phase 1 was to undertake sufficient focus group research until data saturation – the point where no new insights or themes are emerging out of the data (Morgan, 1996) – was reached. In line with many qualitative approaches to research, the motivation was not necessarily to obtain data from a sample that could be said to be representative of the wider population as this was not in the aims of the project. Rather, the aim was to obtain an understanding of the range of different perceptions and opinions that exist, and by sampling participants from a range of different backgrounds it was hoped and expected that this would be achieved (*e.g.* Pidgeon *et al.*, 2014). Macnaghten (2010) argues that conducting focus groups with participants across a diverse range of factors (*e.g.* age, gender, lived experience *etc.*) enables the 'generalisability' of the findings to be maintained and justified. It was anticipated that by conducting the focus groups (one from each of the categories outlined below) sufficient data would have been obtained, however, the option of conducting further focus groups was considered if it were deemed to be necessary (*i.e.* if insufficient or poor quality data had been obtained, or if data saturation had not been reached, which could have compromised the ability to answer the research questions).

Five focus groups were conducted, with 27 participants taking part in total. The group of young professionals were selected because they had recently experienced significant lifestyle changes (such as leaving university, starting careers and moving from large, shared houses to smaller dwellings and households) which may have influenced their awareness and use of electricity in the home. Similarly, the group comprised of undergraduate students had recently experienced becoming responsible for paying utility bills for the first time as a result of living in a shared, rented house rather than in their parents' houses or university halls of accommodation. The group of retired homeowners were selected to identify any potential perceived generational differences as well as to include perspectives from people who had experienced developments in the provision and role of electricity in the home over the course of their lifetime. Furthermore, it was anticipated that differences between renting tenants and homeowners may be identified. The group of mothers with young

children were included as they had recently experienced very significant lifestyle change that would be likely to influence how and why they used electricity in the home. It was anticipated that comparing their responses with other participants may help to identify meaningful aspects of changes in electricity use as a result of becoming a parent. Similarly, insights relating to perceived generational differences were anticipated to be obtained. Finally, the group of homeowners with solar PV panels were included because, based on both limited evidence within academic literature (*e.g.* Mckenna and Thomson, 2014) and anecdotal evidence from personal communications, the researcher aimed to identify possible changes that had occurred in participants' relationships with electricity and how their use of electricity may have been influenced by their ability to generate electricity. It was anticipated that focusing on this little-researched aspect would generate novel findings and help to fill a research gap. More information on the make-up of the groups, which were conducted from January-July 2013, is included in Table 2:

Table 2: Focus Groups Characteristics and Make-Up

Group	Description	Theoretical reasoning for inclusion
Young Professionals	4 male & 2 female participants (age 23-27). Rented accommodation.	Perceived generational differences. Differences between renting/home-owning. Recent lifestyle change.
Retired Homeowners	3 female & 2 male home-owners (age 64-68).	Perceived generational differences. Differences between renting/home-owning. Experience of 1970s power cuts.
Student House	4 female & 2 male students (age 19-20). Living in shared, rented house.	Perceived generational differences. First experience of being bill-payers. Living with others.
Solar PV	3 male-female home-owner couples (age 41-63). Had solar PV panels installed within previous 12 months.	Different relationship with/awareness of electricity – 'prosumers'.
Mothers	4 mothers with young children (age 29-43).	Recent lifestyle change. Perceived generational differences.

Participants were recruited using a range of methods including posters, emails and social media advertisements. Participants in the solar PV group were recruited with the assistance

of a 'gatekeeper' (Arcury and Quandt, 1999) who worked for a solar panel installation company. 'Snowballing' (Fry and Dwyer, 2001) – where respondents to recruitment adverts were asked to identify and recruit further potential participants - was also used to ensure that sufficient numbers of potential recruits were available to participate in each group.

3.2.1.3 Data Analysis

Discussions were audio-recorded and subsequently transcribed. Approximately 60,000 words were transcribed during the focus group phase. Oliver *et al.* (2005) state that transcription plays a key role in qualitative research and forms the first stage of data analysis. Whilst this was a very time-consuming exercise, by personally listening to and transcribing the audio tapes – as opposed to using outsourced transcribers – the analysis benefitted from the researcher's familiarity with the data from the early stages. Additionally it could be argued that the transcription accuracy was likely to be higher because the author was present in the interviews and thus able to recall the context of discussions to help interpret ambiguous sections of audiotape. Lapadat (2000) describes transcription as the initial phase of data reduction. By translating interviews into a text format it is difficult to include all the sighs, gestures and other nuances that make up human speech. For this reason a transcription style that was appropriate for the analysis and sufficiently represented these nuances and subtleties within participants' speech was adopted. As the transcripts were to be interrogated for themes, content and meaning, it was deemed unnecessary to transcribe and analyse every pause or stutter, particularly as doing so would have required an exorbitant time investment for little added analytic value (Halcomb and Davidson, 2006). The transcription protocol adopted fits in between a verbatim, naturalistic approach – where every utterance and component of speech is noted in detail – and a more 'denaturalistic' method where 'noise' from the interview is ignored and grammar is corrected (Oliver *et al.*, 2005). It was anticipated that this approach would have the additional benefit of providing quotes that were more readable than a verbatim approach and therefore would have more impact (Poland, 2001). Despite this general 'reduction' of data in the transcription process, it is important to stress that where appropriate or contextually relevant, some verbatim features (such as laughter, long pauses and 'umms') were included. The transcription protocol (summarised in Table 3) drew upon

McLellan, Macqueen and Neidig's (2003) in-depth discussion of considerations for researchers transcribing interview data and was adapted from Thomas' (2013) approach:

Table 3: Transcription Protocol

Item	Protocol
Inaudible speech	**[Inaudible tape]**
Pause	**[Pause]**
Emphasis	**Bold**
Interruptions in speech	**Interruptions in spee-**
Mispronunciations, slang *etc.*	**Transcribed as participant says them**
Filler words (*e.g.* um, yeah)	**Generally ignored, unless they were deemed important to context (*e.g.* indicating uncertainty)**
Repetitions of words or phrases	**Generally ignored, unless they were deemed important to context**
Laughing, sighing *etc.*	**Generally ignored, unless they were deemed important to context, where they were written as [*e.g.* laughs]**
Gestures	**Not transcribed**
Prosodic features (*e.g.* pitch, loudness)	**Not transcribed**
Discussing irrelevant information (*e.g.* the weather today)	**Not transcribed. Summarised as [*e.g.* discussing weather]**
Other features (*e.g.* pauses to complete written tasks)	**Summarised as [*e.g.* pause whilst participants complete written task]**

Interpretive thematic analysis was undertaken on the data, where transcripts were interrogated for patterns and themes (Miles and Huberman, 1994). To facilitate this analysis a coding framework that drew upon concepts from grounded theory (*e.g.* Glaser and Strauss, 1967; Starks and Trinidad, 2007) was devised through an iterative process. Refinement of this framework was achieved by remaining responsive to themes emerging from the data (Henwood and Pidgeon, 2003) and through the consideration of the research questions and relevant theoretical literatures. The Computer Aided Qualitative Data Analysis Software (CAQDAS) package NVivo (version 10) was used to store, manage and code data. This enabled a coding framework to be developed and applied to the transcripts and for codes and themes identified to be systematically stored, retrieved and managed in a

way that ensured a clear, comprehensive and transparent analysis could be undertaken in a rigorous and straightforward manner. Debates (*e.g.* Richards and Richards, 1994) over whether computer-aided analysis can provide the richness and depth that a manual approach to qualitative data were considered, with the acknowledgement that the creative chaos created by 'messy, multi-coloured paper records adorned with scribbled comments' (Richards, 1999) can sometimes lead to arguably more spontaneous, natural insights from researchers working closely with their data. However, by developing a thorough coding framework and using memos within the NVivo software alongside paper notes to keep records of thoughts, reflections and insights at different stages of the process, it is argued that the risk of analytical conclusions becoming lost under the sheer weight of codes was minimised. Moreover, by enabling data and analytic documents to be instantly retrieved a thorough and efficient analysis was ensured.

Initial open coding (*e.g.* Starks and Trinidad, 2007) was undertaken to generate codes of differing theoretical complexity (*i.e.* from simplistic descriptive codes to more conceptual categorisation). Open coding represents the first stage of 'disentangling' the data (Flick, 2014) and divides and categorises the data within codes that represent the content and concepts within the data. By comparing between and within codes, this process helped to ensure that generated codes maintained a good 'fit' with the data. Building upon this initial open coding, the next stage of analysis involved grouping these codes within more theoretically relevant, broader 'meta-codes'. Emerging codes and themes were discussed by the researcher and supervisory team to ensure that the analysis remained responsive to the data. At this stage, emerging themes were also organised and preliminarily analysed in relation to the research questions. This ensured that data could be drawn together to answer these questions and identify key findings and arguments. Coding and subsequent grouping of codes was conducted and repeated until theoretical saturation was reached and no new codes or themes were emerging. Additional strategies to manage and help inform the analytic process included developing diagrams to portray the relationship between codes, writing detailed analytic memos and defining each individual code to ensure that insights were not missed or forgotten in later interrogations of the codes.

As the analysis was undertaken solely by the author, the issue of differing interpretations from multiple researchers, which can affect the reliability of the analysis - defined by Hammersley (1992) as "*the degree of consistency with which instances are assigned to the same category*" – was avoided, negating the requirement for standardisation conventions (Flick, 2005) that

may be employed in larger, team research projects. This grounded, bottom-up approach ensured that findings and conclusions drawn from the analysis were appropriate for the data and that pre-conceived ideas or anticipated themes (for example, findings from existing literatures) did not negatively impact or overly influence the interpretation. The author acknowledges that inevitably the experiences, ideas and opinions of any researcher interact with the interpretation of data and ultimately influence findings (Alston and Bowles, 1998), however, by reflecting upon and being mindful of this consideration at all stages of the analysis, it was anticipated that this effect could be managed to the benefit of the analytic process. By reflecting upon the possible role the researcher may have had in this bespoke approach - that was influenced by a range of concepts from grounded theory, discourse and thematic analysis - it was further hoped and anticipated that the findings and conclusions drawn would be rich, deep and meaningful whilst also being valid, trustworthy representations of the data obtained (Krefting, 1991). It is worth noting that whilst some between-group patterns were identified (for example, perceived generational differences), efforts were more directed towards identifying themes existing within the whole data-set. This was because the aim of the research was not to investigate differences between groups, but to probe and identify the range of perceptions that could help inform later phases of the research project and answer the research questions.

3.2.1.4 Ethical Considerations

Diener and Crandall's (1978) four main ethical principles for social research (invasion of privacy; deception; harm to participants; and lack of informed consent) were considered when devising the research plan. This was also discussed with supervisors before applying for consent from the Cardiff School of Psychology Ethics Committee and commencing with recruitment.

Following ethical approval and subsequent recruitment, participants were provided with information about the research prior to their providing written consent and involvement in the focus groups. They were also informed that they could withdraw at any time of the study. Additionally, a debrief form was provided after the focus groups to provide more information on the project. Topics covered in the discussions were not deemed to be of a sensitive nature, however, care was taken to ensure that data was managed professionally and in line with ethical requirements. Data collected (audio recordings and transcripts)

remained strictly confidential to adhere to The British Psychological Society's 'Code of Human Research Ethics' (2010). All responses were anonymised, preventing participants from being made identifiable through their contributions after transcription, although, by their nature, focus groups cannot be described as anonymous at the point of data collection. All quotes reported in this thesis use pseudonyms, which has the additional practical benefit of enabling the reader to infer information (*e.g.* gender) which may, or may not, be relevant to the context of the quote.

3.2.2 Research Phase 2 (Expert Interviews)

3.2.2.1 Recruitment and Expert Interview Design

Morgan, Pitelka and Shevlienka (2001; 280) state that 'expert judgements can provide useful insights for policy makers and researchers'. By probing these insights – and the assumptions and expectations that contribute towards them – it was anticipated that an understanding of participants' visions of possible future electricity systems and how they may affect electricity use within the home could be obtained. This would generate data that could directly help to answer research questions 2 and 3. For this reason, 16 semi-structured expert interviews were undertaken between May and December 2013. It was initially anticipated that all Phase 2 interviews would be conducted face-to-face, as it was considered that this would enable the interviewer – through the use of 'visual cues and small utterances' (Stephens, 2007) – to build rapport with and encourage interviewees to talk freely in a manner akin to 'normal' conversations. As participants were based at various university locations across the UK it was deemed impractical for both logistical and financial reasons to carry out all interviews face-to-face, and therefore the decision was made to explore alternative arrangements. In total, eight interviews were conducted face-to-face, five were conducted over the telephone, and three were undertaken over Skype (a software programme using webcams and microphones).

Participants were recruited using a strategy that evolved throughout the research process. It was decided early in the project that Top and Tail network members would be requested to participate in interviews. This decision was made for two primary reasons. Firstly, funding obligations required that materials describing possible future changes in electricity network provision were created to use in public interviews – which required the author to probe expert understandings of these possible future changes. Secondly, as a member of the Top

and Tail network, the author had valuable, rare and exclusive access to a range of leading experts in the field who were willing to give up their time to participate. This opportunity to interview members on a range of topics was deemed too good an opportunity to miss out on, and as such formed an integral part of the research plan.

Potential participants were identified by attending Top and Tail events (where various members provided presentations on their areas of expertise and current research) and investigating project plans that outlined different members' areas of expertise. As the aims of this project were to investigate possible changes that may impact upon how electricity is used in the home, it was initially decided to focus efforts on recruiting participants with expertise in areas with obvious, direct relevance to the 'last mile' and domestic sector – *i.e.* the 'Tail' of the network. For example, it could be argued that an academic with expertise in home technologies is more likely to have a higher professional interest and knowledge in how people use electricity in the home than someone who designs new cable technologies for offshore wind turbines. However, because themes emerged in early interviews it was decided that members of both the 'Top' and the 'Tail' should be approached as this would provide a greater context for technical information emerging from interviews, and enable the assumptions and expectations from a wider range of perspectives to be investigated, thus increasing the depth and breadth of data to help answer the research questions. Once potential participants had been identified, a letter was sent out requesting their participation in an interview (see Appendix F). Upon receiving replies the time and date of interviews were organised via email. Several rounds of emails and letters were sent during the recruitment process, many of which received no response. In one or two instances correspondence was initiated, but interview arrangements were rescheduled or cancelled and never actually resulted in an interview taking place. This difficulty, in addition to simply finding times where participants were free to take part, presented a significant challenge and raised the concern that an insufficient number of interviews would be conducted, which led to alternative approaches to recruitment being developed.

Two alternative strategies were adopted. The first involved meeting potential participants at events and requesting their participation in person. Three interviews were arranged using this approach. Secondly, snowballing was attempted, where participants would be asked at the end of their interview whether they could recommend other potential participants. This strategy had two benefits. Firstly, when contacting new participants the reference to a recommendation from a colleague added weight (and credibility) to the request, which

arguably increased the likelihood of the request being granted. Secondly, whilst providing a reason for their recommendation, interviewees would often give reasons as to why the author should approach their colleagues, often referring to their area of expertise, which would help to tailor requests and subsequent interviews accordingly. Three additional interviews were arranged using this approach. It is worth noting that one or two participants suggested I contact people from outside the Top and Tail network. This was considered at length, however, it was ultimately decided that having a sample of participants from one single network ensured that there was a commonality across the sample, as they were all conducting research that aimed to identify possible innovations that could contribute to a transition towards a future lower-carbon electricity system and were working towards a similar end 'goal' with common themes and aims running through their work. Deciding upon this boundary also ensured that the original focus of the research was maintained throughout, which could arguably have been risked had interviews been conducted with participants who had been recruited through numerous extended recommendations. Furthermore, Lowe and Lorenzoni (2007) state that there is no universally agreed definition of what an 'expert' actually is, therefore having a definitive boundary (*i.e.* being a member of the Top and Tail network) helps to delineate a border between the participants and any other publics or experts. Indeed Collins and Evans (2002) suggest that with increasing public engagement and participation in science, the boundary between experts and the public has often tended to dissolve. One could argue that an expert can be defined not only through the way they approach or work with a topic (O'Hagan *et al.*, 2006), but also through their lived experience of it (Collins and Evans, 2002). This is particularly relevant for this project, as both the public focus group participants and the Top and Tail members are 'experts' at using electricity within their own homes, whilst only the Top and Tail members have the professional expertise relevant for the aims of the Phase 2 interviews. Additionally, it could be argued that within the Phase 2 sample, there are some experts that are more 'expert' in certain topics than others, as participants included PhD researchers, post-doctoral researchers, academic staff and professors. This debate suggests that the term 'expert' itself could be contentious in the context of this project, and consideration has been given to the connotations that come with labelling participants as such. However, a more practical aspect of describing and categorising the sample is also highlighted, where expert participants come from a range of academic backgrounds - including economics, sociology and various disciplines within engineering. Participants could perhaps more accurately be described as informed Top and

Tail network colleagues, but for brevity and clarity they will be referred to throughout this thesis as experts.

The interviews were approximately one hour long. After providing consent, each session began with a few introductory questions about the participant's job title and area of expertise. The interview protocol (see Appendix I) then involved questions and prompts that were asked to all interviewees to ensure that specific topics were covered from a range of different perspectives and to investigate common understandings (and differences). Where appropriate, open-ended prompts were used to invite participants to again discuss their areas of expertise and how their work fitted within the wider research field. The author aimed to build rapport with participants to encourage them to provide opinions and insights towards the prompts being used. As Rapley (2004) discusses, this was deemed to be a key part of ensuring that participants were comfortable in the interviews. This was achieved through a number of strategies, one of which involved allowing the direction of the interview to largely be determined by participants' responses and discussion, thereby ensuring that the interviews included topics that participants felt were important. The semi-structured format ensured that all desired topics were covered by occasionally steering conversation back towards the protocol, thus guaranteeing that topics that were anticipated to be central to answering the research questions were included. An additional strategy employed involved the subjective positioning (*e.g.* Lucious-Hoene and Deppermann, 2000) of the interviewer within discussions. By projecting an image of an 'ignorant, interested layman' and 'naïve newcomer' (Melia, 2000) this would encourage participants to provide simple descriptions and explanations, whilst in other situations attempting to come across as an 'informed interviewer' familiar with the topics being discussed would demonstrate competence and literacy (*e.g.* Welch *et al.*, 2002; Mikecz, 2012) and invite participants to give in-depth, technical descriptions of what they were discussing. It is acknowledged that this interviewer positioning was more readily achievable in the face-to-face interviews as body language and facial expressions inevitably enabled the interviewer to interact more in the intended way with participants. The researcher enjoyed the challenge of developing elite interview skills and reacting to participants' personalities to put them at ease in the situation, and the strategies employed enabled a wide range of responses and useful data to be obtained.

3.2.2.2 Data Analysis

Data analysis was undertaken using a very similar approach to that outlined in section 3.3.1.3. Approximately 95,000 words were transcribed during the expert interview phase, using the same protocol as with the focus groups. Transcripts were imported into NVivo and coded, before being printed off and analysed thematically using the same approach as that outlined for the focus groups. In addition to generating findings in their own right, insights from the analysis also enabled the researcher to develop materials describing possible future change to be used in Phase 3 interviews. These are discussed later.

3.2.2.3 Ethical Considerations

As in section 3.3.1.4 there were a number of ethical considerations relating to the interviews. For brevity the common aspects relating to both the focus groups and expert interviews have not been re-described in this section. Ethical approval, data management (*i.e.* confidentiality), consent and participant debriefing were carried out in identical fashion in Phases 1 and 2. Participant anonymity was an aspect that was considered at length. It is not uncommon in research using expert interviews to publish the identity of participants. This arguably adds to the credibility of publications as they have the weight of the 'name' associated with quotes. It was initially decided to request permission to publish participant names and institutional affiliations, however, after considering the merits of this plan – and the ethical conundrums it would create – pseudonyms were used to protect participants' anonymity. This decision was made as it was deemed participants' names were unnecessary within the context of achieving the overall aims of the thesis. Additionally, the fact that readers would know that participants were from the Top and Tail network already provided some context. It was also suggested that by requesting to name participants' affiliations in publication this would perhaps risk further problems with recruitment as participants may have been unprepared to seek permission from their respective institutions before agreeing to take part. Anonymity also had to be considered when selecting participant quotes, because – even if pseudonyms were used – the content of some quotes could enable people to be identified. Whilst including such quotes could perhaps be said not to contravene ethical guidelines, the author considered it to be an important aspect of their professional conduct as a researcher to ensure that participant identification through this mechanism was not possible. As such, certain quotes were

excluded from publication, or identifying features such as the names of institutions or people were omitted from quotes. A final ethical dilemma that arose in the course of these interviews surrounded participants' reflections on the Top and Tail network itself. As a member of the network, should the researcher exclude such information from publication, or should constructive reflections be included to represent participants' opinions? It could also be argued that, as a member of the network in the privileged position to discuss aspects relating to Top and Tail with other members, the author had a responsibility to provide feedback that may be constructive and useful for the on-going management of the network itself – as long as this was achieved in an ethically appropriate manner, again ensuring participant anonymity. It was decided that certain responses relating to Top and Tail, and academic collaborations and inter-disciplinary working more generally, would be published when relevant to the wider aims of the project. Additionally, where appropriate this feedback was presented alongside project findings to the Top and Tail network at events and conferences.

3.2.3 Research Phase 3 (Follow-up Interviews)

3.2.3.1 Recruitment and Interview Design

The three-phase approach adopted aimed for each new phase to build upon the previous ones to ensure that all four research questions could be answered. For this reason it was important for the third phase to further investigate and build upon insights obtained in both the focus groups and the expert interviews. It was decided early on in the research process that this third phase would involve follow-up interviews with participants from the public focus groups. This was for a number of reasons. Firstly, it is widely accepted that all methodological tools employed in research have some limitations, and by conducting an additional round of interviews with public participants it was hoped that some of the limitations associated with focus groups (such as those group effects discussed in section 3.3.1.1) could be overcome and therefore a more complete data set could be obtained. This process also enabled a more 'grounded' approach to evolve, as the exploratory, open-ended focus groups were followed up with more tailored, specific topics (influenced by these initial insights and emerging themes) being discussed in the interviews.

Twenty participants were interviewed between February and May 2014. Participants provided consent in the focus groups for their details to be securely held and for them to

be contacted about the possibility of taking part in a follow-up interview (see consent form – Appendix B). There was no particular sampling strategy based upon how participants interacted within the focus groups, however, it was hoped that a fairly even spread across the five groups would be achieved. All individuals who took part in the focus groups were invited to take part in an interview. At least three members from each group took part in the follow-up interviews, enabling a broad range of participants to be maintained. The make-up of participants was as follows: five out of six young professionals; four out of five retired homeowners; four out of six students living in a shared house; four out of six residents with solar PV; and three out of four mothers with young children.

As the research focused on how electricity is used in the home, it was hoped that by conducting these face-to-face interviews in the familiar setting of home (Siemiatycki, 1979), and therefore the place in which participants used electricity in their everyday lives, that they may have felt more able to talk freely about their lives within the home than if the interview had been conducted within the alien, formal environment of university premises. Whilst this clearly benefitted the research and ensured that rich, useful data was obtained, it did raise some issues relating to both research ethics and the safety of the researcher. By devising and following a procedure where the researcher informed colleagues of the time and location of interviews, as well as being contactable by phone, it was deemed that the risk to the researcher was minimised and managed. Interviews were typically one hour in length, with some ranging from approximately 50 minutes to almost 80 minutes.

Once participants had provided written consent to take part in the interview they were provided with a blank tabloid template (Figure 2, next page) and were asked to select a future date – ranging from the present day to as far ahead as 2050 – and to complete the various headlines as if the tabloid were being published on this date. This task came at the start of the interview – before any questions or topics had been introduced – in the hope that it provided participants with the opportunity to write about issues that they felt were important, and arguably helped to minimise untoward framing effects that are an inevitable issue within qualitative interviewing (Malterud, 2001; Henwood *et al.*, 2008). It could be suggested that by inviting people to complete tabloid headlines you are pre-conditioning them to provide more 'sensational' responses than if they were asked to complete other templates (*e.g.* for a broadsheet newspaper). This was, however, deemed by the author to be a positive, beneficial outcome as it enabled participants to engage more creatively with the

topic and arguably helped people to think about things they may not have considered if the interviews had been purely conversation-based.

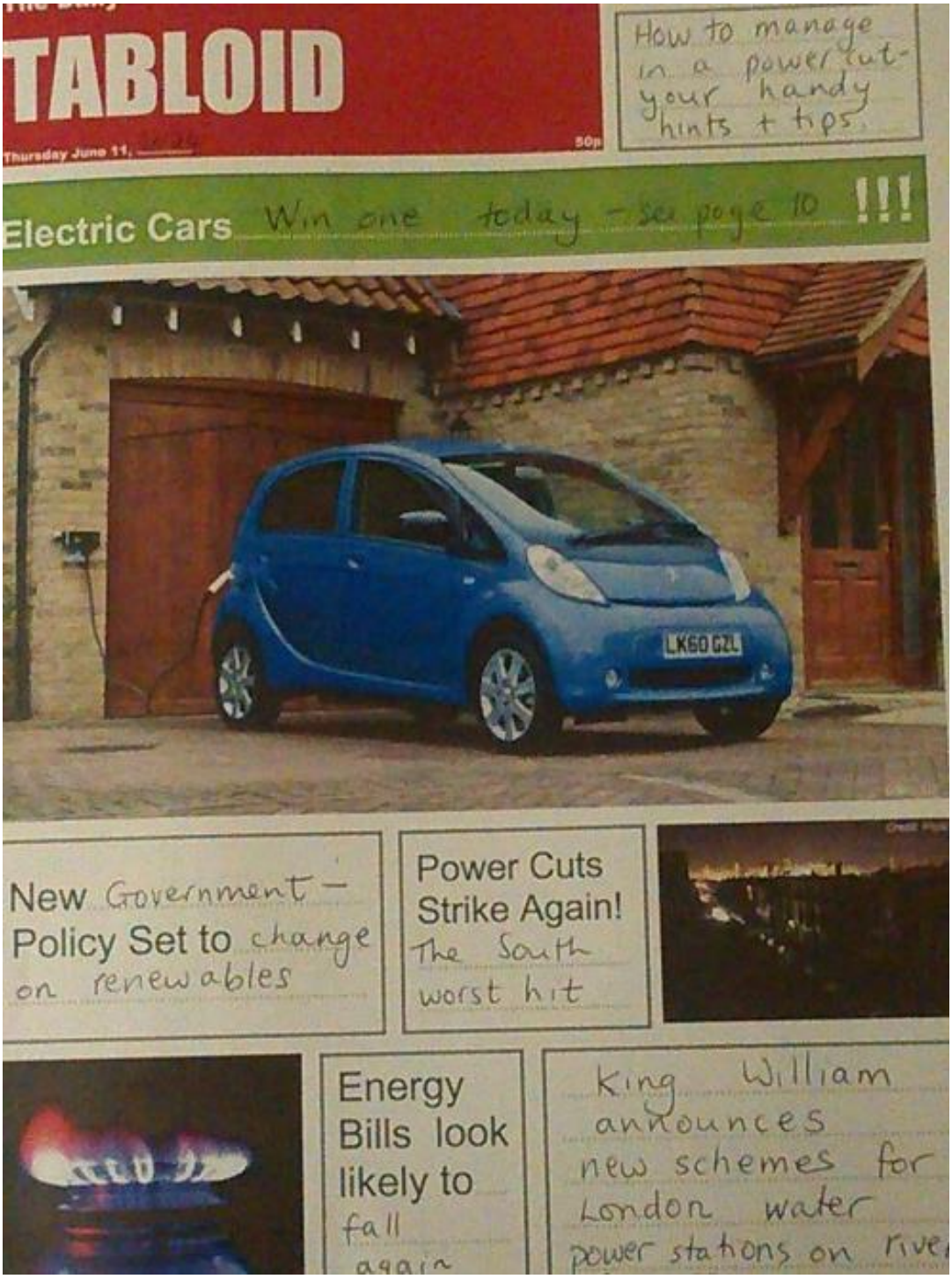

Figure 2: Example of a completed tabloid template

Erikson (1986: 121) posits that interpretive research needs to use techniques that allow researchers to 'make the familiar strange and interesting again'. Building upon this idea Stouffer, Jeffrey and Oliva (2004) suggest that by being creative and abandoning purely language-based approaches this familiarity can be made more alien and therefore open up new insights. Furthermore, Mannay (2010) argues that researchers can often be constrained by their familiarity with the area they are trying to investigate. By using techniques that involve more participation from interviewees this constraint can be overcome as the direction is less guided by the interviewer. It was hoped that by employing the tabloid task in these interviews – and asking people to imagine possible future headlines - that the familiar topic of electricity in everyday life could be made more strange and potentially enable participants to approach the topic from a different perspective, thereby generating more insights and data relevant to the research aims. Once the tabloid had been completed the interviewer set it to one side, and then, at the end of the interview participants were asked to talk through the tabloid and the reasons behind their answers. It is interesting to note that many participants enjoyed this task and talked at length about the reasons for their responses, however, one or two people suggested that they found the task difficult and were slightly uneasy about being asked to discuss the ideas behind their inspiration. This could perhaps be due to the fact that many participants acknowledged that imagining the future is a difficult endeavour (see also Shirani *et al.*, 2015), and being asked to speculate on possible future news stories is an extra step in complexity from this. The author was surprised at how engaged some participants were when describing their completed tabloid, with some even insisting upon changing their initial responses and explaining why their views had since changed. The high interest shown by participants demonstrates how this tool did indeed enable people to interact more in a different context from the rest of the interview, and vindicates the decision to select this methodological approach.

Following the tabloid task, the interviewer asked introductory questions about lifestyle changes since the focus group – to investigate biographical aspects of changing energy use (helping to answer research question 1) and to act as an icebreaker to ease participants into the interview - before moving onto more specific questions to further investigate themes that emerged during Phase 1 (see protocol in Appendix L). The next part of the interview involved questions based on possible future changes to the electricity system (helping to answer research questions 2, 3 and 4) that were based on findings from the expert interviews and insights from literature. Two short film clips were then used as an alternative resource to prompt and probe participants' views towards the presented images.

The first film involved a discussion of smart energy monitors and the role these may have in future society, whilst the second involved a 'walk-through' tour of a futuristic house and depicted possible future home technologies and consumer devices. Both film clips were approximately two minutes long, and were created by editing (primarily to make the clips shorter) YouTube videos (www.youtube.com). Transcripts and web links of the videos are included in Appendix M. Banks (2001) posits that, as images and films are ubiquitous in society, they should be more routinely used as tools to be employed in social research. Indeed, Spencer (2011) suggests that we are 'visual beings in a world which is a visual array of meaning' and that visual methods and presenting images can help to provide more subtle explorations of social contexts, which enables people to look at the 'everyday' with new eyes. For this reason it was decided that this multi-modal approach was an appropriate methodological choice to engage participants in the interview and encourage them to think and talk about electricity use in the home using different prompts. The clips were selected because the topics included in the films were directly relevant to themes that had emerged in Phases 1 and 2, and it was expected that showing these would elicit responses that would further help to answer the research questions. It was anticipated that presenting these topics in a different medium may have resulted in people understanding and responding to them in different ways. Participants were asked to describe their thoughts on the material presented in the film clips as well as more open-ended questions relating to the future and their expectations, concerns and hopes for possible future societal changes. The interviews were concluded with participants being invited to talk through their completed tabloid with the interviewer.

3.2.3.2 Data Analysis

Data analysis was undertaken using a very similar approach to that outlined in section 3.3.1.3. Approximately 110,000 words were transcribed during the follow-up interview phase, using the same protocol as with the focus groups and expert interviews. Transcripts were imported into NVivo and coded, before being printed off and analysed thematically using the same approach as that outlined for Phases 2 and 3. Particular attention was paid to future-oriented responses and themes to help investigate aspects relating to people's expectations of the future and the imaginaries that exist within future discourse (to help answer research questions 2, 3 and 4). Insights from analysing the interview data were also considered when drawing upon extra contextual information obtained through

observations at academic events and within the wider literature. To complement this analytical approach and to help identify the imaginaries and expectations that exist at a range of scales – from individual and institutional to national and international - critical reading of policy and academic literature was undertaken. This involved searching for references and descriptions of future roles of electricity in society (and the home) within these documents to help infer the wider assumptions and visions within these statements. It could perhaps be suggested that this was a form of discourse analysis, however, the author treated this endeavour more as a complementary part of the wider thesis reading that would help to inform the data analysis, and would certainly not claim to have undertaken this aspect of the research with the rigour and defined process of a more formal discourse analysis. Foucault (1972:49) states that discourses are composed of signs, and that they '*more than use these signs to designate things. […] It is this 'more' that we must reveal and describe*'. In other words, Foucault suggests that it is the identification of meaning that can be found beneath the surface and by reading between the lines that is the real value of analysing discourses. By consciously attempting to understand the stated and unstated assumptions and visions of the future in both the interviews and the literature it was hoped that a more informed interpretation could be achieved.

It was decided that the completed tabloids would not be analysed. Advocates of multi-modal research may argue that this is missing the opportunity to work with and present truly multi-modal results. However, following discussions with other researchers who have employed similar methodological tools (such as the Energy and Co-designing Communities[1] project – who refer to such tools as 'cultural probes' (Gaver *et al.*, 2015)) it was decided that analysing the tabloids in isolation from participants' explanations of their responses would ultimately provide no extra insight that would help to achieve the aims of the research.

[1] The Energy and Co-Designing Communities project – based at Goldsmiths, University of London – brings together designers and sociologists to seek to understand how new technologies can be designed to support communities in reducing their energy consumption. Various 'cultural probes' have been developed (such as periodical templates for participants to complete, and the Energy Babble, which provides radio-style talk and 'babbles' about various energy related topics) to investigate how people interact with technologies and use energy. (See www.ecdc.ac.uk).

3.2.3.3 Ethical Considerations

Participants provided consent during the focus groups for their contact details to be stored and for them to be contacted about taking part in a follow-up interview. No novel ethical considerations that have not already been discussed in sections 3.3.1.4 and 3.3.2.3 were identified for the follow-up interviews.

3.3 Researcher Reflexivity

Co-production of knowledge is a key epistemological principle in interpretative qualitative research. Henwood and Pidgeon (1992) state that reflexivity refers to ways in which research shapes the object of inquiry and vice versa. As such, they highlight that "*researcher and researched are characterised as interdependent in the social process of research*" (*ibid.*: 106). The impact that researchers can have may be found across all stages of the research process, from the initial design and choice of methods, throughout data collection, to the transcription, analysis and reporting of data (Flick, 2014). Harding (1991) suggests that self-reflexive enquiry and acknowledgement of the assumptions, values, subjective positioning and perspectives of researchers enables social scientists to attain greater objectivity than more subjective, non-reflexive approaches. For this reason attempts have been made to provide a reflexive account of the methodological and analytical approach adopted in the thesis. Furthermore, ways in which the researcher has inevitably contributed to the construction and subsequent interpretation and presentation of data have been identified and considered.

Whilst accepting and acknowledging that aspects such as personal values and experiences have influenced the researcher's approach throughout the research process, it is important to note that this does not undermine the quality or integrity of the research itself. Moreover, reflecting upon possible influences strengthens and informs the research process, and acknowledging this reflexive awareness helps to portray and position how the researcher exists within the social world in which the research was constructed and produced. Indeed, Forsyth (2009) notes that narrowing down and constraining possible boundaries (both theoretically and practically) for investigation is a necessary part of the research process, and by reflecting upon this framing and boundary-drawing a more informed understanding of how the research has been developed – and fits within the

wider literature – can be obtained. It is therefore important to be mindful of the fact that the analysis conducted within this thesis is merely one of many possible ways of `slicing the debate' (Brand and Fischer, 2013), which may well have been interpreted differently - but importantly no more or less validly – if it were conducted by other researchers.

Reflecting on the role of the researcher in the acquisition of data was deemed to be particularly important as the researcher played a central role as focus group moderator and interviewer. Henwood (2008) highlights Willott's (1998) reflexive account of researchers attempting to avoid their 'voice taking centre stage' in data collection. Referring to 'fly on the wall' and 'ostrich analogies' (*i.e.* "*If I put my head in the sand you can't see me*") Willott describes the different approaches to researchers' roles in interview and group settings and how attempts can be taken to avoid overly drawing attention to and focusing on interviewers. Whilst it would be both impractical and arguably impossible to attempt to become 'invisible' as a focus group moderator, the researcher remained mindful to avoid communicating personal values that could unintentionally influence or dominate the direction of discussions. Krueger and Casey (2000) suggest that focus group research can be jeopardised by novice moderators who are unable to remain 'neutral' or withhold their personal opinions from discussions. Despite this awareness and reflexive practice, it is acknowledged that by attempting to build rapport (*e.g.* Rapley, 2004), probe opinions and encourage discussion it is likely that the researcher's personal values may have had some impact upon the focus group discourse. However, by undertaking a pilot focus group and interview to practise for the role of moderator and interviewer, drawing upon previous experience of moderating focus groups (from research conducted during the researcher's MSc degree), consciously reflecting upon the methods employed and being mindful that all data was co-produced by participants and the researcher, it is hoped that any untoward impacts upon data acquisition were minimised.

A fundamental epistemological issue present in all research is that the researcher inevitably contributes his/her own constructions to the interpretation of data (Henwood & Pidgeon, 1992). For this reason the researcher aimed to be consistently mindful of imparting personal biases whilst conducting the analysis, from selecting which thematic content was deemed relevant and important for the research (Sturgis & Allum, 2004) to interpreting the meaning within comments made during focus groups and interviews. Additionally, thought was given to the presentation of data, where Taylor (2001) states that rich, detailed data

presentation is a key component of rigorous qualitative analysis. As such, the thesis aims to provide a compelling narrative involving detailed description and interpretation of data – providing an illustration of novel and relevant findings – coupled with quotes that highlight themes and topics being discussed. Numerous quotes that portrayed contradictions, humour, concern and a whole host of other aspects of participants' discourse were obtained. However, inevitably – for both brevity and editorial reasons (*i.e.* to aid the narrative of the thesis) – only a small fraction of these have been included in the thesis. As such, reflecting upon the reasons and motivations for selecting specific quotes to portray thematic content was an important part of the interpretation and presentation of data, which, it is argued, ensured that the findings discussed in the thesis are a valid reflection of participants' discussions in the focus groups and interviews. As a final note, the researcher has aimed to identify and portray reflections throughout all aspects of the research process, and in addition to this section, notes and references are made throughout the thesis to portray this reflexive awareness.

4 Empirical Findings 1 - Electricity in the Home: How do People Think About, Talk About and Use It?

This chapter aims to present and interpret data that demonstrates how people relate to, think about and use electricity in the home. The rationale for this chapter is based on the assumption that understanding how people think about, talk about and use electricity in the home will enable research questions 1 and 4 to be answered. Additionally, this chapter serves as a mechanism for 'setting the scene' in terms of describing and interpreting public understandings of and interactions with electricity in the home, before Chapter 5 focuses on expert understandings and Chapter 6 builds on findings discussed in Chapters 4 and 5, before taking on a more future-oriented focus. As such these findings are drawn primarily from the exploratory Phase 1 public focus groups, along with extra insights that were obtained in the clarification and further interrogation of themes during the Phase 3 follow-up interviews. Themes discussed in this chapter primarily help to answer research questions 1) and 4), which are re-capped below:

1) How do people understand and interact with their existing electricity supply system in the home?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

Numerous themes emerged from interrogation of the data and participants' responses. Certain themes recurred frequently within and across interviews and focus groups, and these meta-themes and related topics have been drawn into a narrative, whilst other less frequently recurring themes and concepts have been used to add further interpretation and to supplement the narrative (Willott and Griffin, 1999). The aim of the research was not to compare or contrast between groups, but to present the range of findings found across all five groups and to discuss the implications they may have. However, where appropriate, differences and similarities between groups or individuals have been highlighted.

4.1 Thinking About Electricity: Awareness and Visibility

Across all focus groups the visibility and salience of electricity was discussed. These discussions ranged from images of electricity in the media to the physical landscape and

infrastructure - such as power stations and pylons - that supports electricity networks. However, a greater range of responses and opinions towards the visibility and awareness of electricity within the home was found. Electricity was suggested to be less of a physical, material entity than other utilities found in the home such as gas or water supplies:

Dave, 26: *"Gas is a bit more of a thing - like actual waste or rubbish - I'm much more conscious about rubbish than I am electricity. I would actually say out of everything electricity is the least [salient]."*

Ben, 23: "*Yeah, because gas you can smell as well, and you can see the flames, whereas electricity…"*

This perceived lack of material presence of electricity within the home echoes Burgess and Nye's (2008) findings and suggests that, for many individuals, the role that electricity plays within the home is not the most salient of issues. Furthermore, some responses hinted at a disconnect between using appliances and electricity consumption. For example one participant discussed showering to highlight the fact that water – heated by electricity in their home – coming out of the shower more readily came to mind than the electricity required to heat it, mirroring Hargreaves, Nye and Burgess' (2013) claim that it can be difficult to picture electricity as a commodity that is being consumed.

Discussions on energy monitors arose from prompts on the visibility of electricity, with some participants who had experience of using energy monitors suggesting that by using them their electricity consumption had become a more visible and tangible thing:

William, 53: *"If I go and put the gas on to boil a saucepan, I don't know how much gas I'm using if I put it on full or I put it on half. Whereas I can, because we've got a meter, put the oven or the kettle on and I can see how much I'm using. I can quantify that. All I know at the end of the month is how much gas I've used."*

This ability and desire to quantify consumption was a recurrent theme across the discussions, with participants suggesting that numbers on a monitor – particularly if feedback on electricity use was given in the form of financial cost – were much simpler to understand and visualise than unknown quantities of electricity, gas and water being consumed within everyday life. In addition to monitors providing feedback in meaningful terms, it could perhaps be argued that more frequent information on consumption could help maintain awareness or interest more than, for example, quarterly energy bills. One participant in the shared student house referred to their electricity meter as a constant visual reminder:

Richard, 20: *"I think for me I feel, I think about it more in this house just because when I walk out the door I'm always walking past the electricity meter."*

Participants discussed their experiences of interacting with energy monitors, suggesting that in addition to raising awareness of consumption, feedback also has the potential to influence consumer behaviour. Examples discussed included investigating the demand from specific appliances around the home and using this to help to cut down on the amount of wasted, standby consumption:

Christina, 64: *"When we first had it we'd go round switching things on to see what would trigger it. But our use of electricity is such that we turn everything off. I mean the microwave doesn't stay on with its little light, nothing glints at us."*

However, whilst these findings suggest that energy monitors and feedback on consumption have the potential to raise awareness and influence behaviour, a number of issues were identified that may have important implications for energy monitor design and associated policies. For example, participants referred to a decline in interest and interaction with the monitors (mirroring Hargreaves *et al.*'s (2013) findings), which perhaps suggests that as the novelty of receiving feedback wore off the monitors provided less of a source of curiosity. This sentiment was echoed by participants in the discussion with students living with a pre-paid electricity meter:

Annabel, 20: *"I think at the beginning of the year we were kind of, we watched it and we were quite shocked how quickly it goes down, but we're kind of used to it now."*

Other issues raise questions over the potential for energy monitors to achieve and maintain higher levels of awareness and associated behaviour change over the longer term. Whilst feedback can provide the opportunity for people – if they are motivated to do so - to reduce the amount of electricity that they use, once a baseline of consumption is reached (*i.e.* a point where perceived 'wasted' electricity has been minimised, and any remaining electricity demand is necessary to avoid having larger lifestyle impacts) there may be less motivation to continue receiving feedback as achieving reductions will inevitably be more challenging and require larger changes in the way people live within the home:

Dave, 26: *"So like, we have one [a smart energy monitor], but we don't use it. Because we used to use it, and then, we couldn't, so like we've got an electric hob and cooker, and that uses up almost all the electricity, everything else is pretty low level, and then we were like, what else can we do?"*

In addition to the issues already discussed, a further potential impact that energy monitors may have in households – particularly shared residences – is the possible increase in conflict amongst residents through the ability to quantify electricity use. Discussions within the young professionals group referred to arguments over electricity use with housemates, and one participant was curious about the possibility of adding weight to their argument regarding the amount of electricity another housemate used:

Ben, 23: "*Does the smart meter give you the cost?*

Researcher: *Some of them can give you the cost, or the power that is being used.*

Ben: *And I suppose you could calculate if not couldn't you?*

John, 23: *Yeah.*

Ben: *I think it's definitely something I would look into.*

John: *Because it's in concrete terms, you can say you're costing us this much.*

Researcher: *And do you think that would be a good thing?*

John: *Not for house harmony [group laughs]."*

This section has demonstrated ways that people are aware of and think about – or indeed struggle to think about in meaningful terms – electricity use in the home. By providing evidence of interactions with and perceptions towards energy monitors this section has portrayed how feedback on energy use can increase awareness of consumption and influence behaviour, but also that this relationship is complex and not necessarily long-lasting, which, as Hargreaves *et al.* (2013) has important policy implications.

4.2 Thinking About Electricity: Power Cuts and Everyday Risks of Electricity in the Home

A recurring aspect within all discussions was the concept of power cuts, and how experiencing interruptions in power supply increased the appreciation for and awareness of the role of electricity in the home – at least in the short term. Whilst reflecting upon experiences of power cuts participants referred to different aspects of their lives that relied upon electricity, with some suggesting that in modern lifestyles it is 'taken for granted':

Sue, 53: *"That's when you really realise how important electricity is when you suddenly haven't got any and you can't cook something or warm a baby's bottle. I know it doesn't happen so*

much these days but you don't really realise until it's just gone for three or four hours, how much you use it all the time for everything you do."

James, 63: *"I think the thing about electricity is, like a lot things, you don't realise that you miss it until it's gone, and whilst it's all good and fine when you've got it, all of a sudden all the lights go out and everybody goes 'oh bugger what do we do now?'"*

Whilst most references to power cuts were very negative and centred on the inconvenience and impact that they cause, one participant suggested that planned power cuts could potentially be used as a tool for increasing awareness of electricity consumption. Whilst this may not be the most realistic, acceptable possible intervention or future policy approach, it neatly depicts the perceived strength of the impact on awareness that such a sudden and drastic change in the physical properties of the home – and what appliances can be used – could have. It is also worth noting that some (though not all) of these references to power cuts were made whilst participants were discussing the 'energy tabloid' task that they had completed in the Phase 3 follow-up interviews. It could be argued that asking people to temporarily 'become' a tabloid headline writer inevitably stimulates extreme, emotive arguments and concerns which could perhaps result in participants providing more sensational responses. This resonates with Kasperson's (1992) reflection on the role individuals in the social amplification of risk and suggests that some participants undertaking the tabloid task perhaps magnified or overstated the severity and susceptibility (*e.g.* Becker *et al.*, 1978) of this perceived risk. However, when challenged by the interviewer about this aspect – and whether they felt that the points they had made in the discussion of the headlines they had provided were realistic and reasonable – some participants restated their assertion that power cuts did indeed cause sufficient disruption that they could influence people's attitudes and possibly behaviours.

Risk was a subject many participants alluded to in the course of the discussions. This ranged from unease with electricity itself, with electricity being labelled as 'dangerous' (with some maintaining a desire to remain ignorant of the technical properties of how electricity works), to secondary risks from electrical appliances and products. Some respondents referred to the ways in which perceived risks were managed within the home:

Emma, 64: *"It was instilled in me as a child, my father you know before we went to bed everything would be switched off, all the wall sockets, everything switched off because it's a sort of primary cause of fire, so I think it's something that I was brought up respecting how dangerous it can be."*

Risk management was also identified amongst participants who described installing more sockets in their house to reduce the risk from using 'dangerous' multi-socket plug adaptors. One participant referred to removing a phone handset from the bedroom to reduce unnecessary electricity use and also for the secondary reason of removing the perceived risk from the handset itself:

Paul, 41: *"We don't really need it, it's a bit of a luxury and it's probably better not having a phone in the bedroom actually. It is quite scary the amount of electromagnetic interference that they produce around themselves."*

Whilst risk issues were discussed within a variety of topics, some participants argued that they thought electricity today in this country is very safe, and that electricity was only viewed or experienced as a significant risk when abroad. Furthermore, some suggested that electricity enabled many 'risky' activities to be performed more safely, for example using an electric kettle as opposed to boiling water in a saucepan.

This section has demonstrated ways that people think about electricity in the context of risk in the home. Participants referred to the risk of power cuts and the impact that a sudden lack of electricity supply can have on the ways that people think about the role that electricity plays in the home. Electricity was also discussed by some as a danger and risk that made them feel uneasy, whilst others suggested that electricity had helped to reduce risk in the home by making some domestic practices safer.

4.3 Using Electricity: Changes in Electricity's Role in Modern Lifestyles?

Within discussions on the role of electricity in the home an underlying discourse was identified that referred to the perceived increasingly important role that electricity is taking on in the background of people's lifestyles. Participants referred to products, such as toothbrushes, which in the past would have functioned without the need for a power source, but today rely upon electricity. This electrification of products was also argued to have contributed to and developed alongside the increased range of electrical consumer products in the home:

Paul, 41: *"I think what's really noticeable is, how many power sockets you need in each room in a house. If you look behind the average TV now you'll probably see, I mean I think I've got eight devices behind the TV [...] the telephone, broadband router, sky, surround sound, TV, and dotted around the kitchen you've got so many devices."*

In addition to growing ranges of consumer products and domestic appliances increasing the potential for rising electricity demand, participants suggested that there is an increasing trend for some products – for example television recorders – to be kept on standby constantly in order for them to function, thereby increasing standby consumption within the home. Countering the argument of a gradual, increased accumulation of consumer appliances within the home, falling within Shove and Warde's (2002) discussion of 'inconspicuous consumption', was the suggestion that certain products, such as laptop computers, are becoming sufficiently versatile to perform the role of multiple products (*e.g.* radios, televisions and phones). An interesting question is whether this argument sufficiently considers the possibility that in the future as products become 'smarter' and more versatile, could the range in consumer products within the home shrink, potentially helping to reduce future demand?

Whilst the majority of participants spoke positively and enthusiastically about the increased role of electricity in the home – and the liberation and convenience it can provide – one participant argued that they felt uneasy about their reliance upon it:

Emma, 64: "*I mean I wish I had a house that, you know, I could have a real fire, and then I would feel more independent if there was a power cut. It would be a nice reassurance.*"

In addition to the perceived trend of people obtaining more products a recurring theme revolved around the concept of energy efficiency. Some argued that products – namely fridges and cars – are becoming more efficient, and that efficiency is now becoming an important influence in the decision making process on which products to buy. This perception could perhaps be extended to suggest that as (regulated) market forces dictate that consumers desire increasingly efficient products, this trend for efficiency improvements may continue in the future. Interestingly, when participants were asked how, hypothetically, they could reduce their electricity consumption, answers commonly referred to energy efficiency or conservation measures within the home, such as loft or cavity-wall insulation and more efficient products, as opposed to behaviour changes (resonating with literature on ecological modernisation (*e.g.* Hajer, 1995; Backstrand and Lovbrand, 2007)). Questions arising therefore are whether people struggle to make the link between behaviour within the home and consumption?; or are lifestyle changes as a way of reducing electricity consumption deemed unacceptable?; and is this 'default' consideration of technological solutions rather than behavioural changes the result of discourses played out in the media and markets – echoing Cherry *et al.*'s (2013) identification of social and

behavioural aspects being marginalised in technical and economic discourses of low carbon housing? Or could this, more reflexively, simply be a manifestation of the ways in which the question was framed and asked by the researcher? These questions will be reflected upon and further discussed at the end of this chapter and later in the thesis.

This section has portrayed participants' views on the role that electricity plays in the home, and how there is a perception of electricity taking on increasing importance due to the electrification of domestic products and the growth of product ranges that are embedded in everyday life. This greater perceived role of electricity was found to be a source of concern amongst participants who were uneasy about relying upon electricity. In addition to the proliferation of electronic products fulfilling various roles in domestic lives, a desire for energy-efficiency was suggested by some to be forcing the market towards increasingly efficient products.

4.4 Using Electricity: Biographical Reflections of Change Over Time

Debates on energy use in the home often involved biographical reflection and a consideration of how participants' electricity consumption had changed over their lives. Interviews with participants who had experienced lifestyle change through parenthood referred to a range of changes that had an impact on how they used electricity in the home. A recurring theme amongst mothers with young children was the feeling of having little free time amid a more hectic daily routine (*e.g.* LaRossa, 1983*)*. One interviewee suggested that this time pressure had contributed to significant changes to the way she used electricity in cooking. She stated that since having a child she had changed from her previous routine of cooking fresh meals daily, to cooking batches of meals on a weekly basis (*e.g.* Ross and Geil, 2010), enabling her to freeze and then simply warm these meals up when she had insufficient time to cook a fresh meal. She felt that this change had contributed to a reduction in the amount of electricity used, because she used the electric oven and hob less frequently than before. It is suggested that further investigation into similar experiences of parenthood, and how this impacts upon energy use in the home (*e.g.* Shirani *et al.*, 2013), could perhaps open up and identify opportunities for more targeted interventions to achieve further changes in the future.

Some mothers with young children stated that they felt their values had changed since becoming a parent. Notably, one participant suggested that they placed increasing value

and importance on providing a safer, cleaner environment in which to bring up their child. This included changing how they ventilated their house – investing in an air filter to remove the need to open windows, in the hope of stopping cigarette smoke from a neighbour's property entering their home. Yet, an interesting contrast was identified where the interviewee felt that sustainability and environmental issues were more important to them, but at the same time they felt that due to the demands of parenthood they were less aware and bothered about their electricity use, and also had a less flexible routine that would enable them to change how they use it.

A recurring theme involved people remembering being 'nagged' as a child by their parents to turn off lights. Participants with children (in the mothers, solar PV and retired groups) talked about how they had in turn passed on this 'nagging' to their own children. Parenthood was also perceived by participants with and without children as a major life event that dramatically influences the way electricity is used. Perceived impacts discussed ranged from parents having less free time for leisure activities – which by extension could reduce the amount of leisure-related consumption – to changing comfort requirements (such as the need for the house to be kept at a higher temperature for young children). Furthermore, it was also suggested that parents, particularly those with young children, would be more likely to spend more time in the home. Another novel finding – that was discussed both by groups involving younger (the student house and young professionals) and older (retired homeowners and residents with solar PV installed) participants – was that, despite being fairly energy conscious and careful over their consumption in their own home, they were less careful about turning off lights and appliances when they returned to their parents' houses:

Lorraine, 68: *"Yeah, and, you know, they're responsible adults now with their own homes, and I don't think they do it in their own homes, but when they come, and they go upstairs and the children are in different rooms and they're in a room, and every blimmin' light, the bathroom light… So I go and turn them all off and I shout at them, but, so that's when I think of it.*

Christina, 64: *I think they just relax, you know, they haven't got that responsibility because mother and father take over.*

Lorraine: *Yeah, that's it.*

Charles, 64: *But outside your own home the responsibility is always somebody else's isn't it?"*

Other potential explanations for this change in behaviour and context provided by participants were that people revert back to their old habits when visiting 'home' and that, as they are not responsible for bills outside their home they become less concerned and conscious about how much they use. Additionally, a participant in the student house suggested that they didn't see their university house as 'home', and as a result they were more tolerant of living in a less comfortable house:

Michael, 19: *"Because I don't really consider this home it doesn't really bother me as much, I just have my stuff, which makes it homely. I don't really need like pictures or photos, whereas at home, at my actual home it's different."*

Differences were also found between participants who lived in rented accommodation, and those who owned their properties, with some tenants frustrated at their lack of control to make a house more homely. Some also suggested that, despite being motivated to reduce their consumption, there was little they could do to change the material properties of their home:

Erica, 27: *"I would say I feel a little bit helpless in our house, in that, all the things I think of that we should or would do are things that we can't do because we rent, and because we have no money."*

This frustration led some to suggest that when choosing future houses this consideration may become an important factor in the decision making process. Furthermore, the concept of energy efficiency ratings for houses (such as those discussed by Gram-Hanssen *et al.* (2007)) was discussed, with proponents suggesting that prospective tenants could make more informed choices if provided with more information. Indeed, one follow-up interview participant who had moved house since taking part in the focus group talked about the role that the perceived energy efficiency (and ability to maintain a comfortable home without exorbitant bills) of their new house played in the decision to move:

Dave, 26: *"We've moved house, and partly that was to do with energy costs, so that was a lifestyle change based on energy costs specifically. We haven't changed the way we use it, but we chose a house that is hopefully going to reduce our bills as it's got better windows and it's not as draughty. It seems to keep the heat in so we don't use as much heating."*

Living with others was discussed as a topic which changes over time, as members of the student group and young professionals group had recently experienced living in shared accommodation, compared to the other groups whose members had either never lived in a shared property, or had not done so for a long time (living instead by themselves, with a partner or with a family). It was suggested that living with others can create a culture within

the household that can influence overall consumption. For example if most housemates are energy conscious and actively try to minimise wasting electricity, participants suggested that there is more pressure to fit in with this. However, if a household is comprised of residents who have little interest in energy use or inclination to reduce the amount of electricity that they use, then an individual who may otherwise actively try to manage their electricity may have less incentive to do so. This frustration was particularly discussed in the context of housemates sharing utility bills:

Josie, 25: *"If I knew someone left their laptop on all night it would make me think 'well, what's the point of me unplugging mine because they're using it? They have the heating on all the time, they're using the electricity, if I'm going out of my way to save money I'm saving it for everyone and they're not doing their part!' […] So that would make me not… that would change my actions in a negative way."*

Whilst attempts to reduce overall house consumption were discussed with the group of students living in a shared house, when questioned on whether any disagreements or conflicts over energy use had ever occurred, one participant argued that electricity was not an important enough topic to be the basis of a disagreement, positing that '*if you argued about electricity usage you'd argue about everything*'. Indeed, a participant in the mothers group said that when raising young children there are '*so many other things to argue about that it's not even on the list!*'. Could this suggest a potential barrier to implementing ways of achieving a reduction in electricity consumption and demand in shared houses? Participants also suggested that, as bills were shared, housemates were generally conscious of not being wasteful with electricity as this may be deemed as unfair by others. Considering this aspect in isolation could perhaps lead one to assume that shared houses may have lower consumption than other more communal households of a similar size, such as families. However, there was a perception that electricity use would be significantly higher – and negotiated and used in more complex ways – in a shared house because more individuals may perform tasks such as cooking and washing separately, using energy-intensive appliances more frequently in the course of everyday life (within their individual, intertwined routines) than households with fewer people living independently of one another.

A theme that was common across groups was the perception that younger generations use more electricity than their parents – particularly in terms of leisure activities. These perceived generational differences were also suggested to be influenced by new trends of social interaction and ways of communication – for example younger generations using social media, which arguably has created a new demand for using electrical devices that

members within the group of retired participants saw as inapplicable to themselves. However, in the follow-up phase 3 interviews, participants from various focus groups suggested that they felt younger people may be more likely to change their behaviour and potentially use electricity more flexibly or differently in response to possible policy or contextual changes. Christina (64) stated that people of her generation "*have habits that have developed over a lifetime*", arguing that they may be more resistant to change and less flexible in their behaviour. John (23) also felt that his generation had grown up with more "*information and awareness about environmental issues"* and climate change, and as such may be more responsive to possible efforts to reduce the environmental impacts of their lifestyle.

This section has presented a range of insights relating to people's perceptions towards and use of electricity in the context of biographical change and has aimed to portray the lay rationalities showing how and why people relate to energy at various points or in response to events in their lives. Whilst findings presented in this section all have biographical-related aspects in common, interpreting them provides no clear direction in terms of whether biographical changes tend to result in generalisable trends or impacts upon electricity use (*i.e.* increases, decreases or shifts in demand). This resonates with Groves *et al.*'s (forthcoming) discussion on the role of lifecourse transitions in energy use. A growing body of literature has highlighted lifecourse transitions as 'moments' in which practices or habits may undergo transition (*e.g.* Hards, 2012; Maller and Strengers, 2013). As such, they have been suggested by some to be opportunities for policy interventions to change how people use energy. However, drawing upon biographical, narrative interview findings, Groves *et al* question whether some transitions may instead act as obstacles to desired or anticipated change. This is because unexpected outcomes (for example people discontinuing habits or, as Groves *et al* highlight, people moving house and subsequently changing their comfort requirements and preferences) make it difficult to predict impacts of lifecourse changes on energy use and therefore to design and implement suitable policies. Whilst the findings presented in this section are unable to paint as deep a picture of the nuanced ways in which people talk about biographical and lifecourse changes as Groves *et al.* (primarily because biographical narrative interviews were not conducted as part of this research), they nevertheless resonate with the observation that lifecourse or lifestyle changes can have a range of impacts on domestic electricity use. This highlights the need for further research to be undertaken in this area to ensure that informed policy mechanisms can be devised if these momentous 'opportunities' or 'barriers' for change are to be targeted.

4.5 Using Electricity: Paying the Bill - Do Financial Considerations Drive Behaviour?

Discussions across all focus groups suggested that policy instruments and technological interventions aimed at reducing demand and consumption should perhaps highlight potential cost benefits or savings, as, more than anything else, economics was perceived by participants to be the main driver and influence of behaviour. This preoccupation with the perceived interaction between economics and behaviour could perhaps be described as 'folk economics' (Rubin, 2003) as individuals referred to anecdotal evidence and personal framings to conceptualise their knowledge and beliefs. This section will aim to demonstrate the range of perceptions towards the perceived role of the cost of electricity, and the contradictions and nuances within these.

Participants referred to the widespread use of night storage heaters in the past, where residents 'charged up' and stored heat overnight on the low-cost Economy 7 off-peak tariff (Henley and Peirson, 1997), arguing that the inferior quality of heating provided by this technology was outweighed by the benefit of significant cost savings. This concept of money and economics driving behaviour and influencing electricity use was the most commonly recurring theme within all of the focus group discussions, and echoed sentiments from members of the retired and student groups – who argued that they were perhaps more careful with money than others due to their limited budgets, and were as a result more energy conscious. However, despite this argument, a number of responses were found that contradicted this notion of cost being the most important aspect in decision making in relation to the way people use electricity in the home. The concept of a financial threshold was discussed – where, if people enjoy doing or using something then they will continue to do this without considering the cost. Participants debated this theme within the context of attempting to influence behaviour through innovative pricing approaches, with possible implications for mooted potential policy interventions such as introducing compulsory dynamic tariffs:

Paul, 41: *"I think it's like smoking. You know, the government agree you can't price people out of smoking, no matter how much tax you put on it, if people want to smoke they will smoke. The same with drink, they will pay it if they want it, and I think it will be the same with electricity. You can't force people to do something if they don't want to."*

This contradiction and dichotomy between people's responses – on one hand stating that everything is driven by economics and on the other arguing that affective aspects such as

the meaning and enjoyment that is attached to performing certain tasks or using certain products that use electricity are as, and in some cases more, important – was also found in the expert interviews. This finding – and the potential implications – will be considered and discussed in more depth in Chapter 6.

Parallel to the perception of money and cost having a strong influence on behaviour and decision making, the concept of responsibility for paying energy bills increasing awareness of electricity use was a recurrent theme throughout discussions. This was perhaps most evident in the student group, whose members were living in their first house, therefore for these participants electricity use could arguably be said to be a more salient issue through the novelty of paying bills. In addition to this, they suggested that during the year before they moved into their house, whilst living in university halls of residence, they had been much less energy conscious as utility bills were included in their accommodation fees and as such the amount of electricity they used did not influence their finances. Indeed, the fact that their fees were pre-paid actually encouraged some to use more than was deemed necessary as they felt entitled to it:

Kirsty, 20: *"In halls I ignored it because we paid a certain amount, and then that was that.*

Gemma, 19: *Yeah, I used to leave everything on.*

Richard, 20: *Yeah the bills were already paid for so we didn't really have to think about it.*

Michael, 19: *I always used to think that there was actually a kind of sense that you'd already paid for it so you deserved to use more."*

4.6 Using Electricity: 'Syncing With the Sun' - Users' Experiences of Solar PV

A topic that was discussed solely by residents with solar panels was the perception that being 'eco-friendly' is expensive, and that the majority of people will only invest in efficiency measures or micro-generation schemes if there are obvious cost benefits. Participants also referred to discourses on the environment and climate change whilst talking about solar panels and their reasons for investing, despite stating that their decision was primarily for financial reasons and not influenced by 'green' values (all participants with solar panels stated that, following subsequent reductions in the solar feed-in-tariff (FiT) (Sukki *et al.*, 2013) after installing their panels, they would have been less likely to become involved in the now less financially lucrative investment). The discussion also

touched upon the ethics of homeowners who can afford micro-generation installations benefitting from subsidies and money from FiTs, which could potentially be extended to debates on energy security and poverty, and the exclusion of consumers who cannot invest in the technology. This was also echoed by an expert participant in the Phase 2 interviews, who predicted a potential backlash from people not benefitting from the scheme:

Peter (expert): *"There's certainly the potential where people who don't have micro-generation would get really kind of hacked off that their electricity bills are going up because the subsidies are being paid to the people who do have it."*

A novel perception that could help explain the success of the uptake of solar panels in the UK (in addition to the FiT and other factors) is the notion of solar panels being a 'respectable' investment for consumers. It could perhaps be argued that this 'respectability' could be explored or considered as a way of framing or communicating future policies relating to new in-home technologies designed to influence electricity use (*e.g.* smart meters) or increase localised micro-generation uptake:

Paul, 41: *"There is something in the UK, or generally, um, frowned upon about saying you do things for financial reward. Even though that's why we do it, generally people feel slightly embarrassed saying 'well I'm doing it because I want to get the money out of the government'. So basically solar I feel is something you can do that is respectable, a respectable investment."*

The solar PV industry fits Geels' (2002) multi-level perspective for technological transitions and is a good example of how a niche technology (which solar panels could arguably have been labelled in the recent past), through the assistance of policies (such as the FiT) and social change (including consumers' desires for financial investments, energy security and autonomy), has developed and arguably made the transition to fulfilling a sociotechnical regime. In addition to increased public uptake of micro-generation technologies – increasing (albeit to a small extent) the decentralised capacity of the UK's electricity system – participants' responses indicate that significant behavioural changes have occurred as a result of them becoming 'prosumers' (Ashgar and Miorandi, 2013; Rutten, 2013) through installing solar panels on their properties. Respondents stated that the solar panels were initially viewed purely as an investment, with none of them anticipating or planning to make behavioural changes. However, to maximise the financial benefits provided by having their own small-scale – all participants had small, rooftop arrays producing insufficient

output to enable them to become 'off-grid' and self-sufficient – sources of electricity, they discussed unanticipated changes that they had made:

Paul, 41: *"It wasn't until after we got the panels and thought 'hang on a second we're producing electricity during the day, let's start using things during the day'.*

Sophie, 56: *Yes we hadn't thought about timing.*

James, 63: *That was the big thing yeah, initially you said 'ok, we'll put the panels up, and you're gonna get 43p a kilowatt, great. And then it suddenly dawned on you…'*

Paul: *Yeah, 'hang on a minute, we're making electricity.'"*

The most significant change identified was the change in participants' routines and the timings at which they used electricity, as under the FiT scheme panel-owners would be paid for all electricity generated regardless of whether this was exported back to the grid or used by the panel-owners themselves, effectively enabling participants to use 'free' electricity at times when it was being generated. This developed with more conscious planning and consideration of when electricity should be used within routines, with particular thought given to washing practices and using energy-intensive appliances such as dishwashers and washing machines:

James: *"Because we've got solar panels now, the minute the sun comes out, we throw on the washing machine, the dishwasher and any other appliance [group laughs]. Well no, I mean, I know you laugh and joke, but I mean it is a means of saving energy and saving money at the same time.*

Sue, 53: *We've changed the time that we do things, we didn't even know we had a timer, a delay thing, on the washing machine until we had the solar panels, so now we do that automatically.*

James: *As I say we time everything for about midday in the hope that if the sun's going to come out, it'll come out then."*

This 'syncing with the sun' was identified and agreed upon amongst all members of the group. Indeed, whilst moderating the discussion it appeared that participants enjoyed and were very engaged in questioning each other over changes they had made. Indeed, this reflects McKenna and Thomson's (2014) reflection on residents with solar PV wanting to investigate other users' experiences and share anecdotes and suggestions on internet forums. Aspects of this unanticipated behavioural change could be considered in the design of future policies and technologies. This has particular relevance for possible future attempts to help shift domestic electricity demand and reduce peak loads – which will be

discussed in greater depth alongside responses and expectations of the future from expert interviews in Chapter 5. One response suggested that these routine changes were viewed as a cause of inconvenience, but were deemed to be worth making due to the financial rewards borne from them. However, they suggested that if for any reason their panels were taken away or stopped working in the future – thereby removing this opportunity to use the 'free' electricity that was being produced – then they would be likely to quickly revert to their previous routines because these fitted in more conveniently with everyday life.

Coupled with routine change and shifts in consumption patterns, evidence was found that suggests participants with solar panels generally increased their attempts to reduce the amount of electricity they used. This increase in performing energy saving practices could be described as an environmental spillover (Thøgersen and Ölander, 2003) as, in response to an initial attempt to reduce electricity use, this ethos spread to other aspects of people's lives within the home. Consideration of these responses could perhaps lead one to assume that interventions such as installing solar PV or other similar technologies are guaranteed ways of achieving behavioural changes and reductions in electricity demand within the domestic sector. However, evidence was found to suggest that having solar panels can potentially increase electricity use in certain contexts:

Researcher: *"Are there ever any times when you might actually consume more than you otherwise would?*

Sue, 53: *Yes. Definitely.*

William, 53: *Do you? When?*

Sue: *I would say if the sun's shining I wouldn't hesitate to put the washing machine on twice a day. I'd do two separate loads, rather than do it once. I would definitely on a sunny day I might think 'ooh I'll just put it on again this afternoon'."*

This effect – where more electricity is used as a result of having solar panels, either overall or at specific times (*i.e.* when the sun is shining) – could arguably be considered similar to 'rebound' or 'ripple' effects (*e.g.* Greening *et al.*, 2000; Hertwich 2005), where people save money and energy through efficiency measures, but then rebound by 'spending' this saved money and energy on other products or activities. . This finding could perhaps be explained by participants perceiving generated electricity to be 'free', which therefore provides the financial incentive for using electricity immediately before the sun goes down and this window of opportunity closes. However, whilst this 'syncing with the sun' did enable domestic demand to coincide with 'free', generated electricity from the solar panels,

it should be noted that it is possible the amount of electricity being used at these times could be greater than that being generated. Indeed, when presented with this evidence in Phase 2 interviews, experts suggested that this may well be the case, which perhaps limits the wider benefits for system operators that could be achieved through this effect. However, despite this, some expert participants suggested that this demonstration of people shifting their domestic electricity demand could be valuable evidence to show that some electricity demand can become more flexible if people have the inclination and incentives.

Responses from residents with solar PV panels highlight the dynamics of electricity use within the home and the range of interactions that can occur with a new technology. It is suggested that further research should be conducted to better understand the intricacies of how people in different contexts may react to solar panels (and other similar technologies) in order to develop more informed, tailored policies to help achieve reductions in demand and consumption.

This section has aimed to portray users' experiences of interacting with solar PV. The key finding involved individuals synchronising aspects of their electricity use with sunshine hours. This novel finding demonstrates the potential for demand shifting, and will be discussed in greater depth – in terms of theoretical analysis and a discussion of the implications of the finding – in Chapter 7.

4.7 Using Electricity: Meaning Attached to Electricity Use in the Home

Many aspects of the way people use electricity in their homes are embedded within specific behaviours or practices that have certain meaning or value attached (Hargreaves, 2011). Participants identified a range of affective aspects that were perceived to be particularly important, ranging from 'homeliness', to connection with the outside world, to comfort. Recurring themes involved warmth and heating, which were deemed to be very important aspects relating to comfort within the home[2]. In addition to generally referring to

2 Whilst some participants referred explicitly to electric central heating systems, gas central heating is more common in UK housing stock (Palmer and Cooper, 2010). For this reason, interpretation of energy demand from central heating needs to be undertaken with the caveat that participants may have been referring to gas systems. However, this is still an important, relevant discussion in the context of domestic electricity demand as moving away from gas central heating and towards more electric systems (such as heat pumps) in the future is seen as a key way to help meet decarbonisation targets (National Grid, 2011; DECC, 2012c).

maintaining warm temperatures within the home, some responses indicated specific ways that people made themselves feel warm and comfortable. One participant described their enjoyment of feeling warm under a duvet, and how, to enable them to use their laptop or charge their phone without having to leave the warmth of their bed they had set up extension cables and adaptors to provide plug sockets within easy reach. Some suggested that comfort requirements change over time and also as routines change. For example relaxing at weekends was discussed as an important aspect related to feeling at home in the house, with specific reference being made to televisions, cooking equipment and appliances that are used for leisure purposes, which some suggested are only used and enjoyed at home. In addition to routine changes influencing comfort practices (and thus energy use), the notion that tolerances of what is 'comfortable' may change depending on who is in the home was discussed, particularly in relation to if visitors were being hosted:

Erica, 27: *"I think, actually being homely is partly having people over, and having friends round actually uses quite a lot of electricity, because you were saying about keeping the house a bit warmer, and the lights.*

Josie, 26: *Yeah it's not acceptable to have friends over and let them freeze."*

This notion was also discussed with a more extreme example, where residents significantly increased the ambient temperature of their house – to their discomfort – to ensure that a visitor was comfortable:

Sue, 53: *"So at Christmas where we've just had a 90 year old grandmother staying, you know we're wandering around in T-shirts and having to go and sit on the lawn or stand outside the backdoor every couple of hours to cool down! [group laughs]. But, you do, if someone else is in the house who is elderly, this ninety year old lady, then you're very conscious she needs to have a house that is warm."*

Whilst temperature was the most commonly discussed aspect of homeliness, participants also referred to lighting as a way in which a comfortable ambience could be set. Some suggested that decorative lighting enabled residents to create a relaxed mood and atmosphere, whilst also stating that this could be a source of conflict, with some referring to their partners expressing that they viewed using excess lighting as a needless waste of electricity. Additionally, the dynamics of how the use of lighting within the home changes over time was discussed, with participants suggesting that they turn on more lights and draw blinds around the house to 'lock out the world' to feel safe and comfortable when home alone.

'Power over your power'

An important aspect that distinguishes electricity use in the home from consumption in other contexts – and one of the main reasons that makes a house 'homely' – was suggested to be that within their homes residents have the freedom to do what they want, when they want to, whereas in other contexts such as the workplace this control is not necessarily possible:

Researcher: *"So it's about convenience?*

William, 53: *Yeah, you can choose when you want it because it's then home.*

Paul, 41: *At home you've got power over your power."*

This was considered to be a very important distinguishing feature of 'home' and was also perceived to be a potential barrier to possible future changes if these notions of control and freedom were compromised. This will be discussed further in the context of expert expectations of future changes to the electricity system in Chapter 5. In addition to residents having the freedom to choose what they want to do in the home it was also suggested that different people have completely different considerations of what makes a house homely, and that for this reason every house will use electricity differently. Furthermore this was mooted as a dynamic that could potentially lead to disagreements and conflict between people living under the same roof, with one mother describing herself as someone who felt the cold, and explaining that they often put the heating on, whilst their partner was often too hot and subsequently turned the heating off. There was also a general perception from participants who had grown-up children that had 'flown the nest' that their houses were now kept much cooler than when their children were at home, and that they wore more warm clothes nowadays, suggesting that they now perceived themselves to have a higher tolerance of lower ambient temperatures within the home.

Electricity was also discussed in terms of convenience and the way that it liberates people from having to undertake certain cumbersome tasks within their routines. Members of the group composed of retired homeowners reflected upon the moment when refrigerators became standard items within the home. These were perceived to have made a significant change to people's lives, as being able to store foods for longer periods reduced people's need to shop so regularly. They suggested that this convenience freed up time in people's routines and also contributed to physical, material changes to the layout of houses as

larders became obsolete. Whilst electricity has enabled many aspects of domestic living to become more convenient, some suggested that this has developed into an expectation and requirement for appliances to be able to be used instantaneously and to contribute towards an 'easy' lifestyle (discussed in more depth in Chapter 6). Participants noted their frustration and impatience at waiting for computers and televisions to turn on before they were able to use them, suggesting that these were often left on standby to reduce the need for this delay, thereby increasing standby consumption. Discussions on leisure also focused on technical developments increasing the flexibility for people to view television – via the use of recorders and internet streaming – at times that were convenient for them as opposed to being tied to the specific times when programmes are aired. It could perhaps be argued that this flexibility could contribute to an (albeit small) shift in demand (and therefore a reduction of peaks in demand) from television - potentially reducing demand that corresponds to sections of television schedules and popular programmes – known as the 'TV pickup' (for example the infamous 'EastEnders tea break peak') (BBC, 2013). Indeed, as technology enables increasingly flexible habits and practices to develop, it could be suggested that aspects of people's lifestyles may be suitable for becoming more flexible and tallying with times of sufficient electricity supply in a future electricity system (discussed in Chapters 5 and 6).

This section has portrayed the meaning that is attached to the ways in which people use electricity in the home. Numerous aspects of electricity were suggested to be meaningful including attempting to make a comfortable, homely environment and to benefit from the convenience that using electrical appliances can provide. These aspects, along with the perceived importance of having control over how electricity is used in the home, will be discussed in more detail later in the thesis.

4.8 Talking About Electricity: Reducing Demand - Negotiations and Home Making

A recurring aspect across all discussions was the concept of 'non-negotiable consumption' (Strengers, 2013) – where, if tasked with reducing their overall electricity use, people would not be prepared to compromise on or reduce their electricity use through ceasing to use or do something that was meaningful or important to them. In addition to different comfort requirements it was suggested that the things that people see as non-negotiable differ

between individuals, because using certain appliances or performing certain activities has specific importance and meaning for different people. Participants stated that this aspect is particularly strong within the home, as it is seen as a personal domain within which people can do what they want:

Josie, 25: "*We have the heating on less because we know how much it spends, but it just means we sit in the cold instead. But then we still use the PlayStation and hair straighteners and the things that are really high because, I'm not gonna not straighten my hair because of the cost of electricity.*"

William, 53: "*There is always a bottom line. Everybody will be different in terms of what they will not do without if they can afford it. You know, some people will say 'I want to be able to watch television whenever I'm at home, whether that costs me three times as much or half as much', whereas other people might not be bothered.*"

Approaching this consideration from a different angle, it could be interpreted to mean that in other contexts (*e.g.* the workplace) the idea of non-negotiable consumption is less relevant, and if so this could potentially have implications for attempting to reduce electricity use within the domestic sector. By extension it could perhaps be argued that it may be more readily achievable to target the workplace or other contexts instead of the home as people may be more flexible and open to change. Some participants' responses also indicated that, if they were tasked with having to reduce their electricity use, they felt they would be more willing to cut down on essential demand (such as heating and cooking) than leisure-related electricity use. This perhaps suggests that more meaning is attached to the things people do for leisure, and that there is more resistance to having to reduce leisure opportunities, despite the fact that it is arguably unrealistic to reduce demand from cooking and heating and more realistic to cut down on non-essential leisure-related electricity use. Indeed, this could be considered as participants effectively perceiving their leisure-related electricity use to be more important than that which is typically deemed 'essential'. Whilst these findings suggest that possible future attempts to reduce domestic electricity use may face a range of potential barriers, some participants suggested that they had already made efforts to reduce their demand, and that they had reached what they perceived to be their 'baseline'. Some suggested that baseline, background consumption (for example from refrigerators) overnight contributed to a significant proportion of their electricity usage, despite them making efforts to turn off appliances and reduce what is sometimes referred to as overnight, 'vampire' consumption (*e.g.* Gupta, Intille and Larson, 2009):

Lorraine, 68: *"And we never leave it [referring to television], you know we always turn the red light off overnight and things like that, and the computer always goes completely off, there's no red eyes staring back at us!"*

'***The easy life that we've created for ourselves'***

This concept ties in with the suggestion that participants with energy monitors – some of whom actively investigated the impacts of specific appliances on overall electricity use to help cut down baseline demand – identified their baseline, creating the perception that there were no further cuts that could be made without having larger impacts on their lifestyles:

Paul, 41: *"We have actually done, I would say, as much as we'd be willing to do without making our life more awkward. Anything further would start getting in the way of the easy life that we've created for ourselves at the moment."*

Throughout the discussions participants referred to steps they had taken to reduce their electricity use. These deliberate acts – that could be termed energy saving practices (Wallbridge, Buchs and Smith, 2012) – ranged from routine habits such as turning lights off to one-off acts such as replacing bulbs with more energy-efficient models. Furthermore, some discussed ways in which they had changed the way they performed certain practices – for example using less energy-intensive methods of cooking:

Sophie, 56: "*We've changed a few things. We have cut down on unnecessary heating where we can, and we've got an open fire as well, and since at the moment we get wood fairly regularly free we tend to use that when we can to supplement so that we can cut down the gas and electricity we use in particular. The other thing we use more than we ever did is the slow cooker, which uses less power over the period than it would if you sort of cooked something a lot quicker in a bigger oven."*

Additionally, participants living in a shared house suggested that they had attempted to influence the behaviour of other housemates to reduce consumption, with one participant describing an agreement they had made where a housemate who regularly left lights on had to buy them a chocolate bar if they were caught, insisting that this very quickly 'taught' them to turn the lights off. These energy-saving practices were often referred to as being motivated by the incentive to save money and reduce electricity bills (as well as ensuring perceived fairness with shared bills).

Technologies that enable people to communicate with the outside world – namely telephones and the internet – were deemed to be important aspects of homeliness, enabling this connection to other people and social networks to be extended beyond the physical

limits of the home. Participants also referred to the convenience borne through being able to use the internet from home, stating that – in a similar effect to the impact of refrigerators reducing the need for regular food shops – shopping and research, as well as communication with friends and family, can be performed from within the home. The ever-increasing importance of the internet in people's lives was perceived to be a large-scale social change that had occurred over a short time period:

Sue, 53: *"If your computer goes and you lose internet access it's amazing how quickly you start to, you know, panic slightly because you can't do the things you were anticipating doing and how much you use it, and that's probably the last ten years or so? [group murmurs agreement]."*

In addition to the 'panic' induced by having a lack of internet access it was suggested that, as many new products are now designed to operate using the internet – with specific reference made to smartphones, laptop computers and printers – if access becomes unavailable the inconvenience caused is much greater than that which would have previously occurred before these products became so reliant on wireless communication over the internet. Furthermore, participants stated that as technology has developed and internet connections have become embedded within people's homes this has changed the ways in which people communicate. One participant reflected on the fact that in the past people did not make video calls, however, now that software such as Skype has made this possible - and for some participants in the student and retired groups, the norm - it is now deemed unacceptable and irritating if this is taken away through power cuts or loss of internet access. The ability to communicate online was considered to be particularly important by mothers with young children, who saw online social networks as a key way of avoiding isolation whilst spending a lot of time at home. This resonates with findings portraying the increasingly important role that electricity – and products or services that rely upon electricity – has in people's home lives, suggesting that the severity of risk (*e.g.* Becker *et al.*, 1978) of adverse effects or inconvenience created through power cuts or issues with domestic electricity supplies is perceived to be greater than it may have been in the past.

This section has demonstrated ways in which people talk and think about electricity in the home, in the context of negotiations over energy saving. Some aspects of consumption were suggested to be non-negotiable, with different personal preferences influencing what was considered to be non-negotiable. Participants also discussed how behaviours and

'energy saving practices' had been undertaken with the specific aim of saving energy in the home. In addition to energy saving practices, responses indicated that some participants had experienced negotiating with other members of the household how to reduce electricity consumption. This is reflected upon later in the thesis.

4.9 Thinking About Electricity: Imagining Future Change

This section refers to responses relating to expected future change that emerged from the public focus groups. A more in-depth discussion of visions and expectations of the future is presented in Chapter 6, where Phase 3 public interview participants responded to materials (developed from insights obtained in the Phase 2 expert interviews) that presented aspects of possible future changes to the UK electricity system. In the Phase 1 focus groups participants were asked to imagine and speculate upon changes they thought may occur in the future. This provided the opportunity for participants to discuss their visions in an open-ended, unguided way, enabling aspects that were personally meaningful or important to be discussed. These included debates on future technologies and lifestyles, and spanned from suggestions on immediate changes that may occur in the near future to more longer-term visions. Furthermore, some participants identified future continuations of trends that they perceived to have already occurred. This echoes Brown and Michael's (2003) analysis of 'prospecting retrospects', where people draw upon past experiences and visions to inform and shape their expectations of the future. Other discussions centred on more abstract themes that could possibly evolve in the future. A recurring topic in discussions involved the perception that over time a larger and more diverse range of electrical products and appliances has become embedded within people's lifestyles. Many stated an expectation that this trend would continue in the future, although some also suggested that modern products such as laptops or smartphones perform the same tasks as multiple products (*e.g.* radio, television, alarm clock *etc.*) so may actually lead to a gradual decline in the number of consumer electrical appliances required in everyday life. In addition to this trend participants suggested that products have become, and will continue to become, increasingly energy efficient, reducing the electrical demand from individual products:

Ben, 23: "*I do think though the trend is definitely for things to become more efficient. […] The cheapest fridges now are more efficient than the ones you got five years ago. So everything's becoming more efficient, so I think, as much as we're having more and more gadgets, and*

more and more of them are coming into our lives, they're becoming more efficient as well in the way they use electricity."

Discussions on efficiency also extended to future increases in automation of power-saving mechanisms in electrical products, with some participants suggesting that products themselves will have power-saving modes that can be adopted automatically, negating the need for people to consciously choose to turn appliances off:

William, 53: *I think that things will automatically have elements of saving power on it. I mean at the moment computers will shut themselves down to save power and things like that, and I think a lot more aspects will do that. It may actually be that you can have things that, if you generate your own power, then they will come on when you're generating and won't when you're not. I think there'll be options like that."*

This expectation of increased automation and operation of appliances for power-saving is relevant to similar discussions on the design and implementation of the UK's anticipated 2020 Smart Meter roll-out (Roscoe and Ault, 2010). Whilst consensus on the most appropriate designs of meters is yet to be reached, many suggestions involve an element of remote control or automation from network operators – where the operation of certain appliances within the home may be determined by the responses to network signals to help create a 'smarter' grid that enables the balance between supply and demand to be more successfully managed. This is discussed in more depth in Chapters 5 and 6.

Participants referred to niche technologies that they suggested had the potential to – if this were (however realistically or unrealistically) realised - have significant impacts on both the infrastructure and design of future houses, and also on the ways in which people use electricity and live in the home. For example one participant predicted that three-dimensional printers will become common features of households, enabling residents to effectively become producers of (some of) the products they use – becoming what Silva and Karnouskos (2012) would describe as prosumers. Another discussion involved participants probing one group member's belief that infra-red heating systems could transform the ways in which future houses are heated:

William, 53: *"You could have a heat source that was fairly instant, so you wouldn't have to keep the room hot. For instance, in saunas you can get infra-red heaters, well if you had an infra-red heater that as you walked in the door you touched it, it would then be effectively instantly hot. So therefore you'd only need to use it when you were in the room, and when*

you leave the room it goes off and you turn another one on – maybe automatically as you walk through the room."

Whilst it is not within the aims or remit of this project to discuss the feasibility or technical capability of suggestions on future technologies from focus group participants, considering the meaning embedded within, for example, William's response can help to highlight important aspects that may be relevant to the wider aims of the project. For example, an interpretation of William's response could be that inefficient space heating within homes is seen by some participants as an issue that could and should be addressed in the future. Similar debates involved a discussion on energy conservation and reducing heat losses within the home. One participant suggested that providing residents with thermal images of the outside of houses could help raise awareness and motivation for attempting to reduce heat losses from windows and rooftops[3]. It could perhaps be argued that this suggestion, whilst entirely valid as a participants' understanding and opinion, fits the 'deficit model' (Dickson, 2005).As such, interpreting this finding with the aim of using it as evidence for policy development could perhaps be critiqued, because Deficit Model advocates would likely suggest that simply providing residents with more information on the energy conservation characteristics of their property may not necessarily result in the desired response of residents acting to 'improve' upon these. However, it could also be argued that novel suggestions to help communicate information across a variety of media may help to engage people with ideas about shifting and reducing electricity demand, and could perhaps be given more consideration in the design and implementation of future policy and technical interventions.

'You've got everything there at your fingertips'

A recurring theme in discussions on the potential adoption of future policies or technologies relating to electricity demand centred on the need for people to view change as an improvement (mirroring Demski *et al.*'s (In Press) findings). When asked about technologies such as electric vehicles participants referred to concerns over the flexibility of their usage and decreased range (*i.e.* the range of one charged battery in an electric vehicle compared to a tank of fuel in a conventional vehicle) impacting the ways in which vehicles

[3] Indeed, this concept has been expanded by the Energy Biographies project (a Cardiff University team investigating the dynamics of how energy is used in a range of contexts – see www.energybiographies.org) who, in collaboration with partners from Oxford Brookes university for an exhibition, commissioned an artist to produce a 3D visual model of a thermal image of a house, depicting hot and cold spots around external features.

could be used in people's lifestyles – suggesting that these concerns would have to be overcome to ensure that adopting electric vehicles in the future was seen as an improvement. Participants also referred to significant social changes being influenced by certain technologies. The impact that smartphones were perceived to have had, and their widespread uptake in recent years was discussed:

Christina, 64: "*You look at phones. I mean now you can't go anywhere without somebody, everybody, I don't think there's anybody in the room without their phone, am I right? [group murmurs agreement]. You know, you sit in the doctor's waiting room and everybody is playing games on it, and that's changed so much, the fact that you've got that mobile. You've got internet, you've got everything there at your fingertips. You go out without your phone and you feel bereft, and I wouldn't have said that I felt like that three years ago, four years ago.*"

'Whatever's going to happen, I want to go along with it'

Whilst the changing use of – and perceived change in meaning attached to – smartphones is not directly relevant to domestic electricity, the reference to perceived changes occurring over a short timespan highlights an aspect of discussions that alluded to the role of technological advances both within and outside of the home. Members of the retired homeowners group enthusiastically discussed the role that electricity plays in assisting people, suggesting that they hoped and imagined future products and appliances would continue to help support them as they grew older. Keeping apace with developments – for example saving money by paying for electricity online – was also perceived as being important to avoid being socially excluded from potential benefits of new technologies:

Emma, 64: *'I think the older you get it's harder.*

Christina, 64: *But it's the keeping up, she's [referring to an elderly relative] never taken to that, whereas if you go with the flow…*

Emma: *Yeah, well I had to in work, you know when they brought in computers I was sort of dragged into it, I didn't want to…*

Lorraine, 68: *Yeah, exactly the same.*

Christina: *But you embrace it.*

Emma: *In the end yes.*

Christina: *But there must be something, whatever's going to happen, I want to go along with it.*

Emma: *Well otherwise you're enormously disempowered aren't you, or you feel disempowered."*

Responses also highlighted a perception that society will become increasingly reliant upon electricity in the future. Discussions on new consumer electronic products – for example tablet computers, which were perceived to occupy a niche in the market that previously did not exist – creating new demands and becoming more popular and widespread echoed this, with one participant suggesting that electricity use will rise alongside people's demand for increased social connectivity through new products:

Richard, 20: *Yeah, I would probably go further [than stating that reliance on electricity will grow in the future] with that and say I think just as technology develops they're gonna bring in more and more things. People now say with phones they use them for social network sites and things like that. It's more than just having it if someone wants to call you, it's extended a lot further to kind of keeping an eye on almost everyone and what's going on in the world, and so I think as technology goes further, there's going to be more things available so I think we'll use more electricity.*

A notable finding relating to people's expectations of future energy scenarios is that the vast majority of responses referred to technological changes and new products, as opposed to social or lifestyle change. This mirrors a similar finding where participants suggested technological solutions for improving energy efficiency within their homes to help achieve a reduction in electricity consumption, as opposed to changing the ways in which they used electricity. These findings resonate with ecological modernisation discourses (*e.g.* Hajer, 1995). As such, a discussion on how both public and expert participants preferentially suggest and advocate technological mechanisms for reducing and shifting domestic electricity demand – and the potential implications this may have – is provided in Chapters 5 and 6.

This section has demonstrated how aspects of imagined future changes to the electricity system and the impact this may have on household electricity use were discussed by focus group participants. An aspect of these discussions focused on the idea some felt that change needs to be seen as an improvement to be embraced and positively accepted. Furthermore, there appeared to be an expectation that societal reliance upon electricity will continue to increase in the future, and this was associated with a desire discussed by some to keep pace with technological developments to avoid social exclusion. Reflection and further discussion of the findings (and their implications) discussed in this section is provided in Chapter 7.

4.10 Chapter Summary and Discussion

This chapter aimed to present and interpret data to demonstrate how people relate to, think about and use electricity in the home. In this section the key findings from this chapter that help to answer research questions 1) and 4) (below) and their implications are summarised and discussed:

1) How do people understand and interact with their existing electricity supply system in the home?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

Due to its' perceived lack of material presence (Burgess and Nye, 2008), the role electricity plays within the home was suggested to not be particularly salient. Indeed, some responses indicated that participants do not always make a conscious link between performing specific practices or using appliances and the electricity that is involved. This finding mirrors previous research (*e.g.* Burgess and Nye, 2008; Hargreaves *et al.*, 2013) and suggests that qualitative research into domestic electricity use should involve asking people about more readily relatable aspects such as routines or specific practices that they undertake in the home, as opposed to more direct questions about electricity itself. This perhaps echoes arguments of proponents of practice theory approaches to investigating energy consumption, suggesting that focusing on wider practices may help to indirectly identify the background role of electricity in mundane aspects of everyday living in the home. Exceptions were found with participants who had experienced using energy monitors, which were argued to make electricity use more salient and visible. Within this, evidence was also found that suggested receiving feedback on energy use from monitors provided motivation for people to reduce perceived 'waste' electricity use. However, this was also found to not necessarily be a sustained long-term or significant change. This mirrors Hargreaves *et al.*'s (2013) findings, and has important implications for the anticipated UK smart meter rollout (Roscoe and Ault, 2010). Whilst there are multiple motivations for providing smart meters to all households by 2020 (*e.g.* increasing users' control of their energy supply and providing real-time information for system operators; DECC, 2015), a key 'selling point' in policy documents and consultations (*e.g.* DECC, 2014b; 2015) focuses on energy and cost savings for users, yet focus group findings suggest these may be

minimal and indeed short-term, arguably achieving less significant change than policy visions portray.

A significant perceived risk of power cuts was identified, although participants' references to past experiences of power cuts and concerns over future ones suggested a reversal in the relationship between the perceived likelihood and severity of the risk. Some elder participants recalled frequent power cuts (*i.e.* signifying a high perceived 'susceptibility'; Becker *et al.*, 1978) in their childhood. However, their recollections of the impacts of these power cuts hint towards minimal perceived disruption as it was a reasonably normal, frequent occurrence that people got used to experiencing (*i.e.* the 'severity' of the risk was minimised; *ibid.*). Conversely, participants appeared to perceive current electricity supply in the UK to be secure, and as such felt that the risk of power cuts was minimal. However, this was coupled with the feeling that the consequences and inconvenience (*i.e.* severity) that would be caused by a power cut would be now greater than in the past. This tallies with and can perhaps, in part, be explained by the almost universal perception that electricity is taking on a more important role in today's increasingly technological lifestyles, where it was suggested that people's increasing accumulation of electrical products has contributed to the inconspicuous growth of consumption (Shove and Warde, 2002) and reliance upon electricity.

Key aspects of 'home' – that is distinguished from other aspects of life such as the workplace – appeared to be the notions of freedom and being in control within your own space. As such, this could be interpreted as a potential barrier to visions of change involving the watering down of perceived control (*e.g.* visions of home automation – discussed in more depth later in the thesis). Coupled with the perceived importance of control and the notion of non-negotiable consumption, a recurring theme involved the feeling amongst some participants that any significant change to how and when electricity could be used in the home would result in negative impacts on their current lifestyle (*i.e.* by causing inconvenience or constraining routines and practices). This mirrors Parkhill *et al.*'s (2013) finding that any imposed change needs to be perceived as an improvement to be accepted. This is arguably a difficult ambition to achieve if many people perceive possible future changes as a constraint or challenge on their freedom that imposes limits upon what (and when) they cannot do in terms of electricity-reliant behaviours in the home.

Evidence from all groups – in particular the young mothers and student groups – portrays the complex dynamics and negotiations that occur between people in the home. Along

with different tolerances and preferences this demonstrates the potential difficulties in implementing strategies to achieve change that may be agreed upon, and engaged with, by members within a household. Furthermore, differences between households (such as homeowners and renting tenants or bill payers and non-bill payers), and the vast range of relationships between residents of different households, suggest that designing policies that achieve a good 'fit' with these different contexts may be an almost impossible endeavour. This perhaps highlights the need for policies and governance structures to take these differences into account, enabling context-specific and appropriate strategies to be designed.

A finding that emerged from the focus groups involved the suggestion that reductions in electricity consumption should primarily be achieved through technological solutions such as obtaining increasingly energy efficient products or other energy conservation measures such as cavity-wall insulation. Indeed, technological solutions were often preferred to, and advocated instead of, behaviour change. This finding resonates with literature on ecological modernisation (*e.g.* Hajer, 1995; Backstrand and Lovbrand, 2007) and was also identified in expert interviews and public follow-up interviews. As such, this finding takes on a central role throughout the thesis argument, and will be further explored and discussed (along with potential explanations and implications) in more depth later in the thesis.

Many participants referred to their belief that financial considerations and economics are a key driver of behaviour. Indeed, when recalling personal experiences of using the Economy 7 electricity tariff in conjunction with energy storage heaters, some participants discussed the financial benefits and savings they made, despite acknowledging the perceived inferiority of the service they received (*i.e.* in comparison with conventional – yet more costly – heating systems). Findings relating to economic drivers are relevant to the potential design of policies and financial strategies to encourage or discourage electricity use at specific times (*i.e.* at times of short supply). At face value, evidence obtained through focus group responses suggests that using financial mechanisms to achieve change may be readily achievable as many argued that economic considerations play an important role in decision making and are a key driver of behaviour. Yet, contradictions identified suggested that other factors that held more meaning (*e.g.* comfort and leisure-related activities) were likely to be prioritised over costs, suggesting that – whilst some moderate change may be achievable – strategies relying upon financial manipulation may be limited by their inability to provide enough of an incentive (or disincentive) to overcome more meaningful factors

that influence electricity use. Participants in expert interviews and follow-up interviews also advocated employing economic mechanisms for change, and a deeper exploration of the implications of the assumption that economic mechanisms can drive desired change, along with contradictions in discourse surrounding the role of economics in decision making are discussed later in the thesis.

Evidence was found for novel findings relating to the relationship that homeowners with solar PV panels have with electricity in the home. Participants with solar PV panels were very engaged in attempting to shift their demand to maximise potential cost savings by synchronising their demand with times when the sun was out (and therefore their panels were generating electricity). Despite their engagement and apparent enjoyment of this more active management of their electricity use (a point which will be re-visited in Chapters 5 and 6), participants nevertheless felt that performing this demand-shifting was an inconvenience, and that their sole motivation for continuing this behaviour was financial. This provides some evidence for people following what could perhaps simplistically be described as 'rational-economic' assumptions of behaviour as they seemingly 'put up' with this inconvenience to enable them to save money. This has implications that could be considered and further explored for policies surrounding micro-generation schemes and other possible technological innovations (*e.g.* smart meters). However, this 'syncing with the sun' could also possibly be a characteristic unique to 'prosumers' and not necessarily generalisable to wider technologies – as people appeared to also be partially motivated by the desire to use generated electricity that they perceived to be 'theirs', which may – or may not – be different to generic motivations to shift demand for cost savings. Additionally, evidence was also found for further behavioural change, including environmental 'spillovers' (such as replacing light bulbs with more efficient models) and changes in social practices (see Chapter 7). This evidence for significant behavioural change portrays the complex relationship that solar PV owners have with electricity in the home, and demonstrates how a technological innovation supported by policy (*i.e.* the solar FiT) can have a range of unanticipated effects that can impact wider electricity system operation. For this reason it is suggested that further research should be conducted to shed further light on this novel and dynamic relationship to better inform policy makers. A more in depth analysis and discussion of this 'syncing with the sun' is provided in Chapter 7.

5 Empirical Findings 2 – Expert Understandings of Domestic Electricity Use and Expectations for Future Change

This chapter aims to present and interpret expert understandings of domestic electricity use and their expectations for future changes to the electricity system. The rationale for the structure of this chapter – and how it fits within the wider thesis - is based on the assumption that understanding how experts think about and understand domestic electricity provision; how and why they feel that the UK electricity system should – and how they think it will – change; and the implications they expect this to have on how electricity is used in the home will enable research questions 2 and 3 to be answered:

2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?

Motivations for implementing change will be discussed, in addition to the imagined future role of electricity in society and impacts of anticipated change. The findings include a discussion on the assumptions, contradictions and expectations identified within and between participants' discourse, and as such are drawn primarily from the Phase 2 expert interviews. Additional contextual information to aid the understanding of technical visions and interpretation of participant responses was also obtained through participation at Top and Tail events and other academic conferences relating to electrical engineering and wider sustainability issues. Comparing and contrasting public and expert visions was not a central aim of the research, however, where appropriate and analytically interesting these have been highlighted.

5.1 Knowledge, Ignorance and Emotive Topics: Expert Understandings of Public Perceptions

One interviewee suggested that energy is a strangely emotive subject, where people have strong views on specific technologies or issues relating to electricity. They questioned why this is the case, and speculated that future changes to electricity generation and distribution may be met with resistance due to this emotive aspect of energy systems in society:

Bob: *"Energy seems to be one of those topics where anybody, even people who have nothing to do with the energy industry have really strong opinions, everyone's got a feeling about one kind of electricity technology or another. […] People are quite passionate about it and I don't know why. You know, people don't have such massive views on the way we get our broadband or source our water, but energy kind of has this special role for some reason and I, I've always wondered why."*

Experts appeared to be more positive about new technologies taking on more importance within people's lives than the public. For example an unstated recurring theme that appeared to underlie many participants' explanations of possible future changes involved the assumption that houses will become more complex, connected systems (public perceptions towards this are discussed in Chapter 6). Public surveys (*e.g.* European Commission, 2013) and wider literature (*e.g.* Kozinets, 2008; Carpentier, Schroder and Hallett 2013) suggest that technology is generally viewed positively and is seen as a necessary component of 'progress'. However, it is interesting that experts seemed to have fewer concerns about new technologies than public participants, which raises certain questions: Are experts (particularly engineers) more positive because they are more familiar with the technology and perhaps understand it more?; As most experts sampled in this research focus more on the technical aspects within their professional lives do they marginalise or trivialise the social implications of new technologies?; and does this explain why public participants expressed more concerns, because they were imagining how possible technologies may affect their own lives as well as society more widely?

An unexpected finding involved one participant expressing bewilderment as to why public support for renewable technology is as high as "*a lot of surveys seem to be saying"*. They suggested this positive public attitude was due to people having a lack of understanding of the implications that having more renewables would have for the electricity system and how they would be able to use it in the future. This could perhaps be explained by drawing upon Brown and Michael's (2003) observation that actors who are 'closer' to the production of scientific knowledge (*i.e.* in this context working in close proximity to research and production of new technologies for the electricity system) may be more likely to have (and express) concerns or uncertainties than those who are not so familiar with or proximal to this knowledge production. This finding is interesting because in many ways it is similar to the underlying perception identified within experts' discourse that there is a public knowledge deficit and lack of understanding towards a range of aspects of the electricity system (discussed later in this chapter). However, it contrasts with other

instances of a perceived knowledge deficit in that it was deemed to have a positive effect in terms of public support for future system changes. Most references towards a public lack of awareness or understanding were perceived to be negative and were almost referred to with frustration, in a way that could be interpreted to fit within the information-deficit model (such as the assumption that people would be more likely to change the way they used electricity if they understood more about why this change were needed). This was often accompanied by the suggestion that 'educating' the public is an important tool to help increase support and motivation for participation in pro-environmental behaviour that is beneficial for electricity system operators, reflecting Eden's (1996) discussion of environmental education and its role in 'meeting policy aims'. However, this position was also critiqued by some participants who argued that purely providing people with more information would not necessarily result in them changing their behaviour, which was directly influenced by more affective, meaningful, cultural and contextual factors than simply a lack of knowledge (*e.g.* Owens and Driffill, 2008). This range of views and assumptions towards the dynamics between public knowledge and perceptions of energy technologies shows the variation within the expert sample, which could be interpreted as evidence for the need to have more 'upstream' engagement (such as that discussed in Wilsdon and Willis, 2004) with both experts and publics. Indeed, whilst critics may suggest that electricity system changes have no unusual social or ethical implications (*e.g.* when compared to nanotechnology or genetically modified food production) and therefore do not necessarily require upstream engagement, by incorporating public deliberation and engagement earlier in the innovation process a better understanding of public knowledge, perceptions and aspects such as hopes or concerns relating to change can be obtained by those driving innovation. It could perhaps be argued that better communication and engagement amongst different stakeholders could ensure relevant perceived social, technical and ethical issues are considered before significant decisions are made and subsequently become 'locked in' (Rogers-Hayden and Pidgeon, 2007), thus laying the foundation for more robust policy and public debate alike regarding new developments due to a perceived knowledge deficit.

Interestingly, some expert interviewees perceived the researcher's role as a social scientist as being the 'go-to' person to find ways to 'educate' people and convince them to use electricity in the most suitable way for system operation. Indeed, a contradiction was identified where participants accepted that the public will generally not accept being told

how and when they can use electricity or have to pay different rates at different times in possible future scenarios (discussed later in this chapter), yet it was also felt that by 'educating' people about the reasons for the changing ways of using electricity this social barrier could be overcome. It could be argued that a more appropriate approach would be to focus more on understanding ways of designing the electricity system and supporting policies around people and their lifestyles rather than trying to fix the problem purely using technology and trying to 'shoehorn' people's behaviour into this model.

This section has portrayed expert interviewees' understandings of and views towards public perceptions of the electricity system. A recurring theme involved the assumption that there is a significant lack of public awareness and knowledge relating to aspects of the electricity system and how this is linked to electricity use in the home. Indeed, there appeared to be conflicting views towards this assumption, with some advocating education to increase public awareness of the need for change – and how this may be achieved – whilst others were more critical of this deficit-model approach. These findings – in addition to the related discussion on upstream engagement touched upon in this section – will be re-visited in more depth later in the thesis.

5.2 Identity, Altruism and Intrigue: Expert Motivations for Exploring Possible Change

Some participants, when reflecting upon their own careers and interests, suggested that in addition to chance factors the underlying reason why they had entered their academic discipline and research field was a curiosity for understanding how and why things work, and an enjoyment of solving problems. Indeed, the desire to solve problems and contribute to 'making things work' was discussed by some interviewees as a source of motivation and could be interpreted as a key aspect of their identity as engineers (Kleif and Faulkner, 2002; Faulkner, 2007). Additionally, some interviewees referred to a desire to contribute towards solving societal problems such as reducing environmental impacts and pollution, as well as climate change. This interest appeared often to be situated with particular local contexts, with some participants contrasting the UK electricity system with foreign contexts from their native home countries. One participant also described a fascination with maintaining and developing a functioning electricity network within their home city of London amidst

increasing population growth and societal pressures introducing new technical challenges. The satisfaction of generating research impact in the form of developing technological innovations and patent-protected inventions and influencing strategic thinkers or policy makers was also described as a driving motivation for some participants. However, demonstrating impact was said to be challenging because 'real' impact was often perceived to be invisible and difficult to identify immediately, particularly for future-oriented work such as that undertaken within the Top and Tail project. This was referred to as a concern by one participant, who argued that their own research would hopefully achieve more of a gradual influence over time. It could be argued that the pressure to demonstrate impact (*i.e.* to secure future funding and meet grant objectives) may influence the practice of researchers and ultimately influence the research that is undertaken, with potential implications for research councils and wider academic funding and research structures.

5.3 Changing Agendas and Radical Research

One participant stated that the role of engineering and interdisciplinary projects within academia is to find ways of creating theories or technologies that can help to meet the aims set out by policy makers. Whilst this seems obvious when taken at face value, it does show that the research being undertaken in the field was perceived to be very applied, as opposed to being undertaken for more open-ended reasons or purely for intellectual endeavour and fascination:

Stewart: *"Our job is to provide the tools to be able to meet the requirements set by policy makers. That's going to be tough because we are being asked to do a lot. But I think that'll be the most important thing, to have a set of results, theoretical and material, as well as proof of concepts to be able to show that what we are evaluating is actually worth using."*

It was suggested that most work within electricity systems research did not, until recently, have any significant environmental agenda underlying the directions of research. The prior focus was said to be more about improving efficiency to generate and distribute electricity as cheaply as possible. However, it was perceived that more recently the emergence of the decarbonisation agenda and subsequent government and international policies has introduced a new consideration that has taken on significant importance in influencing work within the field and what it aims to achieve:

Nathan: *"If we went back to the 1980s the attention was to try and make energy conversion more efficient, that was a key thing. There was work on nuclear power and how to do that in a sufficiently safe way - more cheaply, more reliably, but no mention of climate change."*

There appeared to be a range of perceptions towards the changing focus of research and how this would eventually impact 'real world' change. 'Radical' ideas were said to be important in helping to meet the challenges posed by designing a lower carbon electricity system. This was also perceived to be supported by research councils and funding bodies, who in funding projects like Top and Tail were providing the freedom for researchers to be more hypothetical, free-thinking and future oriented. Some participants suggested that this freedom to develop ideas and influence stakeholders would result in significant, radical changes in how the UK electricity system will operate in the future:

Harry: *"I mentioned earlier this Low Carbon Network Fund, this is creating some radical thinking in operation and the planning of our system, and it's fantastic because it's not just people playing in laboratories, it's actual deployment of technologies, which is accelerating everything we're doing in academia. More importantly, it's actually accelerating the change of thinking of the companies - they were totally risk and change averse - but they are now thinking differently, and this is very important, so I think we will have a very different electricity system"*

However, others believed that whilst radical ideas will continue to develop, the actual real, observed effect will be an *"incremental, boring change"* focusing on efficiency measures, and will not involve significant changes to how the system operates and the role that people have within the wider system.

This section has demonstrated how participants perceived environmental aims to be a recent development within electricity system research. In particular, decarbonisation was perceived to be a key policy driver and appeared to be perceived as one the most important aims underpinning research in the field. Varying views towards how this aim should be achieved were identified, ranging from expected incremental, step changes to more radical ideas and developments. The role of expectations of – and views towards – future change, and how this interacts with policy and research agendas will be discussed later in the thesis.

5.4 Motivations for Change - Decarbonisation

Owen *et al.* (2013) highlight the importance of understanding the purposes and motivations for responsible innovation. For this reason it was deemed valuable to ask questions to investigate the perceived need(s) for change: Who (or what) may be beneficiaries of change?; How may this be achieved?; and Will change be equitable or become a burden for some? It was anticipated that questions such as these would open up reflections on the underlying motivations for change, which can help to highlight important aspects that may need to be given consideration within wider visions of change (Stilgoe, 2011).

International climate change mitigation policies and obligations dictate decarbonisation targets, of which the electricity system is an important sector with the potential to contribute towards a significant reduction in CO2 emissions. This was recurrently viewed as the most important reason as to why the electricity system needs to change:

Joe: *"It [the electricity system] needs to change because we have decarbonisation targets to hit. You have a kind of top down driver, inter-governmental panels, filtering down to governments who then filter down to their departments and eventually you get to engineers and then National Grid has to implement changes."*

Dwindling fossil fuel resources were also commonly referenced as a reason for needing to move towards a more renewable-based electricity system. This was primarily framed as a financial argument - to avoid the rising costs associated with increasingly difficult-to-extract resources – as opposed to a sustainability or environmental framing, which arguably suggests that renewable generation sources were (rightly or wrongly) perceived to be more affordable in the long term. It is interesting to consider whether this perception may change over time. For example these interviews were undertaken at a time where debates over fluctuating (and high) oil prices as well as shale gas extraction and 'fracking' were a newsworthy topic in the mainstream UK media. This aspect could perhaps be re-investigated in the near future when the vision of how this industry may evolve in the UK becomes clearer (particularly in the more recent context of decreases in oil prices in 2014/15), to see if this would impact upon perceived economic priorities of energy supply and whether this would re-frame environmental and/or financial arguments.

This section has demonstrated how expert participants considered decarbonisation to be the most important need and motivation for change. Alongside tackling climate change, dwindling fossil fuel reserves (and the expected increased costs of extracting these) was

suggested to be a key reason for why the electricity system should transition towards a decarbonised future.

5.5 Motivations for Change – Energy Security

Energy security is a multi-faceted, complex concept (Chester, 2010) that has numerous definitions which are dependent upon the contexts in which it is being defined. As such, there are various causes for concern that are related to energy security, such as threats to continuous supply (*e.g.* through resource depletion or infrastructure failure), the consequences of a lack of supply (*e.g.* increased prices) and the independence or self-sufficiency of supply (Demski *et* al., 2014). Winzer (2011) states that all definitions of energy security encapsulate the notion of avoiding sudden change to the availability of energy in relation to demand, and as such a resilient system is envisioned as one where the risk of interruptions in energy supply is low. Energy security was a commonly recurring theme in expert interviews, and as such this section portrays how expert interviewees conceptualised energy security and discussed the possible future implications of change.

Whilst decarbonisation was perceived to be the most important driver for change in the electricity system, ensuring a secure energy supply was also said to play a key role in future plans. In particular some participants suggested that with dwindling indigenous fossil fuel reserves the UK was becoming less self-sufficient and more reliant upon foreign imports:

Jim: *"In the past our gas was all from the continental shelf, but now the production has dropped for gas so we must import from other countries. But there is a problem with this – energy security. One country cannot rely completely on other countries for their energy, from a strategic point of view it's a very bad decision."*

This view was used by some as a justification as to why more renewable sources of generation should be developed as the UK was considered to have significant resources that could be exploited to increase generation capacity – for example the most commonly discussed resource involved the potential for UK offshore wind to take up an increasing proportion of the UK's generation. A component of discussions on energy security centred on the concept of a possible European 'supergrid' which could enable increased transmission across national borders (as an extension to the existing Interconnexion France-Angleterre (IFA) High Voltage Direct Current (HVDC) subsea cable between Folkestone and Calais (Asche *et al.*, 2006):

Tony: *"We know already that Europe want to build this HVDC supergrid. There's an expectance that there will be trans-continental energy exchange in Europe. You know, somebody being able to sell energy to another country, if you're gonna have a surplus to do that then we need to have a transmission system."*

This was suggested to enable the diversity of renewable generation to be increased and spread over a wider geographical area which could help to overcome intermittent supply (*e.g.* in times of little wind in the UK there may be a surplus of generation elsewhere in Europe which could be exploited via cross-border transmission to help meet immediate UK demand). Furthermore, proponents argued that this concept may benefit from different demand profiles and peaks across a wider area due to international time differences, which could further help meet demand and balance the wider European system. Interestingly some assumed that a move towards this was inevitable and used this assumption as a reference on which to base their research, whilst others were more sceptical and even suggested that concerns over the geo-political implications of increased international reliance and energy flows didn't necessarily contribute towards the future security of supply.

Within discussions on energy security a recurring theme involved power cuts. Indeed, this topic emerged in each expert interview. Some interviewees were sceptical of media coverage and discussions that portray an increased likelihood of power cuts from a future system incorporating more renewable sources of electricity generation. Indeed, one participant stated that all electricity systems are at some risk of failure due to the nature of generating and distributing electricity across large distances, but argued that future risks would be no greater than current levels and even suggested that portrayals of increased risk of power cuts were perhaps used by energy companies as a way of generating more interest and investment in new power plants. However, it was also argued that system planners should remain cautious and avoid underestimating risks of power cuts when overseeing changes to the wider electricity system, as they did perceive an increased risk of possible power cuts as reliable sources of electricity generation become displaced with less guaranteed, renewable sources.

This section has demonstrated how expert interviewees considered energy security to be of key importance in any future electricity system changes. Indeed, concerns over the reliance upon imports from other nations were used by some as a justification for the need for increased UK sources of renewable electricity generation. This, coupled with visions of a European 'Supergrid', which would help to spread the net wider and diversify sources of

generation, would help to ensure a secure supply. This motivation of ensuring a secure supply will be discussed and re-visited – in the context of visions of electricity system change – later in the thesis.

5.6 Motivations for Change – Alleviating Increased Demand

It was universally expected by all expert participants that electricity demand, and therefore generation, will increase in the future. This was coupled with the assumption that electricity will take on an ever-increasingly important role within future society and become more important in everyday living within the home (mirroring the focus group findings):

Alex: *"There's not a single study I've seen that says we will be using less electricity, pretty much everyone is saying we'll be using a lot more, so the sheer volume of electricity produced and consumed is going to go up, and potentially go up significantly."*

Participants also discussed the electrification of other sectors that are not currently reliant on electricity. A range of opinions was identified, relating to whether electrification of certain sectors (*e.g.* heating) was the most appropriate way to help achieve the overall aim of decarbonising the electricity system and wider society in the future. This was somewhat surprising as a more consensual view was expected to be found, with participants' imaginations of the future more closely reflecting the visions outlined in publications such as DECC's (2012c) '*The Future of Heating: A Strategic Framework for Low Carbon Heat in the UK*'. Electric heating did not appear to be a particularly contentious issue, with most participants suggesting that eventually domestic electric heating systems would become more common and start to replace current gas-based central heating. However, one participant did argue that transitioning towards a predominantly electrically-powered heating sector increased the reliance upon a single 'energy vector'. Whilst asserting that they felt the UK electricity system is currently very reliable, they posited that future changes to the electricity system could perhaps increase the likelihood of power cuts, and that with more aspects of daily life – such as heating within people's homes – relying upon electricity, the social impact of possible interruptions of supply would be magnified (echoing concerns raised by some focus group participants). For this reason they argued that maintaining a more mixed heating sector – that involved both electric and gas systems – would help to balance supply and demand and ultimately 'water down' the reliance on electricity.

Electric vehicles were a much more contentious issue, possibly because they were perceived to be a very young, 'niche' technology (van Bree, Verbong and Kramer, 2010). In addition to concerns over the 'usability' of electric vehicles and discussions on technical limitations that influenced how they may impact people's everyday lives, the impact of this new demand was also considered. Some suggested that introducing electric vehicles on a large scale would not be problematic because people could be incentivised to charge vehicle batteries at times that could be managed by system operators. Indeed, some viewed a fleet of electric vehicles as a beneficial additional component of a future electricity system. It was suggested that they could possibly be used to help fine-tune the balancing act between supply and demand as electricity could possibly be fed back into the grid from vehicle batteries. This was mooted by one participant who advocated the possible introduction of a Feed-in-Tariff for vehicle owners who opted in to schemes that would have some similarities to the solar PV policy that members of one of the phase 1 focus group were taking advantage of. Other participants were less positive about the idea of having to re-engineer the electricity system so that it could cope with this new demand, suggesting that the current infrastructure would not be capable of supporting such a significant change:

Neil: *"One thing that puts this electric vehicle load into perspective is when you consider the amount of power you transfer from a petrol pump into a car. If you want to transfer equivalent power into every electric car, that gives you an indication of the potential for disruption from putting fleets of electric vehicles in. It's just such a huge energy consumer, which the distribution network just was never built for."*

Whilst a consensus was identified relating to expected increases in electricity demand as electricity takes on more importance in people's lives, a recurring theme across many interviews involved the perceived importance of attempting to minimise this increase and to strive to reduce electricity use in the domestic sector. Participants suggested that achieving this reduction would be complex but there were few alternatives due to the prohibitive costs of simply generating more electricity to meet spiralling demand:

Joe: *"It's a cost thing. We could probably come up with a future power system that allows people's lifestyle to remain unchanged. You know, for them not to have to change anything, but it will probably be quite expensive, in fact it will be very expensive…"*

Despite this perhaps seeming to be an obvious statement, some participants in the follow-up public interviews did appear to suggest that the problem of increasing demand could be

met purely through increasing generation, suggesting that this consideration (of the need for behavioural and lifestyle change) is not necessarily understood more widely. Indeed, when presented with alternative visions involving social and technical changes to how people may interact with electricity in the future (discussed later in this chapter), some public participants queried why such fundamental changes were needed instead of simply increasing generation capacity. This finding could have important implications for public engagement and communication strategies relating to future change, and as such could be investigated further in future research. Joe's quote above also hints towards an underlying ambition to maintain current lifestyles and ways of using electricity in the home. Indeed, it could be interpreted to suggest that technological solutions are expected to help solve the problem without relying on people themselves to change how they use electricity. This aspect will be discussed in greater depth later in this chapter.

This section has portrayed how expert participants perceived alleviating increasing demand to be an important part of future changes to the UK electricity system. Unanimous agreement was found on the expectation that electricity demand will increase in the future. However, disagreements over the role of electrification in achieving decarbonisation targets – in relation to the appropriateness of certain sectors becoming electrified – were identified. Despite disagreements over electrification, consensus was also found on the perceived need for domestic demand to be reduced. Reducing demand, and avoiding increasing demand from the domestic sector, form a central part of the visions of future change discussed later in this thesis.

5.7 Motivations for Change – Demand Flexibility

Expert participants envisioned renewable energy technologies accounting for a more significant proportion of the UK's future generation capacity, which would result in a fundamental shift in emphasis in how the system is managed. As such, it was accepted that future supply will become less guaranteed and therefore more difficult to manage due to the fluctuating nature of weather-related energy sources (*e.g.* wind) (Lund, 2006). Maintaining the balance between supply and demand is critical in operating the electricity system and ensuring the risks of blackouts and brownouts (partial power losses) (Nkwetta *et al.*, 2007) remain minimal in the future:

Jim: *"We must keep the balance of the system – generation and demand. […] In the past we controlled the generation to manage the balance, but now you cannot control that with wind or PV, or marine renewables, so another way is to manage the demand."*

For this reason creating a more manageable demand side of the electricity system was perceived to be crucial in future planning. Reducing peak loads was also suggested as a way of enabling costs (which would ultimately be reflected in energy bills) to be kept at a minimum, as this would reduce the need for investment in new electricity generation infrastructure that would otherwise be required to meet these demand peaks. A key component of visions of change involved the motivation to transition towards greater flexibility of domestic demand, requiring the way electricity is used within the home to ultimately become more flexible. It was anticipated that by creating a more manageable, flexible demand that some domestic demand could be shifted to help meet the aim of reduced peaks, and also more readily align with fluctuating supply. This was perceived to be problematic as it would involve significant changes to how people interact with electricity and would impact upon the way they are able to use it in the home. Despite acknowledging the scale of the challenge and anticipating obstacles (both social and technical) that would need to be overcome, many participants had strong visions of what changes they felt would (and should) happen in the future to facilitate this increased flexibility of demand. The most dominant vision involved the automation of some electricity demand. This would involve domestic appliances being programmed or require system operators to take control of some appliances to help reduce peak loads and therefore reduce stresses on the wider electricity system. An alternative vision focused on people within the home taking on a more active role within the electricity system. This was suggested to involve people consciously reacting to signals from system operators to ensure that their peaks in electricity demand occurred at suitable times (*i.e.* when sufficient supply was available). The visions presented in this section – in the context of achieving a more flexible domestic demand - will be discussed in greater depth later in this chapter.

5.8 Motivations for Change – Are We Focusing on the Wrong Sector?

Whilst this thesis is investigating how and why people use electricity at home, and how this may change in the future, a small minority of expert interviewees suggested that focusing efforts for change on the domestic sector is not the most appropriate way forward. Indeed, focusing on industrial and commercial actors was argued by some to be more worthwhile

as there was more scope to have a meaningful impact than in the domestic sector which accounts for approximately one third of the UK electricity demand:

Peter: *"The domestic sector is 1/3rd of the total demand for the electricity system, but 2/3rds of it is not domestic. So it may well be more appropriate, easier and more effective to actually concentrate on the non-domestic sectors to get that flexibility in demand rather than purely looking at the domestic sector."*

Moreover, in addition to the perceived greater scope for significant change in other sectors, it was argued that organisations and businesses may be more likely to consider bottom-line costs in decision making, and therefore arguably more likely to follow economic drivers or incentives (*e.g.* Toke and Taylor, 2007). This was particularly suggested to be important in the context of providing favourable electricity rates and contracts for companies willing to operate more flexibly or be cut off in times of supply deficits (mirroring existing agreements that some commercial and industrial users already have). Whilst this aspect of focusing efforts on non-domestic actors was discussed in a minority of expert interviews, most participants argued that attempts to change how electricity is used should be undertaken across all sectors, as this would achieve the greatest effect and spread impacts across society. Furthermore, both expert and public participants referred to a willingness for themselves and other individuals to participate in change, and as such felt that focusing on the domestic sector was a worthwhile endeavour that would enable people to engage in developments that would ultimately impact the way they would use electricity in their own homes. This could arguably be interpreted as a contradiction, as participants (both public and expert) appeared to desire some level of individual engagement and responsibility on behalf of themselves and other domestic users, yet often would later advocate technical solutions that involved avoiding the need for engagement. This contradiction, and the perceived need (or lack of) for behaviour change and engagement is discussed later in this chapter.

5.9 Visions of Change – Government Responsibility for Driving Change

Experts suggested that whilst a more renewable-based system is the target that planners should aim to meet, it is arguably unattractive politically as it raises the potential for power cuts. However, it was acknowledged that whilst changes may not be politically popular they

were perceived to be necessary. One interviewee advocated developing regulatory mechanisms that provide incentives for all actors at each stage of the electricity system (*i.e.* operators and commercial bodies, power companies and individual users) to 'work appropriately' to assist in the transition towards a lower-carbon system. There also appeared to be a criticism of a lack of clarity in the government's, and particularly DECC's strategy towards renewable technology and funding priorities, which one participant suggested was responsible for constraining "*what we're trying to do*".

A recurring view appeared to be that the government is ultimately responsible for overseeing the transition by incentivising companies and energy providers to ensure a more affordable and lower-carbon system develops. It was also suggested that more appropriate policies need to be devised to influence how people use electricity within the home, particularly in terms of increasing the amount of responsibility individuals have and feel for their own electricity use. This was said to be important by one participant, who argued that the current priority appears to be to try to develop plans that don't affect individuals, but instead to focus on targeting electricity providers. They stated that legislation should focus more on the demand side – which was perceived to receive less attention than generation and distribution – and in particular on the end users of electricity itself, including within the domestic sector. Current policies targeting domestic demand – namely the Green Deal – were also critiqued as being unfit for purpose and only available to a minority of wealthy homeowners, as opposed to being more inclusive and available to the majority.

This section has shown how expert participants felt that the government has the overall responsibility to overseeing changes to the electricity system. Some were critical towards a perceived lack of clarity in government strategies for achieving change. Some responses also indicated that, whilst they felt ultimate responsibility fell to the government, policies enabling and encouraging individual responsibility should be developed. Responsibility for change, and the implications for individuals and policy development are discussed later in the thesis.

5.10 Visions of Change – Automation of Demand to Take Responsibility Away From Users

The automation of some aspects of domestic electricity demand was a dominant, recurring theme in many participants' visions of how greater flexibility of demand should be

achieved. Employing automation technologies within the home was suggested to be an attractive proposition for system operators, creating a more predictable and controllable demand within the domestic sector.

Before discussing the assumptions and expectations embedded within participants' discourse on possible future automation, it is useful to summarise briefly and provide an overview of the characteristics entailed in this vision. This summary is drawn primarily from expert interviews, with extra clarification provided from wider literature. Automation was commonly labelled as a key component of a future 'smarter' grid, involving a number of smart technologies both in and outside the home. Within this new, more intelligent network, participants described domestic appliances being connected to a central hub, or smart meter. These smart appliances (either new or retrofitted existing, 'non-smart' ones) were characterised by two-way communication. This communication was said to enable householders and third parties (such as system operators) to control appliances remotely. Some advocated these appliances communicating autonomously, 'listening' to signals from third parties (such as pricing signals – discussed later in this chapter) (Hledik, 2009) and reacting accordingly. In addition to responding to real time signals, automation was said to play an important role in better scheduling and planning aspects of domestic demand to help shift peaks. This concept mirrors the practice of 'Direct Load Control' (Strengers, 2013) which involves the remote control of large appliances (typically in the US this may be air conditioning units and water heaters). By altering dynamics such as the temperature set-point within the home, or the run time of the compressor and/or heaters (Newsham and Bowker, 2010) a significant reduction in peak loads can be achieved. Indeed, Newsham, Birt and Rowlands (2011) suggest that this reduction can be between 10-36%. Other aspects of domestic demand that were perceived to play an important role in automation included refrigeration technologies, electric heating (with smart thermostats) and washing practices (particularly clothes washing machines and dishwashers). Whilst variations were found in the specific expectations of how the technology may be rolled out, the unifying underlying theme behind visions of automation involved technologies replacing individuals in undertaking the tasks of coordinating, scheduling and managing everyday activities that use electricity in the home. This vision positioned automation as something to promote a future technology-oriented way of living, providing solutions to a range of electricity management problems and ultimately helping to make domestic demand more controllable, and thus more flexible.

An underlying assumption that was commonly referred to as an important reason for advocating this approach involved the perception that the way people use electricity is often unconscious, and that electricity itself is not visible or salient in everyday life. This mirrors findings from the phase 1 public focus groups and wider literature. Indeed, automation technologies themselves appeared to be characterised as being invisible, where they can operate passively, remaining hidden in the background of everyday life. Furthermore, some argued that people are too busy to actively keep tabs on and manage their consumption on a day to day basis, echoing findings discussed by Hamilton *et al.* (2012). Experts interpreted this to mean that automating some electricity demand within the home would not be problematic, and would enable change to occur without requiring conscious change on the part of individuals:

Chris*:* *"Taking the 'I've got to think about this' away from people is probably quite helpful. I think people like to be able to do things fairly mindlessly, so that's why I think the automation comes into play."*

One of the perceived benefits of employing automation was that it doesn't rely on individuals to interact or engage with the system, and takes away less predictable variables that would otherwise be influenced by people's choices in how and when they wanted to use certain electrical appliances. Indeed, it was argued that taking control away from individuals enables system operators potentially to have more confidence in predicting and managing demand, thus aiding the management of balancing demand and supply. One participant went further, suggesting that people cannot be trusted to use electricity in the most appropriate, useful ways for system operators, and that this necessitates responsibility and control being taken away from individuals through the use of automation:

Harry: *"I think that the role of people, I'm not under estimating it, I'm just saying that I think right now the role is zero. We cannot trust people to react to something and change their behaviours just to help the electricity system or whatever."*

Whilst this interviewee adopted what was perhaps a more extreme position than other advocates of automation, it does demonstrate the strength of feeling of the perceived need for control to be taken away from individuals. This hints towards a lack of faith in alternative visions involving people consciously making decisions and actively participating in change (discussed later in this chapter), and also runs counter to Parkhill *et al.*'s (2013) finding that public users desire having more – as opposed to this vision of less - control.

However, other participants acknowledged that public support for automation would be low if they were required to surrender control, and that attempting to adopt such schemes would be problematic. This potential obstacle appeared to be a source of frustration with some participants, who felt that if people were made aware of the benefits and importance of automating some demand, then they should be more willing to accept changes. It could be argued that this approach does not sufficiently consider the role of people within the wider system that is the UK's electricity network. Indeed, participants who were critical of the idea of automation stated that by attempting to minimise or exclude the role of individuals' choices, and instead rely upon technology to achieve this demand shifting, people may not accept change or be prepared to have the technologies required to be installed in their homes.

One suggested way of achieving automation whilst still ensuring that individuals maintain perceived control within their own homes involved the use of an 'override' function, mirroring Parkhill *et al.*'s (2013) findings. This would enable people to connect domestic appliances to smart meters, allowing system operators to externally control them to help manage demand, however, at times when people wanted to guarantee that they could use specific appliances (such as washing machines) within the home they could temporarily 'opt out' or over-ride the system and use their appliance normally. The ability to over-ride was suggested by some as providing people with sufficient flexibility and perceived control, whilst still ensuring suitable third-party control for system operators for the majority of the time. Interpreting this, participants appeared to consider that finding this balance of automation and control will be crucial if individuals are to accept automation within their homes. Indeed, Davidoff *et al.* (2006) conclude that for automation to truly provide householders with a sense of control the system needs to both support the concept of routine, but not strictly bind people to it, and therefore needs to have some level of flexibility built into it.

Debates over public trust in government and energy companies arose, particularly in the context of perceived control and loss of autonomy. Participants suggested that concerns over the 'Big Brother' aspect (Fell *et al.*, 2014) of the role of third parties within automation may be problematic. Indeed, this issue was also discussed in follow-up interviews with the public, who identified concerns over the freedom to use electricity as and when they wanted to, as well as issues of data privacy and security borne through two-way communication between third parties and household smart meters. Interestingly, a counter

argument to this centred on the notion that many other aspects of modern lifestyles are controlled or automated, and that for this reason automation of electrical appliances within the home could be viewed as an extension of this trend and therefore should not necessarily be controversial.

At the heart of visions of automation, users appeared to be imagined as people who will be willing and able to programme domestic appliances and how these will operate on a day to day basis (for example the schedule for when a washing machine or thermostat may be turned on or off). This vision places people in an interesting position, as on the one hand they would be able to control the everyday routine (through programming appliances) of the home system, whilst at the same time they would be assigning control to the technology itself - to operate within pre-programmed limits and by responding to third party signals. For example, as Strengers (2013) neatly summarises, a smart washing machine working in an automated system could enable individuals to take control of their laundry by scheduling it to operate at specified times within their daily routine. Alternatively, they could delegate the control of when the washing machine is operated to somebody (*i.e.* third party system operators) or something (*i.e.* smart meter) else.

Some appliances such as white goods were suggested to be more suitable for automation than others as they were said to be more distant and further removed from people's routines than other products like consumer electronic appliances that people are more engaged with when using them. This could have implications for designing automation strategies, particularly if certain appliances may be switched off at certain peak times – for example a sufficiently insulated fridge being switched off automatically for half an hour would likely have less impact on someone's routine than an oven or television being unavailable at a desired time.

This notion of certain appliances being more distant from people's routines could be an interesting avenue to further explore in attempts to devise policy and technological mechanisms for achieving automation in the home. Visions of change appeared to be muddled and often contradictory in experts' discourse, suggesting that different approaches could make use of different technologies. The underlying aim for automation involved achieving change through technological interventions without appearing to impact upon the way people consciously use electricity, thus enabling existing ways of living within the home to be maintained. This conservative vision of the future, which avoids relying upon individuals to engage and actively participate in consciously reducing or shifting their

electricity demand, could perhaps be critiqued as failing to take account of the fact that society inevitably changes. However, visions of alternative approaches (such as using dynamic pricing and financial incentives to drive demand-related behaviour – discussed later in this chapter) appeared to encourage conscious participation of individuals in the home within the wider system. For this reason, it could be argued that some appliances that are used almost unconsciously and operate in the background may be more suitable for automation than others (such as consumer electronics) which involve greater engagement and take on a more visible role within everyday life.

Some visions of automation adopt what some scholars would perhaps describe as a 'techno-fix' approach (*e.g.* Spaargaren, 2010; Huesemann and Huesemann, 2012), based on the hope that people can continue – superficially at least – to use electricity in a similar manner to how they do already, relying upon efficiency improvements and technological innovations to reduce and shift electricity use rather than behavioural change (with the obvious caveat that they have to accept the technology itself into their homes). This is accompanied by the assumption that people will accept this new technological change if the perceived impact on their lifestyle is minimised and the requirement for them to change their behaviour is small. In essence, participants who advocated automation suggested that it will enable people to change the way electricity within their homes is used without them having to consciously make difficult choices or fundamentally change their relationship with electricity in the home:

Alex: *"Technological solutions can help people make those choices without having to make the choice. Nobody likes being told what to do, but if you can show them that by having that choice taken away they're somehow getting a lower tariff, and that actually it's no worse, you're emptying your washing machine first thing in the morning rather than last thing at night, most people would probably get their heads around it with a little bit of planning."*

However, whilst many participants advocated automation and felt the most appropriate way of achieving significant change is through taking choice and responsibility away from people, some were more critical of this approach. They argued more focus should be placed on understanding the meaning attached by users to what they do within the home, with policies and technologies designed around these suggested to be a more appropriate strategy:

Sarah*:* *"We have to move beyond these very sort of static ideas of 'this technology does this and will lead to this'. I think the way we use it and attach meaning to it is varied and it has*

> *lots of difference. So I don't know technological fixes are maybe a slight red herring, not to deny that technology obviously changes situations and changes things."*

Indeed, some expert participants appeared to oppose the idea of automation because they felt strongly that public participation and engagement should be central to plans for change, and that other approaches aiming to encourage interaction rather than avoid it would be more appropriate. Furthermore, one participant suggested that pinning hopes on technologies is risky, because the way people interact with technologies is often unpredictable, which could lead to people using new technologies in unintended and unanticipated ways. This mirrors Strengers' (2013) discussion of the dynamics of how technology is rarely adopted seamlessly into everyday life.

This section aimed to portray how many experts imagine automation will take on a role in shifting electricity demand within the home. This vision – which takes responsibility and control away from individuals and helps to plan and schedule aspects of demand – was argued by some as an appropriate, achievable mechanism to create a more flexible demand, as it requires less conscious change and action on behalf of individual users. However, other responses, which echo Parkhill *et al.*'s (2013) findings, highlighted concerns over the issue of control, as some expected individuals to desire more control over their electricity in the home. This discussion is revisited later in the thesis.

5.11 Visions of Change – Interactive Participation for Users

An alternative vision was advocated by some participants who imagined changes involving more participation and responsibility for individuals, as opposed to the underlying ambition of taking responsibility away from people that was embedded within visions of home automation. This vision was positioned as a more significant change than automation, as the interactive role for people imagined within the wider electricity system would create more obvious impacts requiring people to change their behaviour. The perceived pros and cons of components of this vision are discussed below. Public responses to these themes are included in Chapter 6.

Before delving further into debates on future electricity systems it is important to highlight that participants did not envision a future that only involved automation, or alternatively one only involving people consciously taking on a more active role. Indeed, a critic could argue that separating participants' responses into two crude categories (namely 'automation'

and 'interactive participation') of visions creates a false divide. More accurately, many participants discussed elements of both approaches, and advocated futures that incorporated some level of automation alongside an increased role for public participation in changing some electricity demand. However, it was decided that responses would be presented using this (albeit imperfect) distinction for two reasons. Firstly, whilst most participants did reflect upon the merits of both approaches, there appeared to be a division whereby some participants felt that automation was the most important, appropriate way to move forward, and that whilst they said there was a role for increased public participation, that this should be kept to a minimum to ensure a more manageable domestic demand is created. For this reason it is argued that, whilst acknowledging that dividing responses into two separate visions is not necessarily a true reflection, it does help to highlight the contradictions and assumptions that were identified in participants' discussions on these visions. Secondly, when presenting these expert interview themes to public participants in follow-up interviews, it became clear that interviewees did not necessarily make the distinction between the two approaches (for example either using a smart meter to enable third parties to control appliances automatically or alternatively to receive signals that could then be interpreted by householders to influence decision making). It was decided that magnifying and contrasting this divide helped to highlight subtleties within the approaches and encourage public interviewees to consider the impacts of components of these visions. Reflecting upon this way of presenting experts' imagined futures, and the benefits of adapting to use this approach in the follow-up interviews, it was subsequently decided that this approach was also the most appropriate way of presenting expert findings in the thesis, enabling a more cohesive narrative to emerge that would discuss the nuances identified, without misrepresenting the data.

When discussing visions of a future electricity system incorporating a more active role for individuals, experts referred to a number of policy and technological changes. Whilst a number of possible changes – along with their implications – were discussed, a recurring assumption involved the expectation that people will become more aware of (and interested in) how their actions of using electricity in the home affect the wider system:

Stewart: *"They will be more aware of their participation in the market. I mean it is going to be like a live animal, so the way that they behave will actively affect the market, by becoming more aware and knowing that they could potentially save money because of their behaviour."*

This included visions of people scheduling demand to coincide with peaks in supply and interacting in real time with signals on smart meters that are transmitted from system operators. Often, the advocated mechanism for change involved providing financial incentives to influence people's behaviour to reduce overall electricity demand and change the times in which it is used.

This section has presented findings portraying an alternate vision of achieving a more flexible domestic demand. This vision of interactive participation involves an arguably more significant change and greater role for individuals as they would be responsible for actively planning and shifting their demand as opposed to third parties performing this role on their behalf. Coupled with this vision appeared to be an assumption that people's awareness and interest in their individual role within the wider system would increase in the future. Whilst this vision was discussed and advocated to a lesser extent than visions of automation, some felt that this was a more complicated, but perhaps more acceptable (as people would not be surrendering control) mechanism for achieving change. This debate and the implications of these visions are discussed later in the thesis.

5.12 Visions of Change – Smart Meters: Differing Definitions and Imagined Roles as In-Home System Hubs

Smart meters were discussed by each expert participant. They were viewed as a key technology which would have an important role in a range of changes to domestic electricity demand. This included working as the in-home hub for automation, and also as a means of providing householders with information and signals to influence how people use electricity. Furthermore, participants referred to the potential empowerment of consumers through providing them with more choice and control over how they use electricity, echoing promissory narratives outlined in both commercial promotional publications and political roadmaps (*e.g.* DECC, 2009a).

In particular, smart meters were discussed in the context of providing feedback on electricity use within the home. Challis' (2004) review on energy feedback identifies variations between forms of feedback. This can include direct or indirect feedback through a variety of media and can refer to individual appliances or (more commonly) to the wider household level. This feedback can also be provided in various forms (such as bills,

ambient displays or mobile phone applications), however, experts typically referred to feedback being provided through displays on smart meters. This mirrors Marres' (2010) positioning of in-home displays on smart meters as the physical link between everyday living (and energy use) and wider societal issues such as energy security and affordability. Whilst the suggested form of feedback provided was often left unstated, participants commonly discussed the primary role of feedback to be to highlight potential cost savings to be made, and as such, most references to feedback were interpreted as being provided in cost format.

Social considerations were rarely discussed in depth when participants described possible technical changes. Significant assumptions on the acceptability of smart meters and other new technologies, as well as how people would interact with these were often embedded within experts' visions of future change. This could perhaps be due to how the questions were framed and prompted, or a manifestation of the fact that most participants were electrical engineers whose specialist expertise is purely technical, and therefore they do not often directly consider these aspects within their research. However, some did reflect upon how and why particular technologies may or may not be successful in achieving their desired effect. Wilhite and Ling (1995) describe the intended relationship between feedback and energy-use behaviour as a 'causal link'. This link can be summarised as feedback from smart meters providing people with more information on their electricity use, which subsequently raises awareness, leading to changes in behaviour and ultimately a decrease in electricity use. Strengers (2013) argues that this anticipated link resonates with the much critiqued information-deficit model, and can result in less significant change being achieved than predicted. Indeed, one participant was sceptical over plans for using smart meters as a means of achieving behavioural change because evidence suggested that positive anticipated changes in the way people interact with them were not sustained over the longer term:

Nathan: *"The reality seems to be from one or two studies that it [change] happens at the beginning - people have a burst of enthusiasm - and then it kind of tails off and they get a bit tired of it and they're saying ah, sod it, how much money is this going to save me anyway?"*

This quote echoes focus group participants' experiences of interest in receiving and responding to feedback gradually waning over time. The interviewee suggested that if evidence does not back up claims made by regulators (in this instance singling out DECC and OFGEM for criticism) for the scope of feedback influencing behaviour and ultimately reducing demand, then less importance and expectation should be afforded to this concept

– at least within the domestic sector. Concerns over the potential scope for achieving impact, particularly in the context of ever increasing domestic demand through the proliferation of new ways of using electricity in the home resonate with Darby's (2008: 502) apt metaphor of "*taking steps down an upward-moving escalator*" Nevertheless, using smart meters to provide feedback on household electricity use appeared to be generally viewed as a worthwhile endeavour.

Other participants expressed bemusement as to why smart meters (which provide real-time communication between the home and the 'grid' and - in some definitions - can control appliances and react to third party signals) and energy monitors (which simply monitor and provide feedback on energy use) are often bundled together or even referred to as the same thing. Interestingly, this could also perhaps help to explain a finding from the follow-up public interviews where many public participants stated they were unsure of what a smart meter is. Indeed, the term smart meter and energy monitor were used interchangeably in public participants' discussions, and could be said to reflect the confusing wider public discourse about these technologies:

Peter: "*When you look at the rollout, the actual smart meter is invisible to the consumer essentially. But when you look at the impact assessment DECC have produced, the financial reason for implementing the smart meter rollout is that consumer behaviour will change, which will result in a reduction in consumption. But that is going to come primarily from the in-home display, which isn't the smart meter. You can put an in-home display in your house now, it's very cheap and very easy to do. So you think 'well, if the majority of the cost is actually in the smart meter, and the significant proportion of the benefits are not from the smart meter but from the display, then why are they packaging them together?'"*

Whilst the wisdom of packaging energy monitors together with smart meters may have been disputed, a commonly held view was that providing system operators with real-time information on domestic demand would help to create a more 'intelligent' system. Indeed, some participants appeared to use the term 'smart' and 'intelligent' interchangeably, and it was this intelligence that interviewees argued would help to build more tolerance of variation and ability to deal with uncertainties in supply and demand into the system.

In addition to scepticism by some participants over the perceived overstated scope for smart meters and energy monitors, one expert also expressed concerns over the impact of introducing 'smart' technologies into people's homes. They suggested that the assumption

people will want and be able to use these technologies risks the social exclusion of residents who do not accept, have the confidence to use, or have access to this new intervention:

Claudia: *"It's sort of pre-conditioned everyone has access to smart technologies, but you know not everyone has a smartphone, not everyone has broadband, and especially in the social housing sector it is really difficult. What happens with social exclusion, that kind of problem? So this techno-fix I have a big question mark from that perspective."*

A final perceived barrier to the roll-out and successful use of smart meters in homes was the concern over whether residents would be accepting of their data being shared with third parties. This data sharing was suggested to play an important role in understanding real-time demand, enabling more tailored and accurate signals to be communicated to households to attempt to influence their electricity use. One expert who had only recently moved to the UK from abroad suggested they felt that distrust of government and energy companies is higher in the UK than in other countries, which could potentially impact the way people opt-in to and accept smart meters taking on an important role in how electricity is used in the home. This will be further explored in Chapter 6 within the context of public perceptions towards smart technologies.

This section has portrayed expert participants' discussions of smart meters, and the role that they may play in a future electricity system. Smart meters were discussed as a technology that would play a key role as the hub of the home system. Imagined roles for smart meters involved providing real-time information on electricity use to try to influence behaviour and reduce or shift demand; acting as a means for two-way communication between the home and system operators; and working as the control centre within visions of home automation – helping to schedule demand and potentially react to real-time signals from system operators. Some responses indicated bemusement towards the perception that the terms smart meters and energy monitors are often used interchangeably, which they suggested may help to explain the perception of public confusion over the difference between these technologies. As a technology that was perceived to play an important role in visions of future change, smart meters – and the role they may play within these visions – are revisited later in the thesis.

5.13 Visions of Change - Dynamic Pricing as a Mechanism for Changing Demand Patterns

Visions of people actively participating in and interacting with the future electricity system commonly referred to aspects of behavioural economics and the use of financial incentives to help drive consumer behaviour and influence how, when and why electricity is used within the home. This was primarily argued due to the belief that cost is '*at the forefront of most people's minds*':

Clive: *"A price signal is one of, I suppose it's THE [emphasis in the original] principal tool we have in our tool box to try to influence people to encourage this demand-response to hopefully integrate more renewables."*

Indeed, the preoccupation with pricing being perceived as the most important influence on electricity-use choices within the home mirrors findings discussed (and critiqued) from the public focus groups. Velthuis (2004: 372) defines price as the '*outcome of the impersonal forces of supply and demand, which are given to economic actors in a situation of perfect competition*'. As such, consumers weigh up and value a product (such as electricity or the service enabled through using electricity) by considering its costs and benefits. However, people do not necessarily follow 'rational' economic rules and behave predictably in response to changes in financial context (Camerer and Lowenstein, 2004). Indeed, the field of behavioural economics has developed to attempt to understand how and why people do not always act rationally in a purely-economic sense, incorporating a consideration of psychological influences and variables that may help to account for deviations from more traditional, neoclassical economics (Lutzenhiser, 2009). Despite recent approaches to develop ways of understanding and predicting consumer behaviour, some participants were critical of economic drivers becoming the main mechanism for attempting to change domestic electricity use and demand, instead suggesting that more tailored, meaningful approaches should be considered. Nevertheless, the dominant vision for achieving a more conscious demand reduction (and shift) involved manipulating the financial context of using electricity. This could perhaps be explained by Reckwitz' (2002b) description of price as a conveyor of meaning about energy, suggesting that whilst the meaning of 'doing' (or using) things that use electricity in the home is greater than the meaning of cost, this cost still helps to signify meaning.

Whilst many advocated attempting to influence electricity use through manipulating the price, a potential flaw in this approach was identified. Electricity was considered by some

to be too cheap a commodity for people to consciously think about in everyday life. For this reason some participants suggested that implementing policies aiming to provide small financial incentives could ultimately prove to create disincentives:

Chris: *"The incentives have to be there. At the moment there are absolutely none. Electricity's cheap! When was the last time you thought "I'll switch that off 'cos of electricity"? You tend not to - even us, who are in the business - sometimes we shouldn't leave things on standby, we all know that. What does it cost, fifty quid a year to leave your TV on standby? But you don't think of it because it is really cheap."*

One could argue that proposing to influence behaviour through pricing strategies appears to be a nonsensical suggestion, as participants advocated this approach, whilst simultaneously providing reasons why it will not work. Could it be that this approach was suggested purely because participants could not foresee any more appropriate alternatives? Whilst views towards the likely success of this approach within the current financial context varied, there did appear to be more hope for the future. It was suggested by some that as electricity becomes more expensive in the future – which appeared to be a commonly held belief – then perhaps people may have more incentive to try to find ways to use less electricity or reduce costs in other ways, suggesting that this approach may become more applicable in the future.

For this reason some proposed implementing dynamic pricing tariffs that reflect the availability of supply. This mirrors Sioshansi's (2012) argument that electricity markets need to reflect more accurately the costs that electricity providers incur, as opposed to providing flat-rate tariffs. Interestingly, whilst participants often referred to 'dynamic pricing', the intricacies of how this idea may actually be implemented and managed were often left unstated. However, a recurring theme involved the suggestion that peaks in demand could be 'smoothed' by making electricity more expensive at these times. This motivation to avoid demand peaks was seen as a critical aspect of future changes to the electricity system, because it was argued that minimising peaks would reduce the need for inefficient investment (*e.g.* in 'reserve' plant). Indeed, Faruqui *et al.* (2007) suggest that even a 5% reduction in peak electricity demand in the US (which they argue is readily achievable) could negate the need for more than 600 rarely-used backup power plants, which could achieve vast cost savings. Additionally, one participant suggested that having prices that reflect operating costs in real time may help to make electricity seem to be more of a 'normal' product. Kurz *et al.* (2005) state that energy is generally considered to be an infinitely producible resource. As such it is assumed today in the UK that electricity should

always be available, as the 'predict and provide' model evolved over the course of the 20th century (Guy and Marvin, 1996). By increasing prices at demand peaks it could be argued that electricity may become a more visible, salient issue (resonating with focus group findings of raised awareness of electricity at times where it is in short supply) and be valued as a scarcer commodity, although there is little evidence to show that this may be maintained once normality has resumed. A counter argument to the ambition of making electricity more of a 'normal' product was provided by one participant who stated that our inability to store electricity on a large scale makes it fundamentally different to other commodities and ensures that it will not follow conventional economic rules.

Despite the various arguments and counter arguments identified relating to dynamic pricing, it did seem to be generally accepted by many (but not necessarily all) participants that some form of dynamic pricing structure will become the reality for domestic electricity consumers in the future, and that they will become a key mechanism for driving behaviour within demand side management strategies. Indeed, discussions on smart meters often involved references to 'price signals'. Reading between the lines, this could perhaps be interpreted to suggest that some participants envisioned dynamic pricing signals and energy feedback being delivered simultaneously using displays on smart meters, in the hope that people may interact with this information and possibly change when they perform certain tasks (or use specific appliances) with a high electricity demand.

In addition to participants critiquing the very ideas that they proposed, one participant provided an extra layer of insight, which hinted towards a possible contradiction. They discussed in detail how they felt that dynamic pricing would provide a strong financial incentive to make people use electricity in more manageable ways for system operators (*i.e.* coinciding household demand peaks with times of sufficient supply). Yet, when asked about how they themselves used electricity in their everyday life – and whether this would change in the new economic context that they were proposing – they stated that bills were unimportant to them and were paid almost unconsciously, never receiving or maintaining their attention:

Jim*:* *"Normally the customer will be confused what the best deal is for their condition […] and I just pay whatever it costs without looking to be honest, I even don't bother to read the bills."*

This contradiction suggests the interviewee arguably has a different relationship with and perception towards electricity in their professional and personal lives, and could perhaps be

interpreted as evidence for an underlying lack of faith in the ability of dynamic pricing tariffs to achieve their anticipated effect and ultimately influence decisions relating to electricity use in the home. Indeed, their stated unconscious payment of bills may simply reflect their financial situation (as a reasonably wealthy, middle-class professional), which would differ from someone living in energy poverty. Yet, even taking the relationship between conscious awareness of electricity bills and financial security into consideration, this contradiction still suggests that the interviewee does not necessarily have faith in the financial mechanisms for influencing electricity use that they are advocating elsewhere. Whilst this participant was the only interviewee to refer to their personal electricity use as an example of how dynamic pricing may not necessarily work, others also provided reasons why people's behaviour may not be influenced by financial incentives. Comfort was a recurring theme that was suggested to be a more important factor in decisions relating to energy use in the home than cost, particularly in the context of thermal comfort. Some argued that if people are too hot or cold in their house then they will simply continue to use electricity until they have created a more comfortable environment, therefore ignoring fluctuations in prices. However, others suggested that people may choose to turn their heating and/or air conditioning down at times of peak demand (or employ smart thermostats to automatically perform this role) to reduce costs. A critical reflection on these positions could also highlight the fact that participants did not appear to consider that some people may alternatively choose to do this because they feel it is 'the right thing to do' – a notion that resonates with the examples of voluntary changes in travel behaviour (*e.g.* Taylor and Ampt, 2003) and recycling (*e.g.* Halvorsen, 2012).

Liam: *"If they [householders] accept that there is a management product, a demand management product that will help them manage their demand then they may change their behaviour. They must be able for example with air conditioning to have it colder or warmer than expected."*

This lack of consensus towards the importance of comfort – and its perceived role in electricity use - within the expert sample is interesting. On the one hand, some participants suggest that this could be a fundamental aspect of non-negotiable demand, whilst others argue that it may be possible to influence people's requirements and expectations of comfort to a small extent. Indeed, de Dear and Brager (2002) suggest that people are able to tolerate wider temperature ranges than those recommended by health advisories. A recent Public Health England report (2014) suggested a minimum temperature of 18C be maintained, however Chappells and Shove (2005) found that people maintained their

homes at temperatures they perceived to be comfortable from as low as 6C and as high as 30C. Whilst expert participants were not suggesting temperature variations anywhere near as extreme as this range, it does perhaps suggest that there may be some scope to use thermostat adjustment to reduce electricity demand – particularly in the context of a future heating sector incorporating more electricity-based systems.

A final contentious issue relating to dynamic pricing involves 'fairness' and the perceived 'unfairness' of possible implications for people in fuel poverty who may be more vulnerable to fluctuations in prices. Interestingly, advocates of dynamic pricing did not mention energy poverty, and it was only brought up in discussions with experts who appeared to be unsupportive of this proposal. Fairness was viewed as a particularly important issue in relation to any policies involving changes to the financial context of using electricity. It was argued that if certain policies were perceived to be unfair then frustration or anger amongst the public may undermine efforts to affect change. In addition to raising concerns over dynamic pricing, one interviewee also predicted a future backlash over the solar PV feed-in-tariff. They suggested that people who could not afford to invest in the scheme may protest over the subsidies that are provided to investors, which would be partly funded through rising electricity bills. It is suggested that further research could be conducted (with both public and expert participants) to investigate the opinions, assumptions and concerns relating to this issue, as it could potentially become a very important (and politically sensitive) factor in any future change. The range of views on this topic and other proposals demonstrates the breadth of opinion, which was (perhaps naively) unanticipated by the author. It was expected that as the expert sample - whilst incorporating participants from a range of disciplines - was taken from one collaborative project working towards a common goal that there would have been more consensus upon key aspects of visions of the future. This range of experts' expectations will be reflected upon in the discussion.

This section has portrayed expert justifications for, and visions of, dynamic pricing being used to influence how electricity is used in the home. Manipulating the price of electricity to influence how and when people use electricity appeared to be a dominant, generally accepted vision amongst interviewees. However, some participants also highlighted concerns over whether the price could ever be increased sufficiently to provide a large enough incentive to alter people's behaviour. Indeed one proponent of dynamic pricing also appeared to contradict themselves by suggesting that the price they pay for electricity

is unimportant and does not influence their behaviour to the extent that they suggested they do not look at their bill. Debates over dynamic pricing and the role that it may play within the future electricity system will be discussed later in the thesis.

5.14 People's Positioning in Visions of Change: A Role for Social Science?

There were a range of different labels used by expert interviewees to describe members of the public who use electricity in the home. It could be argued that the terminology used positioned people in certain ways. Interestingly most experts from engineering or economics backgrounds referred to people as 'consumers' – suggesting that people were thought of primarily as actors who consume electricity. Others referred to 'customers' – perhaps indicating that people were considered to be purchasers of a valued commodity, whilst participants with social science backgrounds tended to call people 'users', perhaps emphasising that electricity is being 'used' to provide other services within people's lives. This aspect was considered when writing the thesis, and thought was given to ensure that the most appropriate label was provided for people within the context of the quotes and topics being discussed.

In addition to a range of labels and terminologies for end users of electricity in the home, there also appeared to be variations in how changes to the electricity system as a whole should be framed and researched. Indeed, some interviewees suggested that focusing on technical change is the priority as it is a more simple endeavour that can be more readily tested and manipulated:

Kevin: *"Trying to incorporate how people actually behave - consumer behaviour - you know, it's much more challenging to try to understand that and influence people than it is to just kind of you know, talk about a technology solution."*

Others argued that the electricity network is a socio-technical system, and that separating this into technical and social components is inappropriate and leads to 'constraints' being identified. One participant suggested that technology is always used (or not used) in ways that designers cannot foresee, and that as long as human users exist within a system then managing it is never straightforward. Instead it was argued that research should aim to consider a wider range of aspects relating to how possible technological change will influence (and be influenced by) users, and that this research should be undertaken further

'upstream' in the process to ensure that designed changes fit more readily within people's expectations.

Debates on the role for social science within engineering projects facilitated reflections from participants on the Top and Tail project and the academic research landscape more widely. Some suggested that social science does not currently have a large role within electrical engineering research, although this was perceived to be growing, particularly in the context of Top and Tail – which as an EPSRC Grand Challenge required some social science collaboration. Critics offered a sceptical opinion – suggesting that the inclusion of social scientists within the project was purely to 'tick boxes' and ensure that funding requirements were met. However, others suggested that there is a growing acceptance within the field that more insights from social researchers are needed to better inform technical projects:

Neil: *"The debates tend to start off in a technical way, or the discussion starts in a technical way. But I think it's, they're trying to catch up a lot now with the social aspects."*

Whilst participants appeared to view the growing role for social research within interdisciplinary engineering projects as a positive trend, some participants suggested that for future-oriented work (such as that being undertaken within the Top and Tail project) it is more difficult to find a role for social researchers as the technological change being researched is so uncertain and open-ended. This perhaps suggests that the role for social research was still perceived to be to investigate the public acceptability of plans for change (*e.g.* Rogers-Hayden and Pidgeon, 2007), as opposed to investigating social considerations that could be directly fed into plans further upstream. Indeed, one interviewee described the role of social scientists as persuading people to accept changes and use the technology being developed in the appropriate manner. It could also be argued that the different terminologies and languages being used within disciplines may perhaps be a root cause for some of the differences in opinions relating to the role of different disciplines in achieving the goals of collaborations. Attempting to consider aspects beyond narrower, normal disciplinary remits could help to bridge this gap and create a fruitful space for interdisciplinary collaboration[4]. For example in each expert interview, I, as the researcher,

[4] It is suggested that as more interdisciplinary projects are undertaken and researchers from different backgrounds collaborate more closely, that the perceived differences in the roles of different disciplines may change. Indeed, the researcher enjoyed having the opportunity to provide feedback on their experience of working within the Top and Tail research network in presentation at project meetings.

had to leave my comfort zone and area of expertise to attempt to delve into the intricate technical details of visions being discussed by participants. Similarly, the interviewees were also being asked to talk about a range of technical, political and social issues relating to future change and question their own ideas and assumptions of these.

This section has shown how many expert interviewees perceived focusing on technological change to be a priority as they felt that this is a more achievable, testable endeavour than more social or behavioural approaches. Despite this, others suggested that technology will always be used in unanticipated ways, and therefore intended end users of the technology (*i.e.* the public) should be included further 'upstream' in the innovation process to ensure that appropriate technological innovations are created. This topic will be revisited in Chapter 7.

5.15 Imagining Future Change

A finding common to both expert and public participants was that imagining and talking about future change is a difficult task (Shirani *et al.*, 2015). Interviewees suggested that the number of variables involved in imagining large scale social, political and technical change – which may be influenced by specific events – makes it difficult to predict the future with any conviction. One participant stated that as society evolves, societal values change, and as such what people deem acceptable may change over time. This was also framed as an economic argument, where the economic context can influence the whole way the electricity system is viewed and managed, which can make it difficult to predict what may or may not be economically viable or acceptable in the future. They argued that it is particularly difficult to base imaginations of future technology within an imagined future context, and difficult to consider possible developments outside of today's current social and economic context. Another participant reflected upon the past twenty years, which they argued have involved fundamental changes to society that have both been influenced by – and also directly influenced – technological changes. They posited that it may be difficult at our present place in time to say what will or will not be acceptable in 20 years' time, and therefore we should keep this consideration of society as an evolving dynamic in mind when planning future changes. Difficulties in imagining the social context within which visions of the future are borne was suggested to be particularly problematic for future-oriented projects such as Top and Tail – which is working towards 2050. It was

suggested that dismissing or over/under-estimating developments could have large implications for the validity of visions:

Liam: *"It's one of our problems of doing long term work, people really struggle to see the context. If you did IT research thirty years ago, no one had a computer in their house, right? And the internet didn't exist, so if you were doing IT research then you'd have said 'well, nobody's gonna spend £40 a month on a telephone, what a ridiculous idea! No one's gonna spend 200 quid on a handset, it's ridiculous.' So, it's very easy to make mistakes like that."*

Social trends were referenced when participants discussed their expectations of how society may change in the future. For example one interviewee predicted that society will become increasingly urbanised, continuing the trend of greater proportions of the UK population living within towns and cities. They argued that living in rural areas would become too expensive due to insurmountable costs of supplying these areas with sufficient energy and spiralling fuel costs impacting the price of commuting. This societal change was suggested to have profound implications for public services including the electricity system, however, these were not discussed at length. Others referred to the emergence of new electricity demand through evolving societal expectations of what is necessary and desirable. For example, the US has traditionally had high demand for air conditioning units, whereas historically the UK demand has been much lower. However, in recent years there was perceived to have been a big increase, which has created a new summer peak demand. It was suggested that changes like this are difficult to foresee and build into visions of future electricity system change. This consideration was also suggested to be an important reason as to why changes to the system should attempt to be 'future-proofed' to be able to handle unexpected or emerging demands – particularly in relation to electric vehicles and heating systems - whilst it is also important to try to predict the impact of these new demands.

An interesting dynamic was identified in both expert and public interviews, where participants had a preoccupation with discussing electricity generation and supply (as opposed to electricity use and demand). This mirrors Kurz *et al.*'s (2005) finding of interviewees focusing on choices relating to aspects of energy generation, rather than on the consumption of energy itself as a resource or commodity. Indeed, when prompted to answer certain questions specifically in relation to using electricity, invariably participants eventually ended up discussing generation. This may have implications for how people think about the electricity system as a whole, which may influence people's visions for change. It could be argued that if more attention is paid to generation – at the expense of

demand – then perhaps this will play a more central role in visions of the future, arguably reducing the perceived need for change to the way electricity is used in the home. This also raises questions – why is more attention paid to generation? Does public debate and media coverage around electricity generation make this a more salient, relatable topic for consideration? Or could it be that people are unwilling to or find it too difficult to talk about the link between their lifestyles and the electricity they use? It is suggested that this pre-occupation with focusing on electricity generation could perhaps explain why social aspects of potential change were marginalised in experts' discourse.

Some participants appeared to be optimistic that existing policies and legislation would ensure that decarbonisation targets would be met, and that government support for new technologies (particularly in relation to renewable generation technologies) was 'set in stone', thereby ensuring their development and application. However, one participant's optimism was tempered with the acknowledgement that future changes have to build upon and be integrated into existing network infrastructure. They argued that any change would be constrained by the historical legacy of how the electricity system was designed and adapted in the past. It was suggested that visions have to simultaneously meet perceived future needs, whilst being readily attainable in relation to achieving a transition towards this vision without risking negative social, political or technical impacts during the period of change. Within this idea, it was suggested that different stakeholders will have varying visions of what is important for future change, which impacts real-world action today. Different priorities were described to have evolved to help meet the different perceived future societal needs and technical requirements of electricity systems. Indeed, it was argued that even 'buzzword' terms such as 'smart grids' incorporate different elements depending on who is defining and imagining them:

Bob: *"Even the concept of Smart Grids, different people have different ideas, there's no agreed worldwide concept of a Smart Grid. Different countries based on their needs, they will give Smart Grids a different definition. The US has one from their department of energy, and the European Commission has one, and China has its own concept. For example China has focused on a strong and smart grid. They have a lot of focus on the transmission level – ultra high voltage. But for the US and the European countries it's mainly focused on the distribution now, so the focus is quite different."*

For example China was argued to be attempting to 'strengthen' its existing system to ensure a more secure supply that would support increasing industrial and domestic demand, whereas the UK priority was perceived to be more focused on developing a more

'intelligent' system with more aspects that can be controlled by system operators to support more renewable generation to help meet decarbonisation targets, whilst reducing capital costs by making the most out of existing infrastructure and limiting the need to invest in expensive new plant. For this reason, it was argued by some that visions of a European-wide supergrid may be problematic as different national priorities could create conflict or disagreement over how to manage and integrate a system that can meet the different prioritised national needs. Interestingly, participants drew comparisons between Germany and the UK, suggesting that both systems had similar levels of reliability that helped to support comparable societies with similar electricity-related characteristics. However, it was suggested that national priorities may differ in the context of climate change and other political risks, which may lead to fundamental differences developing between the two electricity systems. For example, DECC's vision of electrification (*e.g.* of the domestic heating sector (2012c; 2013)) was suggested to contrast strongly with Germany's vision of reducing electricity demand, with one participant speculating that recent post-Fukushima Daiichi nuclear policy changes (Wittneben, 2012) may reduce the role for electricity in Germany's energy mix and counter the trend of electrification. The implications of different visions and perceived priorities for change will be discussed in Chapter 7.

This section has portrayed ways in which expert interviewees talked about imagined future change. A recurring theme involved the assertion that imagining future change is difficult, particularly as the social and economic context was perceived to be complex and difficult to predict. For this reason, some suggested that changes need to be future-proofed to ensure that the electricity system can keep pace with evolving societal expectations of desirability and necessity relating to electricity demand. A finding found amongst expert and public interviewees was the apparent preference for participants to talk and speculate about future changes to the supply side of the electricity system, as opposed to demand. This perhaps suggests that talking about possible changes in demand is a more complex task. Evidence was also found for different definitions of technologies – which can perhaps be interpreted from a sociotechnical imaginaries perspective. Indeed, 'smart grids' – a buzz-word topic in contemporary electricity system research – were suggested to be imagined in a UK context as an intelligent, controllable system., whilst in China visions are more focused on creating a stronger, more secure smart grid system. Findings discussed in this section will be revisited in Chapters 6 and 7.

5.16 Chapter Summary and Discussion

This chapter aimed to present a range of insights that portray expert understandings of domestic electricity use and their expectations for future changes to the electricity system. Visions, hopes, concerns and contradictions have also been highlighted, along with a discussion of possible implications of these findings. In this section key findings from this chapter that help to answer research questions 2) and 3) are re-visited, summarised and further discussed:

2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?

Experts often referred to decarbonisation and energy security, with the former commonly suggested as the most important reason for the need for change to the UK electricity system. However, less importance appeared to be given to the affordability and cost of electricity, which makes up the third strand of the oft-referred to 'energy trilemma' (Poudineh and Jamasb, 2012). This could suggest that decarbonisation and energy security are more directly relevant to the technical focus of many experts' areas of expertise (although the expert sample also included sociologists and economists whose expertise was not so closely linked to engineering and technological approaches). Additionally, it could be suggested that the apparent lack of importance placed on energy affordability may simply be a reflection of the makeup of the expert sample, as academics are perhaps likely to be reasonably wealthy, middle-class members of society, who may have little immediate experience of energy poverty. This reflection is also relevant to the interpretation of findings from public focus groups and interviews, which could perhaps suggest a greater understanding of energy poverty (and related considerations and implications for possible system changes) could have been obtained had the sample been more representative across wider society.

In addition to views towards the relative importance of various reasons for the need for change, a range of differing definitions of specific technologies that may play a key role in future change was identified. For example, some suggested that smart meters – and indeed smart grids – may be defined differently depending on the context and imagined visions of future electricity systems (*i.e.* varying national imaginaries of smart grids). This resonates

with Jasanoff and Kim's (2009) analysis of differing roles for nuclear power in achieving national future visions, and suggests that as smart meters and the concept(s) of smart grids are an emerging and developing field, that different approaches prioritise different aspects of these technologies. As such, it could be argued that this creates a complex, muddled discourse surrounding these technologies, which may impact upon how the public understand and perceive them – which perhaps helps to explain why some focus group and follow-up interviewees expressed a lack of awareness as to what smart meters are and the role that they may perform. As a technology that was identified by experts as having a key role in any potential change – and one that is mandated to be rolled out in the UK – this could have important implications relating to their acceptance and adoption by public users of electricity.

Contradictions were identified in some expert interviews that suggested various mechanisms for change should be adopted, only to then highlight potential limitations and barriers to how these mechanisms may or may not be successful or appropriate. These apparent contradictions may be interpreted in a number of ways. It could be said that contradictions are a normal part of people's understandings of and relationships with aspects such as energy, and that people cannot be expected to be consistent across all their views and behaviours (for example many climate researchers have higher carbon footprints than average citizens; Stohl, 2008). Responses could also be interpreted as a portrayal of how expert interviewees may have different identities which reflect how they relate to electricity. For example some participants could be said to have had their 'professional' hats on when referring to and discussing possible changes to the wider electricity system, but then when reflecting on how these may affect the way they themselves use electricity in the home (i.e. with their 'personal', user hat on) some provided responses that undermined or contradicted their 'professional' suggestions. This could arguably indicate a perceived lack of faith in the potential plans for change being researched and discussed within academia and their wider professional lives, or maybe just reflects that people have complicated, inconsistent understandings of a range of aspects within their lives. For example, one participant discussed in detail how they felt that dynamic pricing would provide a strong financial incentive to make people use (and importantly not use) electricity at specific times to help system operators maintain supply and demand (*i.e.* coinciding household demand peaks with times of sufficient supply). Yet, when asked about how they themselves used electricity in their everyday life – and whether this would change in the new economic context that they were proposing – they stated that bills were unimportant to them and

were paid almost unconsciously, never receiving or maintaining their attention. Whilst there could be a number of possible explanations for why contradictions such as this were identified, it is nevertheless an interesting finding with potential policy and research implications. As such, it is suggested that further research be undertaken to attempt to identify, and more importantly understand and explain, contradictions in the visions of various stakeholders (*e.g.* engineers, designers, policy makers and members of the public *etc.*).

Whilst the expert interviews highlighted a range of responses toward certain topics, other discussion points suggested a more consensual view. Indeed, there appeared to be unanimous agreement that renewable energy technologies were expected to take on an increasing role within the UK electricity system in the future. As such, participants discussed how supply will become less guaranteed and will fluctuate more than the current system, which can more readily respond to changes in demand by relying upon the ability of coal or gas fired power stations to increase or decrease their output. For this reason, to ensure that balance between supply and demand is maintained within the future electricity system, expert interviewees expressed that electricity demand will have to become more flexible and readily managed. This was also accompanied in many interviews with the acknowledgement that this will involve significant change for individuals and households and many interviewees accepted that this will be very difficult to achieve. Nevertheless, there were two suggested mechanisms that were discussed as possible ways of achieving the necessary desired changes. The first, more commonly suggested mechanism, involved the automation of demand within the home to enable some demand to be externally controlled, thereby achieving increased flexibility when required. The second involved visions of increasingly engaged users actively participating in planning and scheduling their demand (both these visions are described in more detail earlier in this chapter, and for brevity descriptions will not be repeated in this section). Various assumptions were identified within interviewees' descriptions of these visions. These assumptions – and their implications – are discussed below.

Whilst describing visions of automation of demand within the home, some interviewees argued that taking control away from individuals is the most appropriate and manageable solution as it would enable system operators to potentially have more confidence in predicting and managing demand, thus aiding the balancing act between demand and supply. One participant went further, suggesting that they felt people cannot be trusted to

use electricity in the most appropriate, useful ways for system operators, and that this necessitates responsibility and control being taken away from individuals through the use of automation. However, many advocates of automation provided little reflection on the need for automation to be accepted by residents. Inevitably with any technological change such as the introduction of home automation there needs to be some level of interaction and acceptance from users to allow it in their homes and to 'opt-in' and adopt the technology (as well as the opportunities and constraints it provides). However, this appeared to be dismissed or not considered as a significant challenge or consideration, with one of the main beneficial aspects of automation seemingly positioned as relying on a lack of user engagement compared to alternative visions of change. Additionally, it was suggested that providing an 'override' function would enable users to re-take control of demand when desired, which would further reduce any public concerns about the technology. It could perhaps be argued that if some level of acceptance is needed anyway, then why not focus on attempting to make changes more inclusive and more likely for people to want to participate – by encouraging participation and designing changes that meet people's hopes and accommodate for concerns? Furthermore, both expert and public participants referred to a willingness for themselves and other individuals to participate in change, and as such felt that focusing on the domestic sector was a worthwhile endeavour that would enable people to engage in developments that would ultimately impact the way they would use electricity in their own homes. Yet technical solutions that aimed to circumvent the need for engagement on behalf of individuals were advocated by both public and expert interviewees when asked how they felt that change should be achieved. This perhaps suggests that approaches that take control away from people are simultaneously viewed as less desirable than other visions involving increased responsibility and engagement for individuals, but also more likely to be successful in achieving greater flexibility within domestic electricity demand.

Dynamic pricing was discussed as a mechanism that could be used in conjunction with signals on smart meters to influence when people use electricity in the home. This appeared to be particularly central to some visions involving increased participation from users who would be responsible for planning their electricity use more carefully and responding to price signals that reflected the availability of electricity supply. However, findings from focus groups suggest that more important factors that influence behaviour in the home may undermine attempts to steer electricity demand using this approach. A significant

potential barrier was also identified by some interviewees who argued that the price of electricity could never realistically (or acceptably) be altered to such an extent as to provide sufficient incentives or disincentives to influence decision making. However, whilst the majority of evidence obtained suggests that electricity users are not influenced by the motivation to maximise financial gain, findings from participants with solar PV highlight that in some cases people will change their behaviour and develop new routines of how and when they use electricity in the home to save money. This perhaps suggests that, whilst there are myriad factors that may undermine any attempted approaches, within specific contexts dynamic pricing may have the potential to achieve change. This has implications for policy makers and the design and role of smart meters, as they would have to be sufficiently 'smart' enough to enable two-way communication and provide real-time price information for users to engage with.

In addition to assumptions of behaviour relating to expectations of what could be termed as economically-rational action, some responses in expert interviews highlighted the expectation that people will be willing and able to change how and when they use electricity if they are fully informed of and understand the need for change. Indeed, many expert participants suggested that educating the public on the need for change and ensuring people were informed about possible changes would ensure public acceptance of any subsequent technological and policy interventions. However, findings from the public focus groups identified a range of important dynamics and factors that influence how people use electricity in the home, suggesting that merely providing people with information will not necessarily result in anticipated changes. It could perhaps be argued that employing alternative forms of communication such as the use of narratives or deliberative methods may be a more appropriate way of engaging people than more limited one-way, didactic forms of information provision (*e.g.* Wynne, 1991; Macnaghten, 2010; Grinbaum and Groves, 2012). Furthermore, Parkhill *et al.* (2012) suggest that engagement undertaken with the aim of persuading people (following the 'Decide, Educate, Announce and Defend' structure; Hartz-Karp, 2007) is likely to fail in achieving its aims, or even exacerbate the potential controversy that the engagement is aiming to avoid (Jasanoff, 2003). As such, dialogue between publics, experts and policy makers should involve two-way communication and begin with broad questions that present a wide range of possible sociotechnical changes, as opposed to being narrowly constrained as a result of this engagement being conducted after major decisions have been made (Sykes and

Macnaghten, 2012). Drawing upon this literature, it could be suggested that the majority of expert participants' expectations of aiming to raise awareness to influence behaviour is not necessarily supported by the wider literature. This could potentially have implications for strategies for achieving change, as communication about the need and mechanisms for change needs to be successful for people to accept and adopt possible technological innovations that will impact upon how they are able to use electricity in the home.

In addition to identifying assumptions on public engagement and the provision of information, a related theme involved the perceived role for social sciences in sociotechnical (or perhaps in this context simply technical) change. Arguably some experts – despite many being receptive to the need for understanding how and why people use and relate to energy in the home – perceived the role of social science to be to 'get the public on board' with and accepting of technological change, rather than incorporating their hopes and concerns into designs of possible interventions and solutions. This may perhaps help to explain why some primarily advocated technological solutions , because they approach their research from a technological position. As such, social or behavioural considerations are seemingly marginalised until late in the research process, and when these are considered the focus appears to be on persuading the public to accept change. Stirling (2007) argues that engagement should not be undertaken to legitimise technological choices, but should instead be undertaken further 'upstream' (*e.g.* Rogers-Hayden and Pidgeon, 2007). Indeed, Sykes and Macnaghten (2012) state that approaches to sociotechnical innovations should involve increasingly upstream engagement to facilitate the start of a new form of relationship with the public. A (critical) interpretation of these findings could suggest that participants' expectations of how change should be achieved do not necessarily tally with the ways in which Stirling and other scholars argue innovation and engagement processes should be undertaken. This is a particularly interesting finding as it could suggest that the scholarly 'ideal' scenario of visions adopting increasingly upstream engagement are perhaps somewhat discordant with expert participants' understandings and experiences of current practice, and their visions of future change. This forms a central argument of the thesis and will be re-examined in Chapter 7.

6 Empirical Findings 3 – Imagining and Responding to Change: Public Visions of Possible Change to Electricity in the Home

This chapter aims to present and interpret public understandings of electricity systems and how electricity is used in the home, with a particular focus on expectations of how this may change in the future. The rationale for the structure of this chapter – and how it fits within the wider thesis - is based on building upon the findings discussed in Chapters 4 and 5, to focus on future-oriented aspects of imagined futures and the acceptability of possible future change. Responses to materials outlining possible future change (developed as an outcome of the public focus groups and expert interviews) are also covered, which helped to delve more deeply into the perceptions and views towards specific possible changes. Continuing the grounded process (see Chapter 3) adopted throughout the thesis, these findings build upon those presented in Chapters 4 and 5 to include a discussion of various concerns, assumptions and contradictions identified within interviewees' responses, along with a reflection on the impacts these may have for future research and policy design. As such, the findings presented in this chapter primarily help to answer research questions 2), 3) and 4):

2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

As with Chapters 4 and 5, comparing between participants (both public and expert) was not a central aim of this chapter. However, where appropriate and analytically interesting, these comparisons have been highlighted and discussed to demonstrate the variation and breadth of responses.

6.1 Talking About Energy and Cost – An Intrinsic Mental Connection?

Discussions on how people think about energy emerged in interviews, with participants reflecting upon themes from the focus groups. Some suggested that most people do not link wider energy and societal issues with the electricity that they themselves use, and that these wider debates are not seen to have any direct relevance to their everyday lives. Indeed, this was extended by one participant who argued that people do not link their everyday lives to the 'bigger picture' and societal issues and challenges:

William, 53: *"People don't necessarily link their own life to the bigger picture. When you see ministers arguing in parliament, what they actually say has got very little to do with them. A lot of people don't listen to the budget for instance, even though it does actually affect them in some way. So they're quite happy to go on with their own little lives – I don't mean that in a demeaning way - but they're in their own little bubble and do what they like, and they pay their bills and they're quite happy, without actually seeing the bigger picture."*

A recurring theme across the public focus groups and interviews involved the way people referred to electricity – and energy more widely. Many people referred to energy in monetary terms, and said that the only times they generally discuss energy in everyday life are in cost terms including moaning about bills and energy price rises. Indeed, energy was perceived as quite a dull 'thing', and is often associated with negative things, such as receiving bills. Furthermore, it was suggested that it is only when something goes wrong (such as in a power cut) that it takes on more prominence, mirroring findings from the focus groups:

Kirsty, 20: *"Talking about energy is not the most interesting thing, when you're just talking about usage it's quite a dull thing. […] I mean the only times we talk about energy at the moment it's about 'oh god our British Gas has gone up or our bills have gone up' and I associate energy with money and particularly with losing money, so it's not kind of a happy topic. I think money, bills and energy are inextricably linked."*

A further dynamic that was identified in the way people talked about electricity, energy and cost was that people often referred to 'costs' or 'bills' when reflecting on more longer-term change (such as making decisions on investing in the home or energy-efficiency measures) or when referring to specific time periods (such as a quarterly energy bill). Yet when talking about more immediate decisions that are undertaken in daily life (such as turning on the heating or using an appliance), they suggested that (with the exception of people living in

energy poverty) cost does not come into decisions so readily, as there are more important factors or immediate needs that have a stronger influence:

Erica, 27: *"Over our lifetime money is a big thing. You measure your progress with how much money you've got and what you can spend that on, and it marks out your options in life. […] But then on a short term scale, everything you do is not based on money, it's based on what you want right now, on a minute by minute basis. It's not exactly about pleasure, but it's fulfilling everything that you want at that moment, whatever it is, whereas on a long term basis everything is a bit more planned, and I think that's why people think about money and cost together."*

This could perhaps be considered a contradiction, as in some contexts participants will refer to and think about energy in cost terms, yet in others, considerations of cost will not factor into conscious decision making. Indeed, scholars such as Shove and Walker (2014), Strengers (2012) and Southerton *et al.* (2004) to name but a few, argue that energy users in the home perform interconnected practices that rely upon energy to meet immediate needs and conduct everyday routines. As such, the underlying energy use associated with these practices is less salient and visible, which may explain why participants suggested that cost does not come into decision making at the immediate point of performing certain tasks or practices in the home. However, this does not directly help to explain why some participants felt that cost is still an important factor in longer-term decision making. Indeed, there appears to be little or no existing literature on this contradiction between short-term and long-term considerations of cost in energy-related decision making. It could perhaps be argued that as longer-term, 'bigger' decisions are further removed from immediate, everyday decisions, considerations over the anticipated costs and benefits of change may more directly influence their planning. The way people think – or indeed do not think – about energy use in the home is likely to have direct implications for policy makers, and as such it is suggested that this aspect of energy/cost considerations varying over different timescales be further researched to help to better understand and explain this dynamic.

Despite the dynamics and contradictions in relation to the role of cost in considering immediate and long-term decisions, conversations about electricity were routinely framed by participants as a financial discussion, and – even when prompted to not talk about money – many conversations eventually ended up focusing on cost. Whilst this was anticipated to some extent, the degree of focus on cost by many participants was unexpected and prompted further investigation in subsequent interviews. With the aim of

understanding this dynamic, participants were asked why they felt money and cost were often used interchangeably for energy in debates over electricity use. Lorraine (below) suggested this may be because media coverage and advertisements relating to energy are often framed within a financial context, which creates this association between energy and cost:

Lorraine, 68: *"The price of energy is in the media so much, so I think it's being kept in the public domain, and we're constantly being told these energy companies are greedy, they're making so many profits et cetera et cetera. I think people feel that they're paying over the odds for their power, so when somebody asks that question I think you automatically, because we've been almost brainwashed – it's constantly a focus in the media –so that's why I think people say money."*

Additionally, it was suggested by some that cost is the go-to, default response when asking people about possible change. This was argued to not necessarily be due to cost actually being the most important factor in decisions over change, but because other concerns or barriers that need to be overcome make that decision difficult. It was suggested that by saying that the cost of something is prohibitive, other more complex considerations and arguments can be avoided, even if cost is actually not the main issue. Indeed, this echoes conclusions of a report by OXERA (2006) that found that homeowners felt potential savings had minimal influence on deciding whether to install insulation or energy-efficient appliances in their homes. Ben's quote (below) demonstrates the range of considerations (on top of cost) that may influence decisions on investing in energy efficiency measures in the home, and could be interpreted as evidence for the need to provide information, policy support and other mechanisms that can perhaps help people to overcome their concerns and thus make making changes appear to be a less complex and stressful endeavour:

Researcher: *"And is that why people still say cost when you're asking them?*

Ben, 23: *Yeah, and because you're asking them a big question. Like if you wanted to put in energy efficiency measures in your home it costs lots of money and takes lots of time, and they have to find a reputable builder and they have to trust them to come into their home, and they have to move all their furniture around and undo their lofts to put the insulation in, and then they have to find somewhere to put all their stuff and it takes three weeks and then it all goes wrong and they hate the builders and they have to go to the ombudsman, and it's like a big long-term drama. These kind of things - as much as people will go 'oh it's just loft insulation, it's really quick and easy' - it's actually not that quick and easy. And I think that's why people just go 'oh it's too expensive'."*

This fixation on cost could also perhaps be explained by considering Simcock *et al.*'s (2014) suggestion that referring to energy in monetary terms enables people to more readily

contextualise information and 'anchor' their energy use in relation to 'frames of reference' within their own lives. Indeed, this finding of people referring to energy in monetary terms could be interpreted as evidence of the need for communication and information about electricity use (*e.g.* energy feedback and policy communication) to focus on financial aspects. However, others (*e.g.* Crompton, 2010; Dobson, 2011; Simcock *et al.*, 2014) also highlight that focusing on money – and in particular saving money – may ultimately result in limited, short-lived outcomes from attempting to encourage people to lead more sustainable lifestyles, including reducing their electricity use within the home.

This section has presented ways in which public interviewees talked about the relationship between energy and cost. A key finding centres on the way that interviewees appeared to routinely refer to energy in cost terms, regardless of whether questions or prompts had involved a financial framing. Participants also identified differences between one-off, long-term decisions – which were suggested to be subject to financial consideration – and shorter-term, everyday decisions which were suggested to be subject to prioritising more immediate needs. This will be discussed – in the context of literature on habitual behaviour – in Chapter 7.

6.2 Moving Beyond Money – Decision Making, Financial Considerations and Comfort

Particularly in the context of immediate, everyday decisions, comfort was suggested to be more important than cost, although it was acknowledged by some that this may not be the case if they were not able to afford to pay their electricity bills. This mirrors Chatterton's (2011) assertion that expense may be perceived to be worthwhile if someone's comfort needs are met and maintained:

Christina, 64: *"For me comfort is the big thing, and although yeah the money is important, comfort comes above money. We're lucky to be in the situation where we can afford to heat the house properly, and it's an old house so it takes more heating. If we were really struggling it might be different – I mean don't get me wrong we're living on a fixed income – but there is enough there to heat the house well."*

Furthermore, some participants referred to the perception that comfort preferences and practices have changed over time (Brager and De Dear, 2003). One retired participant referred to memories of their parents' concern over ensuring that when they were children they were not too cold at night, but that now it appeared to be that parents were more

worried about their children overheating – possibly reflecting the perception (and measured trend (*e.g.* Palmer and Cooper, 2011)) that background temperatures in houses are higher today. Whilst again this may not be directly relevant to their current electricity demand, if domestic heating in the future were to become electrified, this would have implications for how their demand would be influenced by their comfort requirements and heating practices.

Other responses that highlighted the perceived importance of comfort included one participant – living in rented accommodation – who moved to a more energy-efficient property so that they could afford to maintain a higher temperature in their home. This, they argued, was a big decision involving significant lifestyle change, and one which the participant said was strongly influenced by the desire to live in a more comfortable, warm house. This demonstrates the importance of this factor in decision making – which has possible implications for any perceived changes to domestic electricity and energy provision, as people would need to feel that their comfort needs would be met within the context of any changes (Parkhill *et al.*, 2013). One mother who had an infant child also reflected upon the way they had changed how they heated the house, as they felt their child required a higher ambient temperature (Healy and Clinch, 2002) and that they needed to keep their child's bedroom temperature as constant as possible. She also stated that occasionally if she felt cold she would use 'the baby needs to be kept warm' as a bargaining chip in negotiations over when to put the heating on. This mirrors findings identified in the focus groups that highlighted the different preferences and comfort needs that people have, and how household discussions and other dynamics influence the domestic energy use associated with heating the home.

This section has built on Phase 1 findings presented in Chapter 4, and has portrayed how public interviewees referred to cost as an important factor in decision-making, whilst also suggesting that comfort needs are more important and as such will be prioritised. This perhaps suggests that for any changes – such as visions involving dynamic pricing – to be successfully embraced people's comfort needs will need to be fulfilled and maintained.

6.3 Convenience, Control and Privacy Invasions: Visions of Automation of Demand in the Home

This section outlines public responses and opinions towards the idea of some domestic electricity demand becoming automated in the future. A range of views on automation was identified. Positive and negative opinions towards automation were presented by participants, with some of these optimistic visions and concerns reflecting those identified in the expert interviews. Other unanticipated responses were also obtained, and are discussed below.

There appeared to be a feeling amongst some interviewees that people would reject a smart meter or other 'black box'-type unit that would be at the centre of an automated home system as it may be perceived to be another way in which the government could peer into their lives – although this was also suggested to be a concern that would not necessarily be held by everyone. Indeed, one participant had particularly strong views on automation, and smart technology more generally, because they felt it was invasive (Cuijpers and Koops, 2012), and reduced people's control, while increasing the perceived power of energy companies and other system operators who have access to the data. This echoes other research on perceptions of smart meters (*e.g.* Stragier, Hauttekeete, and Marez, 2010; Paetz, Duetschke and Fichtner, 2012) and was accompanied by concerns over data security and privacy (*e.g.* Brown, 2014; Paverd, Martin and Brown, 2014), as well as how personal consumption data may be used:

Researcher: *"How do you feel about this idea of automation?*

Josie, 25: *I don't like it, but I don't think I like smart technology generally, I think it's invasive.*

Researcher: *Why?*

Josie, 25: *It's to do with control and power. I think energy companies have enough power over everybody already, they're already buried into government getting what they want there, and they're putting everyone's bills up and making everyone miserable, and in the end what's going to happen with all the data? It's just getting more and more electronic data on everybody. I can't really predict what would be the problem, but it just puts me at unease if you see what I mean."*

There appeared to be a feeling that people should have the freedom to do what they want to do in their own home, and the idea of automation and third parties potentially controlling demand within the home was perceived to threaten this notion. This was contrasted with the example of the workplace, where it was argued that people may be

more likely to accept different arrangements as part of the context of the job, and that this is not such an imposition as upon the more personal context of home. This finding could be interpreted to suggest that policies should also target workplaces, as people may perhaps be more willing to accept automation outside of the home and in their work context, where they may be expected to follow employer's regulations. In their exploration into employee energy-conservation behaviours in the workplace Scherbaum, Popovich and Finlinson (2008) suggest that instead of focusing on individuals and the factors influencing their behaviour – which they argue would enable potential long-term impact (Siero *et al.*, 1996) and organisation-wide interventions (McKenzie-Mohr, 2000) to be developed – organisations have instead prioritised structural and operational changes to decrease their energy use. This has been suggested to be a barrier to achieving more significant change that may otherwise be possible through influencing employees' behaviour However, considerations including – but not limited to - employees prioritising work efficiency over energy conservation (Lo, Peters and Kok, 2012) and having a lack of direct financial incentives to reduce energy use (Carrico and Riemer, 2011), would likely impact any potential interventions, and how automation may actually be applied to a 'work' context remains unclear and is outside the remit of this thesis.

Richard, 20: *"I don't know how they would implement it [automation]. I personally feel it's playing a very dangerous game. I don't know if people would like [other] people controlling what they have in their homes. That may ultimately be the only way you can kind of control that with a varying supply.*

Researcher: *What are you uneasy about?*

Richard: *I don't know really, I just don't like the thought of not having full control of things in my home. If it's in the workplace ultimately you're working for someone so if they accept it then you have to accept it as well, but I think in your own home it's kind of your opinion and what you want."*

Some participants argued that automation would only work to a small extent, as a lot of people's domestic demand is still heavily influenced and constrained by their routines. It could be argued that demand is a social phenomenon brought about by societal structures, therefore solutions that aim to influence the way people's lives are structured may be more effective ways to influence demand profiles. Indeed, one participant (Judy, below) suggested that more flexible working hours (or home working) should be encouraged by policies to influence employers' requirements for how and when people are at work, which

may have significant impacts on energy consumption (Ott, Slavin and Ward, 1980) and scope for increasing the flexibility of when people perform certain tasks within the home:

Judy, 43: *"Demand is pretty much driven by people's lifestyles, so if everybody is in work in an average 9 to 5 Monday to Friday working capacity then the demand is going to be before everybody goes to work and when they come home from work, there's not a lot that people can do to shift. Also I think the recession was the worst thing to happen for flexible working in this country because employers – including my own – that were flexible are not anymore, and the biggest pull back on flexible working is government driven."*

Some participants stated that they wanted lifestyles within the home to become more simple in the future. For this reason they suggested that they did not like the idea of automation as it was perceived to be more complicated than the current situation (although visions involving more active participation for individuals could perhaps be argued to be even more complicated). One participant also felt that automating some demand within the home would not be feasible or worthwhile, arguing that demand should either be left completely un-automated – thereby enabling people to maintain control – or become completely automated, effectively creating a 'smart home', which they suggested would never become reality as they felt no technological system could ever be sufficiently smart to manage and 'run' a home. They argued that for this reason people would still ultimately have to manage and organise the majority of their demand, which therefore made efforts to automate domestic electricity demand futile.

A recurring reflection on automation involved the concern that it would make people lazy as they would have to do less themselves. This resonated with aspirational visions of easy living (discussed later in this chapter), which were said to be promoted in 'selling' new technologies by highlighting the lack of effort required to use them. Some even suggested that this trend of automation should be discouraged as it may contribute to a less active society that increasingly has difficult tasks performed by technologies. This finding was unanticipated, and raises questions as to whether or not this concern is directly related to the automation of domestic electricity demand, or whether responses may be more a reflection of the way questions were presented or framed. For example, it could perhaps be argued that participants were potentially responding to the word 'automatic', as opposed to the actual vision of some demand within the home being automated, as the use of a remote television controller (discussed by Sue, below) is arguably entirely unrelated to the wider discussion on electricity demand. Alternatively, Brush *et al.* (2011) found that homeowners living in properties with home automation expressed guilt about certain 'lazy' aspects of

their lifestyles, however this was outweighed by their enjoyment of the convenience provided by the system. For this reason it could be argued that communications about future change involving automation should consider the possible unintended ways in which specific words or phrases may be interpreted:

> *[In response to video clip of walkthrough of a possible future home, followed by a prompted question on automation]*

Sue, 53: *"That video appeals to people who want things to become automated and complicated. It's back to, if you never have to get off the sofa to turn on the television everyone is going to be 25 stone because they never take any exercise. Yes, it's very convenient to have a remote control for your television, but actually you could just go and turn it off couldn't you, and it's encouraging people to take less and less exercise and spend more time sat down. So I don't think the way forward is to make things more and more automated, but the industry is probably thinking they can make lots of money out of it."*

There also appeared to be some scepticism over why automation is being considered and advocated, with some suggesting that the drive for automation is to help sell 'smart' technologies as opposed to helping reduce or shift demand. This could perhaps also be influenced by the apparent lack of understanding and importance placed on the need to both reduce domestic demand and make it more flexible (as opposed to assuming that simply producing more electricity to meet demand will be sufficient). Some interviewees, however, were more receptive to the need for and positive about the idea of automation. Indeed, one participant suggested that it may be the only way to achieve change as they felt that people do not take responsibility for change, and by taking this responsibility and control away from them then change can actually be ensured, mirroring the stance of some expert interviewees who had advocated automation:

Holly, 29: *"I don't think people take enough responsibility for what they do, so taking the responsibility away from them – if it's going to benefit this country, the world and so forth – well that's the way it's got to go I think, because people won't take the action."*

Some saw automation as a positive development as it was perceived to be easier – requiring less effort and conscious awareness – than other visions that would involve more engagement from individuals. Indeed, some participants stated that as long as agreed limits and boundaries on control could be ensured then they did not perceive automation to be unattractive or controversial, mirroring findings from expert interviews and Parkhill *et al.*'s (2013) investigation into public values and attitudes towards possible change to the UK's energy system.

Views on automation often appeared to hinge on what specific technology or technologies they were imagining becoming automated. For example, when imagining and discussing washing machines many participants appeared to be optimistic that automation could be applied without a negative impact or inconvenience to people's routines, providing that the washing was completed by a set, desired time. However, when referring to some aspects of domestic demand such as heating and cooking, participants often discussed the possible application of automation as a potential constraint and limit to freedom. This was expected and fits findings from the public focus groups on comfort and leisure-related electricity demand. Indeed, the overall theme in relation to this finding could be summarised as 'I am open to the idea of automation being applied to some technology in my home, however, this would need to be limited to technologies and appliances that can be turned on or off without having a significant impact on how and when I want to use them.'

Whilst concerns over data security were a recurring theme in many discussions on automation, some participants did not appear to have the same misgivings. In fact, one participant argued that data on a large range of aspects of modern lifestyles are available to third parties, and that having data about their domestic energy use in a future 'smart' grid was not deemed to be concerning, and that this was just perceived to be a natural progression or continuation of the trend of increased data gathering and sharing:

Christina, 64: *"I think people are, the fact that they say 'I don't want a national identity card' well you know, what planet are you on? That's that! [gestures to smartphone] You know, everything I have is in there. I have a national insurance number, I have a credit card, so if you use those, and most people seem to, then what's the difference?"*

Another recurring theme centred on the concept of change itself. It was suggested that people will initially be sceptical and resistant towards any significant change, irrespective of what the change may be. However, some argued that people will get used to change over time, and so may accept automation of some domestic demand after it is established in place, even if there may be high levels of opposition beforehand. Others suggested that whilst some may adapt to change over time, other people will simply avoid or side-step any changes imposed, which may have important implications for the roll-out of smart technologies and/or the introduction of automation or other technology and policy interventions. People referred to the recent compulsory phasing out of incandescent light bulbs (Waide, 2010) and gradual replacement with new energy-efficient alternatives

(achieved by prohibiting the sale of older models), and how they had heard anecdotes of people stock-piling old light bulbs to ensure that they did not have to change to energy-efficient models (Narendran, 2011). One participant echoed this sentiment in relation to automation, suggesting that they would aim to by-pass any change and continue to use electricity as they desired. They - and others - hinted that they felt people in the UK have a rebellious streak and therefore will not necessarily accept being dictated to as they perceived some other countries do. Indeed, two participants appeared to talk with pride over the perceived disobedience of UK residents in comparison to residents of other states who they suggested may be more likely to "*fall in line and do what they're told*".

Automation was perceived to be quite a technical and confusing development, which some referred to as a possible concern. However, as the emphasis was placed on taking responsibility away from individuals this was not generally considered to be a significant concern that would need to be overcome for people to engage with. Furthermore, it was suggested that domestic appliances and technologies are becoming increasingly complex anyway, and that them having the ability to work automatically within a 'smarter' system was just a natural progression of this trend of increasing complexity, which would be unproblematic if their function and use remained simple:

Erica, 27: *"If everyone's appliances had a - because they're already stupidly technical anyway - if everyone's washing machine and dishwasher had a little something in them that got a signal saying 'now's a good time' and then switched itself on, that would be ok. Because it's not that different from putting on the washing machine with the 'wait three hours' setting. You know, lots of things have timers anyway, so it would almost be just a continuation of that."*

Interestingly, participants with solar PV panels seemed to be more open to the idea of automation, possibly because they have already experienced interacting with installed technologies and changing their habits and routines to make use of generated electricity at times of surplus, and therefore may arguably be less fearful or concerned than others who have not experienced recent change. Future research could perhaps investigate whether this is the case, and if so whether this could be generalised to other innovations that involve feedback on energy (such as smart meters), or whether this increased acceptance of – and openness towards – new technologies influencing energy use is unique to 'prosumers'. Despite these participants' openness towards possible new innovations, their experience of using timers to coincide their electricity demand with peaks in solar generation could perhaps be argued to fit more closely with a vision involving less automation, instead

requiring more conscious involvement and participation from individuals. For this reason it is arguably counter-intuitive that these participants would be open to the idea of having less control and engagement within a more automated system, which would be a reversal of the recent change in their relationship with electricity in the home. Perhaps it may just be that people who have recently experienced significant change to how they use electricity in the home may be more open to possible further change, as they have their own positive experiences to reassure them.

This section has discussed public participants' views towards automation and the role that it could play in possible future changes to how electricity is used in the home. Concerns were identified over the perceived invasiveness of third parties having access to and control of aspects of demand within the home, coupled with general privacy and security concerns highlighted by participants. These concerns led some to suggest that automation may perhaps be more appropriate for non-domestic contexts as the notions of freedom and control – which were suggested to be stronger in the more personal setting of home – would be less threatened. Other interviewees appeared to be more positive towards automation, and saw this vision as a natural progression of current technological trends. Views towards automation appeared to differ depending on the specific application. For example, washing machines were discussed in ways suggesting that automation could be applied without causing too much inconvenience, whereas ovens or appliances that involved more meaningful interaction, or performed more significant roles in daily routines, were suggested to be less suitable. This finding, along with the concerns discussed above, suggest that some people may oppose automation and change *per se*, whereas others felt that automation may be accepted if applied in a suitable way – or to suitable appliances – that does not overly threaten the notions of control and freedom in the home.

6.4 Responsibility, Planning and Real-Time Response: Visions of Interactive Participation in Shifting Demand

This section discusses the perceived pros, cons and other considerations identified in participants' responses to a vision involving the possibility of people taking on a more active role in engaging with and planning how electricity is used in their home (as outlined in the 'Interactive Participation' section in Chapter 5). Participants with solar PV panels identified a perceived link between the similarities of how they had started to interact with

feedback from the inverters in their micro-generation systems (see 'syncing with the sun' – Chapter 4) and how people may be required to interact with signals from smart meters or other devices in this vision of increased participation. Indeed, some appeared to be very open to this idea and supportive of individuals being required to engage more in the electricity system and having more responsibility:

William, 53: *"I think we've already up to a point started it [responding to signals] because we've got the solar panels, so we would try and use the electricity that we're generating, and we can obviously only do that when it's sunny."*

Whilst some appeared to be very supportive of changes to the system that would involve more participation from residents, there did also appear to be a common expectance that people would initially be reluctant to accept change, before slowly over time adapting to these new changes in their daily lives. This is perhaps more relevant within this vision of interactive participation (as opposed to automation), as change will be more conspicuous. Participants appeared to be generally positive towards receiving signals and real-time information on the availability of electricity. However, most were far less positive towards two-way communication of data (with system operators), which, via smart meters, would be a key component within this vision of future electricity systems in the home (Strengers, 2013). This concern appeared to be influenced by two factors. Firstly, some referred to their distrust of energy companies and their unease at them being able to see what electricity they were using and when. Secondly, some suggested that they didn't understand or see the need for companies to have access to this data. This is interesting as some expert interviewees implied that the main value and 'usefulness' of having smart meters in houses from the system operator's perspective is that the two-way communication will help to inform management plans and real-time operation. This could suggest that future communication strategies that accompany any future smart meter rollout should aim to ensure that users are presented with sufficient information explaining the reasons for their introduction, which may arguably increase support and engagement.

A recurring aspect that was relevant to both visions of automation and visions involving more active participation for individuals involved the concern electricity users becoming vulnerable to fluctuating electricity prices (*e.g.* Faruqui, 2010). It was suggested that for people with less flexible routines they will have less ability to shift some demand to off-peak times and risk having to pay increased prices under dynamic pricing schemes. This aspect was particularly discussed in interviews with mothers with young children. Some suggested they would be in a position where they would be less vulnerable than others as

they had some flexibility within their lifestyles, and would welcome the opportunity to potentially benefit from taking advantage of dynamic pricing, but they also reflected on the possible difficulties that working parents may have as they would have particularly high demand and structured routines around working hours which – they argued – would make changing their own electricity demand schedules particularly difficult. This aspect of perceived vulnerability influencing acceptance of potential interventions could also be considered in the context of wealth. Spence *et al.* (2015) found evidence suggesting less affluent people who had high concern about the affordability of energy were – perhaps counter-intuitively – less likely to accept demand-side management schemes, even though this may help them to save money. This was coupled with higher resistance to sharing data on their energy use, which Spence *et al.* suggest fits with the idea that people from less powerful parts of society may feel themselves to be more vulnerable to exploitation , rendering them less likely to be supportive of potential interventions.

Whilst changing routines to influence electricity use was perceived by many to be difficult, Hand and Shove (2007) suggest that programmable appliances (such as washing machines) have opened up the possibility for specific practices to be scheduled and coordinated within daily routines, which arguably suggests that some flexibility in terms of how and when daily practices are performed may be achievable, further mirroring evidence from participants with solar PV. Furthermore, Strengers (2010) found evidence for some households who were informed of a critical peak pricing event (where electricity prices dramatically increased to reflect a short-term deficit in electricity supply compared to demand) embracing the opportunity for change, such as playing games and making the most of 'quality time' as a family (Southerton, 2003). This suggests that whilst there may be many potential obstacles and concerns that need to be overcome to enable possible change involving financial drivers or dynamic pricing interventions, there could also be some unanticipated opportunities for users to open up new routines and benefit from the changing role that electricity may play in daily life. In addition to routines and other social structures acting as possible obstacles to change, one participant suggested that it may be difficult to get people to engage with and take up a more active role (*i.e.* in interacting with signals) in something that is so separate and distant from their everyday life. Indeed, when reflecting upon focus group findings on the awareness and visibility of electricity in everyday life, transitioning towards a system where people are aware of what electricity they use and are prepared to become more flexible in their electricity use appears to be a very significant challenge.

Concerns over the complexity of signals portrayed on smart meters and how easy it would be to interact with these was a recurring theme, which mirrored expectations identified in the expert interviews. This was particularly in relation to how signals on smart meters would be received and how people would be expected to use these signals in terms of scheduling demand. This could also arguably be interpreted as a possible explanation of the support for automation that some participants had. Some felt that the dominant current trend appeared to involve technology becoming increasingly automated and therefore simpler for users to interact with, whilst the vision involving more active participation in scheduling and shifting demand on behalf of imagined future users goes against this perceived trend.

Perhaps the most important factor in some interviewees appearing to prefer a vision involving more interaction with and participation in the electricity system – as opposed to automation – is that people would still be able to maintain control and choice over how and when they use electricity, rather than a 'black box' making some of these decisions on their behalf (again matching Parkhill *et al.*'s (2013) findings):

Researcher: *"You appear to be quite open to the idea of a more active role for individuals?*

Christina, 64: *Yes. And guidance, I'm not one for being told 'you will not do this at this time' but I'm more for the guidance that says 'if you do it at this time it's going to cost megabucks, but if you don't do it you can have it cheaper later'."*

However, one person suggested that having to plan electricity use or regularly interact with signals would be frustrating and that it would get in the way of living, and result in having to micro-manage everything within the home rather than just getting on with life. This aspect had been anticipated to be a commonly recurring theme in participants' responses to the presented vision involving more participation for individuals, however, the only interviewee to raise this concern was Dave (below), suggesting that this was not perhaps as significant a possible barrier as expected. It was expected that more participants would consider themselves to be too busy to monitor their energy use and interact on a day-to-day basis (*e.g.* Hamilton *et al.*, 2012), instead preferring what Berst (2012) describes as a desire to remain in 'cruise control'. As this was not the case this arguably undermines experts' visions for automation, as interviewees appeared to prefer maintaining perceived control over their demand at the expense of moderate inconvenience:

Dave, 26: *"My initial reaction is that I find that quite annoying because it's just too much to do. I guess it depends slightly on how expensive it would be to ignore it, but yeah, I would find that quite annoying because you'd have to start managing what to do, which you have to obviously do for some things. It's just that it seems like an overload of information and things to do, and you want to actually enjoy your life and not have a diary that sits there and says 'I need to do the washing at this point'."*

This section has presented ways in which public interviewees talked about visions of individual users becoming responsible for taking on a more active, participatory role within the electricity system to help create a more flexible domestic demand. Interestingly, participants with solar PV drew comparisons with this vision and the ways that they had changed their electricity use in response to having solar PV (see Section 4.5). Some participants appeared to be open to the idea of embracing visions involving this change, which possibly suggests that a more active role for users – that does not aim to by-pass individual engagement – may be met more enthusiastically and result in a less defensive reaction or backlash than other alternatives (such as automation). Despite this, concerns over the complexity of actually taking on a more active role suggest that communication strategies, public engagement and the design and implementation of technologies and supporting policies will need to be clear and accessible to alleviate concerns.

6.5 Empowerment, Confusion and Vulnerability: Visions of the Expected Role for Smart Meters

Smart meters are likely to become a key component of any future change to how electricity is used and managed within the home (DECC, 2009b). Indeed, participants reflected upon the possible role that smart meters may have in visions involving automation of demand or an alternative requiring increased active participation of individuals in attempting to shift domestic electricity demand. One interviewee who had solar PV panels generating some of their household electricity described their enjoyment of viewing data on the amount of electricity generated on their solar-system inverter display. They discussed the empowerment they felt in being able to dictate their own bill payments to their energy supplier, and suggested that they were optimistic about the possible effect of having a smart meter, which they hoped would also become a tool for empowerment and enable them to have more control over their household electricity use:

[In response to video clip discussing possible impacts of smart meters]

Anne, 53: *"I thought it was interesting how he [contributor in video clip] was talking about taking control away from providers. I remember when we first had electricity bills as a homeowner, we had no control, you'd be sent a paper bill and you had really no control at all. When I think now how I manage it online I can suggest 'well I think I only need to pay this as my monthly direct debit' and then they'll come back and say 'no, you can't change that because…' and I can go back and say 'yes, I know I'm not going to use that much because…' so I find that empowering."*

"You either embrace it or you go back in your cave"

Whilst some participants viewed smart meters as a positive future installation within their home, others focused on concerns they had about how these may operate – particularly in terms of data and how this may be used and kept secure. Some referred to customers being in a 'weak' position, where if they wanted to be provided with the service (*i.e.* electricity provision), then they would have to accept their electricity use being monitored. However, others argued that data monitoring is already an intrinsic part of everyday life that should be accepted, and that providing electricity providers and network operators with more data was a natural progression of societal trends and made sense:

Christina, 64: *"It [data security] would be a hassle if it went wrong, but it's like people who go on about protecting from Big Brother, if you carry a phone with you and a credit card then people can know where you are what you're doing every second of the day. I mean I can actually ask this [gestures to smartphone] where my husband is and it will tell me! So you know, you either embrace it or you go back in your cave. I think if you understand it and at least know that technology is there then you can use it as a tool rather than letting it take over."*

It was also suggested that public support may be influenced by concerns over who ultimately pays for smart meters, with some stating that the cost will be met through electricity bill increases. A further concern, which was only identified in a small number of interviews, centred on the disruption and potential risk of having the home as a connected system. One participant discussed their fear that 'hackers' could break into the system (*e.g.* Rahman, 2009; Li, Luo and Liu, 2010) and take control of appliances within the home. Clare's quote (below) also demonstrates the strength of feeling that some may have towards having an over-complicated, connected system within the home, which by extension may be linked with concerns over the potential disruption and inconvenience that system failures could cause:

Clare, 35: *"It's just more things to go wrong really. My ex-husband is a computer engineer and he used to say the more gadgets you've got on a laptop the more bits of it there are to break down. If you link everything up it's just got more potential to go wrong. I wonder as well if you link everything to a smart meter and the smart meter goes wrong what do you do then? And they don't want to talk about that, they'll just say 'it won't go wrong'. But it's electric and therefore at some point it will."*

Whilst some participants referred to the potential pros and cons of having a smart meter controlling electrical appliances within the wider home system, many interviewees simply discussed smart meters in the context of providing feedback on electricity use (as opposed to possibly also providing real-time information such as cost). Indeed, there appeared to be a general lack of understanding of what smart meters are and the role they may have – despite the interviewer attempting to ensure that participants were provided with sufficient information – although it could be argued that this is perhaps a true reflection on the variation in definitions of what a smart meter actually is or does (mirroring expert discussions on the range of definitions for smart grids). This resonates with some of the perceptions towards public knowledge of smart meters identified in the expert interviews, and suggests that public communication on what smart meters are (and what they may do) needs to be designed with care in order to enable the public to better engage in debates and more clearly be able to imagine the impacts of possible future change. Furthermore, it could be argued that a better understanding of the dynamics of how different people understand and may interact with smart meters could help inform various designers, engineers and policy makers. Indeed, considering Walker *et al.*'s (2010) investigation into renewable energy technology experts' (*e.g.* designers, policy makers, financers *etc.*) imagined subjectivities of the public or 'imagined laypersons' (Maranta *et al.*, 2003) - and how these imaginations have real implications for technological design, communication and strategies for engagement - it is suggested that more importance should be placed on understanding the range of 'publics' and different social groups in different contexts, to better inform how communication and public engagement can be improved to ensure that if and when new technologies are 'rolled out' that people will be more likely to accept, understand and embrace subsequent change.

This section has portrayed public interviewees' discussions of smart meters and the possible role they may have in the future electricity system. Smart meters were imagined – and hoped – as a tool for empowerment, particularly by participants with solar PV, who

drew comparisons with their own positive experiences of interacting with information provided by their solar PV inverters. However, in addition to confusion over the differences between smart meters and energy monitors – discussed in Chapter 7- some concerns were identified, which may have implications for their design and rollout. Some referred to the concern of users being put into a 'weak' position as monitoring and potential control from third parties was perceived to reduce their control.

6.6 Financial Incentives to Drive Behaviour: Expectations of Economic Rationality and Action

Using financial mechanisms to influence behaviour was commonly discussed as a more appropriate method – with a perceived higher likelihood for success – of achieving change than through appealing for people to voluntarily change how and when they used electricity, or by the concept of 'rationing' electricity, which was mooted by some participants. Kotchen and Moore (2008) found evidence that people with strong environmental values are more likely to engage in voluntary reductions in energy consumption, which could suggest participants who felt voluntary measures would not work do not identify with having strong environmental values. In particular, interviewees with solar PV panels installed on their properties advocated strategies based upon assumptions of economic-rationality and suggested that using dynamic pricing tariffs in conjunction with displays on smart meters may influence people's relationships with electricity and mimic their experiences of scheduling their demand for times when electricity may be cheaper during periods of sufficient or excess generation. Indeed, some evidence has been found in the US where experimental trials of real-time, dynamic pricing have demonstrated that consumers shifted and reduced their demand in response to price signals from smart meters (*e.g.* Hammerstrom *et al.*, 2007; Pierce and Paulos, 2012). This championing of financial mechanisms could also be interpreted as contradictory to the notion that considerations over cost do not influence immediate, everyday decisions, which again highlights the dynamics of how people think about electricity use and the contradictions and assumptions that influence their visions of how change may be achieved.

Many participants advocated manipulating the price of electricity to influence the way it is used in the home. This concept – of moving from static prices to a model that more accurately reflects real-time costs (*e.g.* cost spikes during peak load events) – has been

discussed in various forms for at least fifty years (*e.g.* Boiteux, 1964; Kahn, 1970) and mirrors suggestions from some expert interview participants. However, they also suggested that they felt that this ploy in isolation would not achieve the desired change and may create other problems, thereby reducing the suitability of this as a strategy. Common critiques echoed those of expert interviewees and involved the notion that the scale of changes in the price of electricity would be insufficient to affect significant change (*e.g.* Andrey and Haurie, 2013) because they predicted the majority of people would simply accept paying slightly more for their supply. Indeed, it could be argued that the scale of price increases required to steer wealthy domestic users of electricity away from peak-load events would have to be so great as to be impossible to implement, due to the likely profound ethical and moral implications (and public outcry) of what may be perceived to be pricing people out of their existing routines (Joskow and Wolfram, 2012). Abrahamse *et al.* (2005) suggest that interventions aiming to 'reward' people financially who participate in energy conservation measures in the home tend to have short-lived effects, which could suggest that similar schemes aiming to influence electricity use may arguably be limited. Participants also expressed a concern that modern lifestyles are fixed within societal structures and routines, which would make changing the times of electricity demand an insurmountable challenge. This could be interpreted as interviewees acknowledging that wider social changes need to be undertaken to achieve the desired change in electricity use. However, rather than questioning this and proposing societal changes, participants appeared to accept that routines simply will not change, and that therefore other approaches and solutions need to be considered:

Charles, 64: *"We're so familiar with how electricity works at the moment. The only way to make it different would be if it was financial. If you say 'if you use electricity at this time it is going to be this expensive, if you use it at six o'clock at night when everybody's cooking it's even more expensive'. People can't get to work outside the rush hour, they can't plan their timing to do it differently, you know they're so regimented into this situation and I think the only time it hits is when it hits your pocket."*

This section has presented public interviewee responses to the concept of dynamic pricing strategies to influence the ways in which electricity is used in the home. Many responses mirrored findings from the expert interviews, with general support being found for the idea that dynamic pricing would influence the times at which people use electricity. However, some also suggested that lifestyles are perceived to be reasonably 'fixed', perhaps hinting

towards a lack of belief in the ability of dynamic pricing strategies to provide enough of an incentive to have much of an effect. This notion resonates with contradictions identified in expert interviews that also seemingly undermine the faith in dynamic pricing to be an appropriate strategy for achieving significant change. This has important implications because many expert interviewees explicitly suggest dynamic pricing to be a useful, achievable mechanism for change, yet implicitly both expert and public participants appear to have doubts about the suitability of this vision.

6.7 Looking Back to the Future: Reflecting on Experiences of Electric Heating and Imagining Possible Futures

There were mixed views towards electric heating, which was suggested as a possible mechanism for achieving decarbonisation targets by some expert interviewees. Public participants who had experienced living with electric heating felt that it offered an inferior service that provided a less comfortable, drier form of heat:

Josie, 25: *"I find that electric heaters make it feel like you've got, what's the word, it feels unnatural, it's just fake air and stuffy. Also you can't dry clothes on it or things like that so you can't use if for other purposes, but also when you turn off gas radiators they stay warm for a bit longer, whereas with an electric one it's just on and then there's heat, and then it's off and then there's no heat. […] But we knew our place had electric heating when we moved in and it wasn't a consideration whether it was electric heating or gas, and I'd still go into a new place with electric, but I would prefer gas because I prefer the way gas heating works."*

This perception of electric heating systems being inferior to gas-based systems also appeared to be held by people who had no experience of living with them. Furthermore, some suggested that they thought electric systems were less controllable and more expensive to run – indeed, when asked about their views towards electric heating, many participants simultaneously said they had little experience of such systems and expressed the thought that electric heating is expensive. This could perhaps be explained by the fact that some interviewees referred to memories of using electric storage heaters – which were universally discussed negatively - and the legacy of these experiences could arguably be influencing perceptions of modern, alternative forms of electric heating systems:

James, 63: *"I think the experience a lot of people have is of the older systems which were very inefficient. When we first moved into this house they were really old fashioned heaters that didn't actually give you what you wanted because they charged up over night when it was cheap, which was good, and then they were red-hot at seven o'clock in the morning. But generally the time people want the heat is as the sun has gone down and it's getting cooler towards six-seven o'clock at night, and they were almost at their coolest, which made them very inefficient."*

This could be interpreted as evidence for the need to communicate about new, electric heating systems (such as heat pumps) by making clear the distinction between their function and storage heaters. Furthermore, when discussing electric heating, many participants stated that they were unfamiliar with heat pumps. This lack of public awareness provides an interesting contrast, as heat pumps were routinely discussed and advocated by engineers as a suitable way of electrifying heating demand and replacing gas-based systems. Indeed, as heat pumps and other electrical heating systems receive more attention and become more widespread – as predicted by expert participants – it is likely that people's awareness and perceptions towards them may change (mirroring the trend observed in Norway as the market for heat pumps and other alternative heating technologies has grown; Sopha *et al.*, 2010; 2013).

'Achieving a sensationless, thermal Nirvana'

It was also interesting to see how participants made sense of their differing comfort preferences and how these interact with views towards possible changes to how their homes may be heated in the future. Some interviewees discussed their desire for a uniform, comfortable temperature being maintained throughout the house. For this reason they appeared to be positive towards heat pumps (which could also help to explain why companies (including Worcester-Bosch, Verten and Purmo to name but a few) promote the 'desirable' and 'pleasant' uniform temperatures that heat pumps can deliver). Other participants discussed their desire for having focal points of heat (for example to gather round or dry clothes on) and variations in temperature throughout the house (avoiding what Prins (1992) describes as an aim of modern building design to achieve a '*sensationless, thermal Nirvana*'). As such they discussed their preference for gas central heating systems with conventional radiators, along with coal and gas fires.

Robert, 64: *"I've heard of them [heat pumps] but don't know much about them. I'm not sure about losing a focal point of heat though as I think different spaces need different heating. We have a heater in the bathroom to dry clothes on, but we don't have the radiators on in the bedroom. We find we don't need it, especially with the wood burner that heats the top*

floor. So different rooms need different heat and to try and control a whole house system like a heat pump would be difficult I think."

It appeared that an additional perceived benefit of these involved their controllability, as it was suggested that a 'boost' in temperature could be provided by using these as and when people require. This range of thermal comfort preferences highlights the difficulty in designing systems that accommodate for and satisfy everyone. However, by considering participants' desire for controllability it could be argued that systems that do not purely circulate air throughout the home (like some heat pump systems), but also provide the ability to manage the temperature in individual rooms (possibly using electric heaters) may be met with less scepticism and opposition if and when they are rolled out.

An additional insight from a small number of participants involved their assumption that visions to move towards electric heating systems eventually replacing gas-based systems do not actually help to reduce carbon emissions. Indeed, it was suggested that the electricity generation to power this newly electrified heating sector may be as carbon intensive as the gas it would be replacing (which is a valid point if the electricity was being generated in today's context, but this would not necessarily be the case within imagined visions of a future, lower-carbon electricity system (such as those outlined in DECC's (2012c; 2013) future heating proposals). However, despite this criticism, some also suggested that it may perhaps be a suitable option if electricity generation and distribution itself becomes less carbon intensive in the future, and therefore should be considered for the future. A final concern about replacing existing heating systems with electrical alternatives involved the assertion that the layout of homes has developed around incorporating radiators into rooms, which has also influenced the way people use heating within their everyday lives (such as using airing cupboards – which may become obsolete under some visions of change - within wider washing practices and behaviour). However, other participants discussed this change as a possible opportunity to free up living spaces within their home – again demonstrating the range of opinions towards and interactions with visions of change.

This section has highlighted public participants' views towards electric heating and the role it may possibly play in the future electricity system. Reponses suggest that the memory and legacy of previous experiences of electric heating (or indeed second-hand accounts of other people's experiences) influenced perceptions towards modern, alternative forms of electric heating. Indeed, some participants' negative memories of using electric storage heaters appeared to negatively influence their views towards alternative, unfamiliar technologies

such as heat pumps. The range of comfort preferences discussed by interviewees again highlights the assertion that what may be appropriate or acceptable for one household may differ significantly from other, suggesting that future heating systems should ensure sufficient controllability, which may have implications for radical visions of system change that include heating systems.

6.8 International Interconnectivity and Energy Flows: Perceptions Towards a More International Electricity System

Some participants raised concerns over the idea of having more interconnectivity and transfer of electricity over a wider, international scale. They suggested that political uncertainty and potential conflict – referring to recent instability in Ukraine - made the prospect of 'outsourcing' electricity generation and having more energy flow across Europe a less attractive option – mirroring some experts' concerns over energy security:

Mark, 24: *"Historically Europe has always been fighting and having wars, say if there was another war now. […] You're outsourcing your power, and you're dependent on someone else, and each country then would be such a vital thing in the system, and they'd be dependent on their source of energy from offshore or something and it would be under someone else's control. Like now in Russia, they've just been like 'well we're just going to cut off gas to Ukraine' and some countries are dependent on Ukraine gas."*

Indeed, one participant argued that having increased interconnectivity amongst European states may actually increase possible tensions. Interestingly, when told about the existing link between the UK and France (via the Interconnexion France-Angleterre (IFA) High Voltage Direct Current (HVDC) subsea cable) they expressed surprise that this existed and suggested that maybe this international link was deliberately not publicised to ensure public concerns are not raised. Whilst on the one hand this may appear to be trivial, it could be interpreted to show the level of concern (and anticipated negative public reaction) that this interviewee had towards the idea of international-scale transmission forming part of the UK's future electricity network.

Other participants were also reluctant to consider further European-wide energy transfer as they felt that the UK should aim to reduce – as opposed to strengthen – its political ties with Europe and become more independent. This concern and unease over an increasing reliance upon and interaction with other nation states may possibly be explained by underlying, unstated social commitments (*e.g.* Wynne, 1992; Macnaghten *et al.*, 2005;

Stirling, 2008). Being optimistic about an increasingly international electricity system requires a social commitment of long-term stable governance and international cooperation. However, as this commitment may not necessarily be perceived as realistic, genuine or guaranteed to be long-lasting then concerns about new or evolving sociotechnical arrangements may not necessarily be appeased. Despite this range of concerns however, many participants did appear open to the concept of having a larger 'supergrid' that would enable European states to 'spread the net' and generate electricity from diverse sources, and felt that the potential benefits outweighed their concerns over the political implications of this possible change.

This section has presented the ways in which public interviewees discussed energy in the context of a possible future energy system involving more international interconnectivity and transmission across national borders. Geopolitical concerns were identified, with some referring to possible conflict and political instability. Others suggested that they felt the UK should develop a more independent energy system that is less reliant on other nations. This has potential implications for some expert visions of future European-wide electricity networks because this would incorporate aspects that appear to be causes for concern for some members of the public.

6.9 Individual Action Versus Governing Intervention – Who is Responsible for Achieving Change?

A range of perceptions towards the governance of how electricity is used in the domestic sector were identified, which helped to illuminate how and why public participants felt future change should be achieved. Common responses indicated that participants felt government should ultimately be responsible for overseeing and directing change. This was often identified alongside hope for a move towards a system where individuals would also have more responsibility for how they use electricity. Indeed, some expressed a desire for the government to promote involvement and a feeling of empowerment, which may help to move away from their perceptions of current individualised priorities and ways of living:

Fiona, 20: "*I think we need a less self-involved government, one that makes people more proactive, makes people feel more involved. […] I think people become so individualised because they feel that the government is in it for themselves, that people are in it for themselves and that attitude has just grown.*"

Despite many interviewees suggesting that responsibility for overseeing change should lie with government, a range of responses indicated distrust of and cynicism towards politicians. This appeared to be particularly influenced by the perception that economic priorities (and related pressure from private companies) would be given greater consideration than other factors in decision making. Furthermore, some argued that they felt politicians were more interested in securing votes and public support rather than necessarily striving to achieve the most appropriate long-term targets. This was also used as a possible explanation for why one participant felt that policies aiming to influence longer-term developments were less likely to be prioritised over short-term, immediate needs, thereby influencing future change to the electricity system:

Dave, 26: *"I don't think they [the government] have a drastically different future vision. I guess maybe it's partly because with elections you can't plan that far forward. […] I think politicians' ideas of policy are very much immediate, I don't think they really, like, do you think they really think about Britain running off wind farms in the future?"*

However, whilst politicians and the wider political system were often referred to in the context of delaying developments or focusing on the wrong priorities, some participants suggested that this was a wider reflection of societal attitudes and apathy towards change. It was argued that if societal attitudes changed then political priorities would realign to follow this shift, thereby ensuring that policy developments would be more likely to maintain public support. Whilst this could be interpreted as evidence for the perceived need for society to ultimately demand change for this to occur, some responses indicated a perceived lack of self-efficacy in terms of people's belief in their personal ability to impact upon the future. Indeed, it was argued that individuals are primarily limited to affecting change through voting, because some believed that the government would still have the overriding power to dictate future change. A contrasting belief was also identified, where some interviewees felt that their consumer choices (in the context of buying electricity-related domestic products) may have the power to influence markets, which over time may help to drive change in specific directions (for example, products becoming increasingly energy efficient). This was an interesting dynamic as it could be argued that legislation has been the primary driver influencing energy-efficiency, whilst this could also be made into a more circular argument where consumer choices can have impacts through market forces and by increasing pressure on policy-makers to further promote or prohibit products.

In addition to contrasting opinions towards responsibility, and the role of government in the transition towards a new system involving changes to how electricity is used in the

home, some participants referred to a lack of clarity in government visions and perceived contrast between what government say will occur and what actually occurs. It was suggested that this may be a result of the negative impact that some policy interventions promoting pro-environmental lifestyle change and renewable technologies were perceived to have on people's lifestyles (notably inconvenience and an impact on people's routines and comfort), making these decisions an unattractive proposition for policy makers. Indeed, some suggested that the fear of alienating the electorate may be the key obstacle in getting politicians to attempt to implement change, and reduces the scope for ambition within aiming to achieve imagined futures and radical visions:

Sue, 53: *"Government and policy makers need to keep voters on their side to stay in government. They don't want to make policies that are unpopular, and making people uncomfortable is unpopular. Taking things away from people, things that people like and use, is unpopular, so I don't think governments and policy makers are actually going to do the right thing because they don't want to lose votes and lose power."*

Whilst some described their concerns over the ability of policy makers to achieve and help steer significant change to how electricity is used in the home, others felt that focusing on the home was insufficient, as other sectors may be more appropriate to target. Some participants argued that minimal reductions in electricity demand and changes to how and when electricity is used could be achieved within the domestic sector. Instead, they advocated targeting industrial users - mirroring findings from expert interviews – which they said would involve greater scope for more significant change to be achieved. An interesting contrast between expert and public opinions on this issue was identified. Some experts stated that the greater scope for targeting industrial users meant that they felt that the domestic sector should be treated as a lesser priority. However, public participants stated that they felt individuals in the home still had a responsibility for their electricity and an important role to play in future changes.

This section has presented views towards responsibility that were identified in public follow-up interviews. Many responses echoed findings from expert interviews, with perceived ultimate responsibility being attributed to the government, whilst many also had a desire for more of a role and responsibility for individuals. Frustration over a lack of perceived self-efficacy – with some suggesting that their role in achieving change is limited to voting and consumer choice – also suggests that participants advocated a transition towards an electricity system that would involve greater participation for individuals.

6.10 Gimmicks and Progress in Tomorrow's World: Imagining the Future and Its Role in Achieving Change

Literature on promissory narratives and sociotechnical imaginaries depict how expectations and visions of the future have real-world implications and actions today by steering political decisions and motivating societal developments. When discussing visions of the future and the possible role that these may have, participants provided a range of responses. One interviewee drew parallels with the fixation on attempting to keep up with Moore's law within the field of computing – which predicts that as technology evolves the number of transistors on a microchip will double approximately every two years (Moore, 1965). Indeed, Kish (2002) states that Moore's prediction has proven to be sufficiently accurate to be adopted within the industry as a target that must be met by manufacturers to ensure they maintain their competitive edge. The interviewee argued that this phenomenon demonstrates the powerful effect that a prediction of the future can have, and how pursuing a particular vision can influence current behaviour – resonating with what van Lente (1993) refers to as 'forceful fictions', where expectations of the future can guide activities, provide structure and attract interest and investment.

The role of portraying future visions was suggested to be particularly important in the context of trying to sell products and create new markets – which was a recurring theme in discussions on the materiality of future homes, particularly in response to images depicted in the video clips. One participant argued that hypothetical futures portrayed in advertising, films and other media can be compared to modern art, where new ideas and technology can be introduced to generate interest and push the boundaries of our imagination – with the aim of creating support and aspiration for products portrayed within these visions – even if aspects of these imagined futures will never be borne out in reality:

Charles, 64: "*People say modern art is ridiculous. It's silly. You can't see the point of it. But what it does is that it's an ice breaker for the things that follow. […] You can't finance the research for all these things unless you actually produce something, and if you produce something somebody has got to use it, so you've got to actually have this hype, this enthusiasm. You only have to look back at all the other future pictures of times past to see how the future doesn't actually ever measure up to it, you know, personal flying machines haven't happened.*"

Indeed, many participants spoke positively about visions of the future and the process of trying to imagine future change, in addition to the influence that these visions can have on

real-time action. However, some participants suggested that they felt that too much importance was given to attempts to try to predict future trends:

[In response to video clip showing possible future home, and being prompted on imagining the future]

Ben, 23: *"I saw someone with a job title called 'Future Analyst' and I was just like 'what does that actually mean?' Its rubbish, I think they just do it because they have to. It's like that is some paradigm, because I think the future home would not be that much different from this home, it would probably have a smart meter, but I don't think it would be massively different. Most homes will still be the same ones as they are now, so it will just be new homes that will be drastically different."*

Furthermore, it was suggested by some that the underlying perceived need for societal progress has become the driving force behind change. Indeed, one participant argued that this strive for progress drove change at such a pace that there is little opportunity to "*just reflect on what actually needs to be done*". In addition to varying levels of optimism towards future-oriented visions and their role in influencing change, some participants were also sceptical about the importance of these visions. For example, Dave's quote (below) suggests he feels that change occurs randomly and in response to chance factors or contextual influences, as opposed to being significantly planned or impacted upon by directed management. Whilst this position may perhaps over-minimise or dismiss the role that imagining (and attempting to achieve) specific visions of the future may have, it does provide an interesting counter argument and critique which may be relevant to scholars trying to interpret (and explain) past, or predict future societal trends. Furthermore it could be interpreted as a reminder that large-scale visions and outlines for future changes to the electricity system and its role in society may be met with scepticism by some:

Dave, 26: *"The way I view it is in terms of something evolving – society evolves – and you can sort of see it like an organism. It's a silly example, but the environment changes in one aspect, it selects for different organisms with certain features that best fit that environment. It's not directional and they don't choose it, and it's just a response, one thing to another thing that then changes and it just moves around, which, if you look back on it then looks directional because you've gone 'oh look they started off with four legs and now they've got six'. So they've increased their amount of legs, but the process was actually quite random, it's just stuff reacting to stuff. In a way I think society and progress is that."*

When public interviewees reflected upon prompts and questions developed from the expert interviews, some felt that the issues being presented revealed things about the experts' visions, and in particular engineers and the wider field of engineering. Engineers

were perceived to have a preoccupation with improving technology to maintain 'progress'. There appeared to be a juxtaposition identified by some respondents, where visions of the future on one hand appeared to focus on 'progress', whilst at the same time the actual aim of this progress appeared to be maintaining (as opposed to changing) existing living situations in the home and quality of life. Some were critical of this approach as they felt that less focus is given to the users of technology and as such, some considerations that could make possible change more user-friendly and manageable for individuals may be ignored. Indeed, it was suggested that as engineering is about finding technical solutions to problems, that aspects such as behavioural and societal change will not be considered so deeply, and as they are more comfortable working within the boundaries of their usual expertise that technical solutions will always be championed as the most appropriate course of action:

Mark, 24: *"People don't want to be telling people that they want to change the way they live. And I guess engineers, that's the way that they think, if you asked other people maybe they would say behaviour change, rather than an engineer thinks about probably what they want to do.*

Researcher: *So it's a mind-set?*

Mark: *Yeah, because the whole thing in their minds is about engineering and technology, so, they can find the next fix using technology, why would they, why would you think about behaviour change?"*

Other participants also suggested that focusing efforts on technical change and efficiency improvements is inevitable as they felt that this was a smaller, more manageable challenge than trying to affect the way people's behaviour influenced electricity demand. Furthermore, many public participants echoed assertions from expert interviewees that people want to maintain their quality of life and do not want to change the way they live in the home, which appeared to be used as a justification and explanation as to why technological solutions were perceived to be a suitable approach. Indeed, it was argued by some that innovations are sold on the promise of contributing towards easy living, as it was stated that visions of 'progress' and easy living were closely linked. They suggested that engineers and other researchers work to this assumption and therefore try to develop technology that reduces electricity use without requiring large-scale behaviour change. For this reason it was also argued that engineers, designers and companies that sell products have a large responsibility for achieving change.

Part of the Phase 3 interviews involved asking open-ended questions about participants' expectations and hopes for the future and tasked them with imagining how (and why) changes in their lifestyle – and society more widely – may influence (and be influenced by) the way electricity is used in the home. A recurring theme involved the assertion that imagining the future is a complex endeavour involving many uncertainties (Adam, 2005) – mirroring findings from the expert interviews. It was also argued by some that imagining social or societal change is more difficult than picturing technological change, as it involves so many variables and considerations to render the task futile:

Anne, 53: *"I think it's easier to imagine the concrete, or the gadgets, or this is what your living space might look like, I think that is easier to imagine than how people will change."*

This consideration, along with the fact that technology is often viewed positively (European Commission, 2013) and generates excitement, may help to explain why both experts and public participants felt more comfortable discussing possible future technological change. Additionally, some participants hinted towards a perceived lack of self-efficacy in relation to their ability to have a significant impact on their electricity use in the future through imagining how their behaviour may change, which may explain their preference for considering technical change. Furthermore, it could be interpreted as a possible explanation for the reliance on and support for technological solutions in political visions of transitioning towards a lower-carbon electricity system. This notion was also highlighted by participants when viewing the film clip that depicted a walk-through of a possible future home. It was argued by some that the visions portrayed in the film – and other 'Tomorrow's World'-type programmes – show little social change, and effectively reflected how we live our existing lives, but within the context of a more futuristic materiality of the home involving technological aesthetics.

An interesting contradiction was also identified in some discussions on technology and its positioning in people's lifestyles (and imagined future lifestyles). Participants talked about the positive role technology may have in helping to reduce electricity consumption within the home without adversely affecting their routines and lifestyle. Yet this was also juxtaposed with the concern that rapid technological innovation and adoption may have an adverse effect on society. Indeed, some participants appeared to be simultaneously optimistic and fearful over the possible role that technology may play in future change to life within the home (in particular, concerns mirrored expert interview findings relating to social exclusion and a fear of becoming 'reliant' on technology). Indeed, one participant

described their excitement about the possible convenience and luxury that could be attained with future domestic appliances, yet also felt that an increasing reliance upon technology in the future may become a cause for concern. This was followed by them outlining their hope that technology will take on a less important role in future lives, thereby ensuring that people maintain control of everyday tasks and have the ability and requirement to personally communicate without using technology, which they felt would protect people from living what they perceived to be over-individualised lives.

In addition to optimistic and pessimistic views towards possible changes to how technology may be used in future homes, some participants expressed concern over domestic appliances and consumer products 'sneaking' into people's lifestyles. Indeed, some argued that many products (such as electronic toothbrushes) are initially obtained as a gimmick or novelty item, but then over time become 'essential' in people's daily routines. Lorraine's quote (below) depicts how this aspect of what is perceived to be essential can change over time and thus influence household electricity use:

Lorraine, 68: *"In the seventies my sister had a dishwasher and I thought she was a lazy madam, so that's thirty plus years ago. Now if somebody took my dishwasher away I would poke their eyes out! So I can remember all those feelings and doing those things, and yet now it's an integral tool."*

The notion of some products and gadgets becoming adopted into people's lives was accompanied in some interviewees' responses with the stated hope that future society may become less materialistic and that people will be able to lead 'simpler' lives with fewer products (and thus have a lower domestic electricity demand):

Paul, 41: *"I don't want an electric carving knife, I can use a knife, I can use a whisk not a blender, you don't need all these electric gadgets. You know, I'd like it to be a nice simple house. […] That is my overriding vision, that I hope everything will be more simple. I don't think we can carry on getting more and more technological."*

'Why should you have strawberries in December?'

Similar responses from other participants also indicated that some people perceive aspects of their current lifestyle – in relation to how and why they use certain electronic appliances – to be unnecessary, and for some this was described as wasteful or over-indulgent. Interestingly, when participants talked positively about future roles for technology they tended to refer to new products and innovations as 'technology', whereas when discussing negative expectations and opinions towards technology they tended to refer to 'gadgets'.

Whilst this positioning of the role of gadgets within everyday domestic life contrasts with some who felt more optimistic and even excited by the possibilities that future technologies may bring, it does demonstrate a general feeling of concern and frustration amongst some participants in relation to what may or may not be necessary in terms of maintaining a comfortable, modern and pleasant quality of living within the home, without becoming 'wasteful' (echoing findings from Demski *et al.*, In Press). Indeed, for some participants this frustration appeared to fit within a wider desire for radical changes in society that fit more closely with their values and determined their hopes for the future. In particular some participants expressed a desire for more local production (*e.g.* energy and food), which was discussed as being a mechanism for transitioning towards a more sustainable, 'fairer' society that may help to reverse the perceived trend of people living more individualised, resource-intensive lifestyles. This was also accompanied in some participants' responses with the assertion that people's everyday expectations of convenience and necessity may need to be scaled back to achieve a more sustainable future. Whilst not directly related to domestic electricity demand, Sue's quote below neatly sums up this notion, and demonstrates her feeling of bemusement and frustration as well as her implied hopes for large-scale future societal change:

Sue, 53: *"How do I think the future is going to pan out? I suppose I'd like to see more awareness of things like food miles, and people not thinking that they should, so for example why should you have strawberries in December? Why should we? Why not just have them in May and June when they're in the fields? Why do you need your car to get in to the shops, there needs to be a much greater awareness of waste of energy and what is necessary and what isn't necessary."*

This section has demonstrated how public interviewees discussed visions of future change and how imagined visions may influence change. Visions of the future were perceived by some to play an important role in steering societal developments. Some referred to an underlying societal discourse and need for 'progress', which they perceived to be a driving force behind change.

Influencing behaviour change was viewed as more difficult than developing technological innovations. This, coupled with the fact that technology is generally viewed positively (European Commission, 2013), could help to explain why both expert and public interviewees appeared to be more comfortable imagining and talking about technological change as opposed to societal or behavioural change.

Some participants referred to a desire for a 'simpler', less materialistic lifestyle in the future – with fewer technological 'gimmicks'. This perhaps conflicts with visions of technology taking on more of a role in domestic demand, efficiency and scheduling within a future electricity system.

6.11 Hopes and Concerns: Assessing Expectations Through Multi-Modal Portrayals of the Future

When viewing the film clip involving a walkthrough of a possible future home, many participants expressed that they felt the vision being portrayed was misleading, and questioned why specific statements or claims were made by the commentator. By challenging and probing participants' responses, deeper insights into their own visions and expectations for the future were obtained. Some queried why the commentator in the video stated that the house portrayed was 'environmentally friendly', instead implying that the abundance of high-tech, electronic products within the futuristic house would result in significantly higher electricity demand, thereby opposing the claimed pro-environmental credentials. Additionally, participants critiqued references to 'easy living', suggesting that they felt the filmmakers assumed that above all else people aspire for their future homes to organise and perform domestic tasks, creating an environment where residents' lifestyles within the home require as little effort as possible. It is also interesting to note that the home depicted – which was portrayed as a clean, futuristic, almost clinically-styled space – conjured references to similar futuristic-styled visions portrayed in the media (such as iRobot, Tomorrow's World and The Hitchhiker's Guide To The Galaxy). Some participants argued that the futuristic aesthetics of the home portrayed were unlikely to be a realistic portrayal of future homes, which were instead expected to mostly remain more similar to today's conventional styles involving less of a technologically-oriented space. However, whilst many interviewees highlighted this perceived unrealistic, futuristic vision, they suggested that the video clip – and other media portrayals of future settings – had to project this dramatically different and exaggerated vision to help viewers identify the differences between the 'now' and 'then' that the filmmakers were aiming to depict.

Requesting that interview participants complete the tabloid task (outlined in Chapter 3) helped unearth further insights into how they imagined wider societal energy issues may evolve in the future. Responses demonstrated the range of concerns some had over energy security, with some predicting significant power cuts for the UK in the near future.

Suggested reasons for this included an expectation (and concern) that the UK will increasingly rely upon foreign electricity companies that "*don't necessarily have the same priorities as us"*, and that investment in 'indigenous' renewable sources will be insufficient to meet demand. This again suggests some interviewees felt that unacceptable social commitments (*e.g.* Stirling, 2008) – such as long-term political stability and international cooperation – had been guaranteed to provide them with the confidence to support a vision of a European-wide, international electricity system. Interestingly, the imagined severity and immediate cause of power cuts differed from those who discussed large scale outages caused by severe weather events to more mundane, gradual impacts (*e.g.* 'TV pickup' (BBC, 2013) of increasing domestic demand:

John, 23: *"Demand is always going up because we're getting a bigger population. We can't continue to just increase how much electricity we make, surely at some point the day will come where too many people make a cup of tea after Coronation Street and just by virtue of more kettles being in existence it's going to hit. I like the idea of city-wide power cuts coming from something really mundane like making tea."*

Discussions on energy security that emerged from the tabloid task often included reflections on the affordability of electricity in the future. The majority of participants predicted increases in electricity pricing, whilst some extended this argument to suggest that as future governments come under increasing pressure to provide affordable energy, there will be more pressure to use resources such as UK shale gas, implying that this may be perceived to be a cheaper alternative than more conventional and other renewable resources. Conversely, one participant who had solar PV panels installed on their property predicted that electricity prices would plateau in the future because they felt that renewable sources of electricity generation would be cheaper. This is interesting as it countered the implied feeling from other participants that developing renewable sources would result in more expensive future electricity generation, and resonates with the International Renewable Energy Agency's (2014) assertion that solar PV and other renewable generation sources (notably hydropower, geothermal and onshore wind) are becoming increasingly competitive with fossil-fuel based systems and in some circumstances cheaper. It would be interesting to know if this were an individually held belief, or whether this is common to other people with solar PV panels. For this reason it is suggested that further research investigates this, and whether positive experiences of reaping financial benefits from solar feed-in-tariffs had further influenced their wider views on electricity generation and network provision. Other participants with solar PV systems used parts of the tabloid task

to criticise government policy and suggested that policies should encourage homeowners to invest in other forms of micro-generation, which again perhaps reflects their positive experiences with solar PV systems:

[Reading aloud a headline from the completed tabloid]

Sophie, 56: *"New Government [I'm hoping that there might be a new government then] Set To Change Policy On Renewables' so it might be that the government would be saying that people can have a wind turbine in their garden and they might make planning permission easier for people, they might be helping people to convert their solar energy so that they can use it more rather than be dictated to by the grid."*

It is also interesting to note that whilst there appeared to be a desire from participants with solar PV systems to invest in more micro-generation and maximise the use of the electricity they were generating, there did not necessarily appear to be such a strong desire to reduce their household electricity demand. On one hand this could be interpreted as a possible contradiction. Yet on the other this may be a perfect example of how participants' responses demonstrate that every decision in managing a home is a compromise of many variables and that people may not necessarily hold consistent views or act predictably in response to cost or other considerations, highlighting the difficulties in designing policies or other interventions.

This section presented ways in which public follow-up interview participants interacted with and discussed topics presented in the film clips and tabloid task. Responses suggested that participants were aware of the 'exaggerated' portrayals of possible future scenarios, and that this helped them to identify and consider aspects relating to differences between the 'now' and 'then' presented. This helped to identify concerns over relying upon foreign companies providing electricity, and also apparent sceptism over the UKs ability to generate sufficient renewable energy under what were perceived to be current low levels of investment. Concerns identified that related to increasing electricity prices and the role that this may have in political decision-making relating to Shale gas also demonstrates the suitability of this method in helping to achieve the research aims. As such, in addition to generating novel findings, the researcher suggests that this novel methodological approach – which to the author's knowledge has been applied in very few, if any, studies combining home energy use and energy-systems research – should be applied or further developed in future research.

6.12 Chapter Summary and Discussion

This chapter aimed to present insights that portray public understandings of electricity systems, how electricity is used in the home and expectations of how this may change in the future. Various visions, hopes, concerns and contradictions have also been highlighted, along with comparisons with expert interview responses and a discussion of the possible implications of these findings. In this section key findings that help to answer research questions 2), 3) and 4) are re-visited, summarised and further discussed:

2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

One key finding from this chapter is that public participants – like expert interviewees – struggled to imagine possible future change in the context of social or behavioural change. This contrasted with their optimism for and confidence in imagining and describing possible technological change. This fits well within the wider thesis argument as the difficulty expressed by both public and expert interviewees in imagining the future (as well as the perceived futility of this endeavour by some participants) may perhaps help to explain why many visions focused on technologies more prominently than social change. By extension, this can perhaps, in part, help to explain how and why many public and expert interviewees advocate technological mechanisms as the most appropriate solutions to achieve reductions and shifts in electricity demand within everyday life. Furthermore this may help to explain why the underlying implicit aim and desire for change appears to be to maintain the existing status quo (in terms of how electricity is used in the home) as much as possible, whilst still enabling the transition towards a lower carbon electricity system, as opposed to attempting to aim for a more radically different alternative vision that would require users to more drastically re-negotiate their relationships with electricity in the home. This resonates with Kurz *et al.*'s (2010) discussion of political rhetoric around climate change in Australia, and how discourses relating to ecological modernisation were constructed to highlight 'lifestyle maintenance' that does not necessarily constrain individuals' freedom to consume at will. A final related reflection highlights that both public and expert interviewees seemed (cautiously) optimistic about the future impacts of

technology, yet at the same time, for those – admittedly few – visions of the future (as discussed by public participants) that were dramatically different to the present, participants generally tended to portray dystopian scenarios and highlight possible negative change as opposed to positive ones, which may arguably have more readily tallied with their techno-centric focus and optimism over technology. This counter-intuitive dynamic in (some) public interviewees' negative visions of the future, juxtaposed against their apparent optimism for technology, is both interesting and curious, and may be worth investigating in further research. Additionally, it is worth reflecting on the role that hopes or concerns may have within visions of the future – particularly in relation to the conviction in which these visions are held – and how this may have implications for theoretical approaches to understanding expectations of the future. This is further discussed in Chapter 7.

Building upon Pidgeon and Rogers-Hayden's (2007) paper, Macnaghten (2010: 24) discusses the difficulty of engaging members of the public 'upstream' in the development of technologies that exist in 'future-oriented promise rather than material reality'. Drawing upon this notion, Parkhill *et al.* (2012) suggest that this can lead to discussions becoming too focused on normative assessments of technology which can impact the usefulness of the engagement exercise. Findings that demonstrate the difficulty participants had in imagining the future resonate with Macnaghten's and Parkhill *et al.*'s proposition, and highlight the challenges for future-oriented social research. However, this further demonstrates the value of the multi-modal methods employed (such as the open-ended questioning, video clips and tabloid-task) in the thesis, as many participants managed to overcome – to some extent – their initial discomfort at struggling to imagine and discuss the future by engaging with the materials. This suggests that similar innovative methods should be employed in further investigations into expected futures relating to energy issues, because they may help participants to engage with complex topics and provide context that enables people to consider the potential impacts of change to their individual lives.

When comparing concerns raised by expert and public interviewees in relation to possible change, there appeared to be a general trend and difference between the two sets of participants. It could perhaps be said that generally expert participants appeared to almost minimise or not fully consider public concerns that may act as potential barriers to change. Yet it could be said that some public interviewees perhaps over-estimated the potential barriers (*e.g.* in predicting or expecting public outcry in response to possible changes being discussed). In other words, public participants suggested that they felt they – and the wider

public – were less flexible in their electricity use than many expert participants perceived them to be, and some appeared to be more resistant, or reluctant to endorse, visions of possible change than insights obtained from expert interviews would suggest. This has potential implications if experts' assumptions of public acceptability of technology significantly vary from reality, and provides further evidence for the need for greater engagement and participation of members of the public in the development of sociotechnical systems. An additional consideration of this finding relates to upstream engagement of members of the public in innovation processes. A central theme of the thesis argument involves suggestions of greater engagement with the public in innovation to enable various concerns and hopes about change to be more readily considered further upstream in the process. However, it could perhaps be argued that if public concerns appear to highlight potential issues or barriers to all possible change, does it become counter-productive or futile to attempt to move engagement further upstream, as all possibilities may be vetoed or dismissed? Whilst this argument could be critiqued as being too dismissive and as such fails to take into account important and relevant considerations from members of the public in the innovation process, it does help to demonstrate the balancing act required in deciding how far 'upstream' engagement should be moved, particularly in relation to visions of future-oriented technologies and social change, which, as evidence discussed in this thesis shows, can be difficult to imagine and talk about.

Visions for achieving increased flexibility of demand within the home raised numerous concerns amongst public interviewees. Despite visions of automation and interactive participation adopting differing approaches (*i.e.* the former aims to take control and responsibility away from individuals, and the latter increases the active role for individuals in managing their demand), there were concerns that were common to both. For example, some discussed their lack of trust of third parties or external actors (including government), particularly in the context of data security and privacy, whilst aspects of technologies aiming to manage demand were described by some as invasive. Concerns such as these highlight potential perceived barriers to change, and whilst many were foreseen and expected by expert participants, these concerns would still need to be overcome or acceptably managed in the design and implementation of any possible future change. A potentially significant barrier identified centres on the apparent belief amongst many public participants that demand for electricity in the home remains inflexible. This suggests that many participants did not believe that visions of people consciously planning their electricity use to shift demand – or of technological tools automatically managing this

process – were realistic or achievable, despite evidence from solar PV users demonstrating that shifting demand can be possible.

Despite some findings from public interviews highlighting greater perceived concerns than expert interviewee responses suggested, there were other potential concerns identified by experts that did not appear to be seen as problematic by public participants. For example, some expert participants anticipated that automation may be perceived as a technically confusing concept which as a result may alienate or concern potential users. However, most public interviewees did not appear to be concerned about the perceived difficulty of using it (despite them not necessarily supporting the idea of automation itself). This anticipated public response differing from reality could be further interpreted as evidence for the need for public hopes and concerns to be considered earlier in the research process. However, it should also be noted that public participants were a self-selecting sample who replied to recruitment adverts primarily over email. It could therefore be argued that participants were confident and competent at using information technology, and as such may not be truly representative of the wider public.

Whilst many potential barriers to change – such as 'Big Brother' concerns for visions of automation (Goulden *et al.*, 2014), and reluctance to having to actively manage demand within visions of interactive participation – were identified, some public participants did not appear to view visions of change as problematic or unacceptable. Indeed, some suggested that they felt many people are simply generally opposed to change, particularly if they do not see the need for the imposed changes. Whilst this in no way reduces the validity and significance of the concerns that have been discussed in relation to possible change within the electricity system, it could perhaps be interpreted to suggest that the notion of imposed change *per se*, as opposed to the specific components of visions discussed, may in part explain opposition. This expectation of resistance to change may also perhaps help to explain expert participants' apparent ambition of superficially maintaining the status quo (*i.e.* not requiring significant change on behalf on individuals, but instead reducing and shifting some demand through technological mechanisms such as automation), which involves less conspicuous change than visions requiring a more active role for individuals in managing their demand. A further dynamic was identified in some public interviews where participants appeared to want to portray themselves as open to and accepting of possible change, whilst simultaneously discussing possible concerns that they felt other people may have and suggesting that they felt other people may be less willing or

able to accept change. These 'us and them' narratives could perhaps be interpreted as a way for participants to air their own concerns without wanting to outwardly admit to them or portray what they felt to be socially undesirable responses.

Many expert interviewees' visions of change positioned smart meters as the 'hub' of home future electricity systems, which suggests that these devices will play a key role in any changes to how people use electricity in the home. As such, public concerns relating to a variety of aspects of visions of change may be perceived to be linked to smart meters as central components of the system, which could suggest that the planned UK smart meter rollout (DECC, 2012b) may not be met positively if concerns remain. For example, some public interviewees did not appear to appreciate the need for smart meters to enable two-way communication between homes and system operators (to assist in the management of balancing supply and demand). This could perhaps show a lack of understanding of how smart meters work, or may be a reflection of the concerns and lack of trust many participants discussed in relation to third parties with access to the data. Other participants suggested that they were unfamiliar with smart meters and were unaware of what smart meters are and do. This arguably reflects the lack of 'expert' consensus on the role for smart meters and how these may be designed and implemented in the future. Jasanoff (2003) argues that participatory processes of engagement and interaction can help to move away from traditional, limited 'technologies of hubris' – where science is afforded the authority to steer developments and innovation – towards 'technologies of humility' which engage people as active, imaginative agents and sources of knowledge and insight. For this reason it is suggested that deliberative, upstream engagement may enable both public and expert hopes and concerns to be identified and considered before technological designs and supporting policies are finalised, which may help to produce smart meters that are met with more acceptability and support when they are rolled out.

A key finding from the public focus groups and follow-up interviews involves the apparent mental link between energy and cost. Indeed, when discussing electricity use – and energy more widely – in the home, even when explicitly instructed to focus on aspects other than cost, participants often eventually reverted to financial framings. This preoccupation with thinking about energy in cost terms may perhaps help to explain support for the idea of financial mechanisms or incentives to achieve change. An interesting contradiction identified in public and expert interviews involved financial mechanisms being advocated to drive change in the times people use electricity (to achieve greater demand flexibility),

yet some participants simultaneously suggested that these would not work due to the constraints on how far the economics could be manipulated (*i.e.* how expensive electricity could feasibly be made) to make financial considerations more important than other more immediate and meaningful factors in decision making. This therefore suggests that many public and expert interviewees felt that financial mechanisms would be unable to deliver significant change, which raises questions over why these still appeared to be the go-to suggested strategy for achieving change. A further interesting dynamic in discussions over costs related to distinctions between long-term and short-term decisions. Longer term, 'big' decisions (such as investing in energy efficiency measures) were suggested to be strongly influenced by cost considerations, and as such could be described as loosely conforming to 'rational-economic' assumptions of behaviour. However, shorter term, everyday decision making was stated to be more strongly influenced by the motivation to fulfil and meet immediate needs (such as comfort). Indeed, this resonates with literature on habitual behaviour, where everyday habits are not subject to conscious cost-benefit analysis (*e.g.* Verplanken *et* al., 1998). For this reason cost was suggested to be a less important factor in everyday decision making, thereby demonstrating that people may be less likely to follow economic drivers in this context.

Public mistrust and concerns over the ability and motivations of government make it difficult for policy-makers to provide the impetus for change. This is perhaps most challenging in the context of aiming to shift or reduce energy use which has significant implications for people's lifestyles and may infringe upon important and meaningful aspects of domestic life. Additionally, the notion that many people did not perceive themselves to be wasteful of electricity – coupled with the feeling that electricity demand is relatively inflexible – demonstrates the potential scale of the challenge. However, whilst many public responses to visions of possible change highlighted a number of implications and potential barriers, other findings demonstrate the potential scope for change. Indeed, evidence from solar PV users suggests that – at least within their own specific contexts – people may change how and when they use electricity, thereby demonstrating that increasing the flexibility of domestic electricity demand can be achieved (with the obvious caveat that these participants 'opted-in' to a scheme as opposed to having a technology imposed upon them, which would be a vastly different context).

In summary, this chapter has demonstrated how public participants perceived and related to visions of possible future change, and identified a range of implications for potential

policy and technical innovations. Furthermore, findings suggest that public hopes and concerns need to be included further upstream, and that the current reliance upon and support for (by both public and expert participants) techno-economic solutions to the problems of reducing and shifting electricity demand may in part be explained by assumptions of 'rational-economic' action and the desire for the current status quo of domestic electricity use to be maintained, even if participants themselves felt that these may be insufficient approaches to achieving significant change.

7 Conclusions

7.1 Addressing the Research Questions

Understanding how and why people relate to and use electricity in the home is critical in attempting to facilitate change in domestic electricity demand to enable the UK electricity network to accommodate an increasing proportion of electricity generation from renewable sources, thus contributing towards the transition to a more secure, affordable and lower-carbon system. By conducting focus groups and interviews with members of the public, in addition to interviews with expert participants, this thesis has sought to investigate and understand the dynamics of domestic electricity demand and how people imagine this may change in the future. To achieve this, the following research questions were devised:

1) How do people understand and interact with their existing electricity supply system in the home?
2) What are the reasons and motivations for implementing future changes in network provision?
3) What role do public and expert interviewees imagine electricity will have in future society and domestic settings?
4) How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

This chapter provides a brief summary of the answers to these research questions, and synthesises the overall findings from the thesis. Novel contributions and the implications of the research findings are discussed, in the context of possible avenues for future research and for policy makers and designers or engineers responsible for technological innovations that may be employed in attempts to achieve the transition to a future, desired electricity system.

7.1.1 How do people understand and interact with their existing electricity supply system in the home?

This section outlines and summarises key findings relating to research question 1. Whilst some participants suggested that they were aware of their electricity use, most public interviewees and focus group participants stated that they felt they were generally unaware of the amount of electricity they used, and how their electricity demand directly related to their behaviour within the home.

Whilst different levels of perceived awareness of electricity use in the home were identified, a more consensual view was discovered where electricity was perceived by both expert and public participants to be taking on a more important role in everyday life currently. Whilst the UK's electricity supply was perceived to be relatively secure by both public and expert interviewees, this importance of electricity today playing a crucial role appeared to be reflected in people's concerns over the magnified perceived risks of the potential impacts of power cuts, as the increasing number of products and systems that rely upon electricity would create significant inconvenience if significant power outages were to occur.

Many participants appeared to regularly relate energy with cost and money - to the extent that attempting to get interviewees to avoid financial or economic framings in discussions proved difficult. In particular, participants across all three research phases described how they felt economics is a key driver of decision making and behaviour. This preoccupation with framing discussions on electricity use in financial terms, coupled with the assumption of 'economic–rationality' may help to explain public and expert advocacy of policies that aim to manipulate the financial context of using electricity. However, contradictory statements – particularly, though not exclusively, in the public focus groups where participants quizzed and challenged each other – provided evidence that demonstrates how more meaningful aspects of homeliness and the desire to fulfil immediate needs (*e.g.* to be comfortable or relaxed) are considered to be more important drivers of behaviour than financial considerations. This, coupled with the suggestion amongst expert interviewees that electricity prices could not realistically be sufficiently manipulated to the extent that cost would become more important than other considerations, arguably suggests that financial mechanisms for achieving change may be limited. Conversely however, whilst evidence obtained generally suggests that only limited change may be achieved through economic mechanisms, evidence from public interviewees with solar PV does demonstrate how change can be achieved. Indeed, these participants argued that they put up with the

inconvenience of changing routines and 'syncing demand with the sun' purely to save money.. Investigating this from a practice-theory perspective can perhaps help to explain the theoretical and policy implications of this novel finding.

Changes in individual elements of practices – such as new knowledge materials (such as the electricity generated by solar PV systems) – can result in significant change and reconfigurations to wider 'networked assemblages' of practices (Reckwitz, 2002a). The findings from interviewees with solar PV indicate that the meaning attached to electricity appears to be changed. This perhaps resonates with Goulden *et* al.'s (2014) discussion of participants with experience of community energy schemes, where people who are involved in both the creation and consumption of electricity attach new meanings to electricity, which creates potential for more intuitive engagements. Indeed, as Pierce and Paulos (2011) discuss in the context of human-technology relations, the meaning attached to electricity changes when it becomes 'presenced' as an object in its own right. This helps to make the role that electricity plays in daily life more visible and salient, and, from a practice theory perspective, reorients electricity as an active (as opposed to background) component within practices. Indeed, perhaps this has helped to raise electricity above the parapet of normal, mundane everyday life, and as such has transformed electricity from being a background force to a more meaningful resource that is both used and produced, and as such is more 'preciously' treated, resulting in people wanting to use their 'own' generated electricity. The lengths to which participants appear to go to maximise their use of 'free' generated electricity demonstrates evidence for a reconfiguration of interlinked domestic practices, and resonates with Southerton's (2006) discussion of the temporal organisation of daily life. Furthermore, it could be argued that the ways in which solar PV participants started to actively check weather forecasts in order to 'sync with the sun' demonstrates new skills and knowledge development, which in turn may further influence the practices being performed (for example, the weak evidence found for environmental spillovers – such as replacing bulbs with efficient models – could perhaps be a result of this).

This finding is potentially very important as many findings from this thesis and the wider literature suggest that achieving voluntary or acceptable change in household domestic electricity demand is very difficult, yet the new meanings that people attach to electricity produced through their solar PV systems appears to increase the value attached to it. There are also theoretical implications and avenues for further research that could be explored in

the light of this finding. Rettie (2012) discusses 'practice domain owners', who take ownership of sets of practices within the household, and thus influence electricity use relating to these practices. It would perhaps be interesting to study householders' interactions with solar PV from an ethnographical perspective to investigate in more depth the changes and reconfiguration of domestic practices that appears to be occurring. For example as Kan *et al.* (2011) highlight, there is often a gendered distribution of household practices, and it could be interesting to see if the new meanings attached to electricity itself - as a result of the 'ownership' from generation – resulted in negotiations or changes in the performance (in terms of who, how, when and why specific practices are being performed) of specific, gendered practices within households.

7.1.2 What are the reasons and motivations for implementing future changes in network provision?

This section outlines and summarises key findings relating to research question 2. Expert interviewees were asked to provide reasons for why they thought change needed to occur in the operation of the electricity system. Public participants were not specifically asked about this, however, implicit motivations for change were uncovered throughout some interviews and focus groups. Affordability of energy was never explicitly discussed as something to strive to achieve or maintain, however, both public and expert interviewees expressed concerns over affordability, particularly in the context of possible dynamic pricing strategies and how those on limited budgets and rigid schedules may be adversely affected by peak demand prices. This perhaps suggests that, implicitly, some felt that an underlying reason for the need for change is to create a system that enables and ensures a more affordable energy supply. The fact that this was identified, but generally not explicitly stated, is interesting and could suggest that more research should be undertaken to unpick why this appears to be deemed important, yet often remains in the background, left unstated as an implicit aim. Energy security was commonly discussed by expert interviewees as an obligatory requirement of all visions of possible future electricity systems. However, both public and expert interviewees expressed concerns about the possible risks of power outages becoming greater with more intermittent renewable generation – although this appeared to be stated with the expectation that this challenge could and would be managed, as opposed to being considered as a critical risk that undermined visions of change. Decarbonisation was suggested to be the main driver that

necessitated change by nearly all expert interviewees, and appeared to be the basis upon which all considerations for possible changes to the electricity system are built – namely increasing the proportion of renewable generation, and thus the resultant need for achieving change in how and when electricity is used within the home. Indeed, striving to decarbonise the system appeared to be the key, stated motivation for driving change, with both affordability seemingly being an extra consideration within this approach. Interestingly, whilst decarbonisation did appear to be the 'ideal' vision positioned at the end point of the imagined transition from the current energy system, and as such was discussed as the dominant driver of research and policy focus, energy security was also discussed as being important, but from a slightly different dynamic. Indeed, whilst decarbonisation was discussed in ways that appeared to frame it as an 'aim', energy security appeared to be considered a fundamental, obligatory component of any visions of change, and as such was not framed as an aim of future energy systems, but a requirement that underpinned and prescribed any other aims. This subtle difference is interesting as decarbonisation appeared to be discussed as a – albeit very important – target, whereas energy security was framed as crucial, despite decarbonisation – and the ways of achieving it - being more widely and explicitly discussed. In summary, many implicit and explicit motivations for change were identified, with the most commonly discussed being the 'energy trilemma' of decarbonisation, affordability and security. However, the different dynamics between each of these components and their framing as targets or necessities was interesting and unexpected. A reflexive note to qualify findings here is also appropriate. Whilst it is perhaps expected to some extent that expert participants taken from a sample of academics researching possible innovations to help to decarbonise the electricity system would prioritise decarbonisation as a key reason for the need for change, the author argues that, having witnessed the wide range of responses and discussions within the Phase 2 interviews, the views and topics being discussed appeared to be varied and considerate of the wider context, as opposed to focusing solely on decarbonisation. Furthermore, whilst the thesis has consistently referred to Phase 2 participants as 'experts', no claims to the wider generalisability of the findings as a representative sample are made. It is also argued that this in no way diminishes the relevance or importance of the findings, as it is still interesting and useful to understand and identify the understandings and motivations of a small, unrepresentative sample of experts working within the field, even if this in some cases acts purely as a base point to inform future research. Visions of expected change that were discussed by both public and expert participants helped to further demonstrate the

underlying motivations and perceived need for change, however, to avoid repetition and enable a more concise narrative to be drawn together, these are discussed within the following sections of this chapter.

7.1.3 What role do public and expert interviewees imagine electricity will have in future society and domestic settings?

This section outlines and summarises key findings relating to research question 3. To enable greater penetration of renewable generation technologies in the UK electricity system a key vision that appeared to be prioritised by experts – even more so than the need to reduce demand – was the desire to achieve more demand flexibility within the domestic sector. As a result many discussions on future electricity use in the home focussed on mechanisms to achieve greater flexibility. A finding that emerged from expert interviews involved the notion that there exists a wide range of definitions of what a smart grid is, and within this there is variation in the definitions of – and perceived role for – technologies such as smart meters (Balta-Ozkan *et al.*, 2014). Indeed, some discussed the differing definitions of these technologies that may develop as a result of different (*e.g.* national) priorities driving the evolution of electricity networks. This resonates with literature discussed in Chapter 2 on sociotechnical imaginaries, where different roles for smart grids may be imagined. For example, one expert participant suggested that they felt Chinese visions of smart grids involved developing a strong, secure system. This perhaps mirrors Jasanoff and Kim's (2009) discussion, where – like nuclear technology's role in South Korean economic development – a smart, secure grid in China may help to provide societal and economic opportunities for development as a more resilient network increases the number of households and commercial or industrial users with access to a reliable electricity supply. In contrast, imaginaries relating to European and UK smart grids may be positioned more as an opportunity for the electricity network to become more intelligent (echoing Strengers' (2013) discussion of 'smartness' as an imaginary of intelligent technological systems), which subsequently enables a greater proportion of generation to come from renewable sources, and thus contributes towards achieving legally binding policy-targets for decarbonisation. Many public participants talked about their own lack of familiarity with smart meters, particularly in terms of devices that are more complex than simple energy monitors. This lack of familiarity with, and perhaps understanding of, smart meters and their imagined role within future systems amongst public participants is both

interesting and potentially important as the implementation of DECC's smart meter roll-out gathers pace in the coming years before the 2020 deadline. Indeed, this may reflect the lack of expert consensus in visions of the role of smart meters and how this will impact the ways people use electricity, which has perhaps contributed to muddled discourses surrounding smart meters and thus may influence public awareness of (and potential perceptions towards) smart meters (indeed, Popovic and Sahovic (2014) discuss the various definitions of smart meters that are used within expert and academic discourse).. This resonates with Krishnamurti *et al.*'s (2012) findings of US survey and interview participants confusing smart meters and energy monitors. However, to the author's knowledge this thesis offers the first published evidence of a muddled and confusing discourse relating to the seemingly-interchangeable use of smart meters and energy monitors in the UK. It is suggested that further research, possibly adopting a discourse analytic approach, be conducted to investigate this further, as this has potentially significant implications for the future rollout of smart meters in the UK. After being provided with a brief summary of the characteristics of a basic smart meter and the role that it may possibly play in achieving both reductions in demand and attempts to increase the flexibility of demand, participants provided numerous insights that identified the hopes and concerns associated with possible change. For example, some participants expressed a desire to feel empowered, and smart meters were suggested to be a means of achieving this by providing people with feedback on their electricity use, enabling them to potentially manage their demand more readily – resonating with the desire for autonomy and freedom in relation to energy use identified by Parkhill *et al.* (2013). However, many expert visions of change that involved smart meters did not necessarily position users as active, empowered participants, but centred around the motivation to minimise the role and responsibility for individuals in creating a more flexible demand from the domestic sector (mirroring Strengers' (2013) discussion of 'smartness' as an imaginary involving making devices – as opposed to people – 'smart' about energy). Popovic and Sahovic (2012) classify smart meters into two broad categories, which seem particularly salient here. Advanced Meter Reading systems are discussed as smart meters that provide feedback and accurate billing information – which may fit well with public participants' desire for empowerment. However, Advanced Metering Infrastructure that involves two-way communication and provides the opportunity for external actors to control demand (and therefore arrest control from individuals to some extent), fits more closely with some expert visions, but does not necessarily appear to tally with the stated desire for empowerment and autonomy within public findings (both in this thesis and the

wider literature (*e.g.* Parkhill *et al.*, 2013)).

In summary, the apparent assumption within expert visions that by-passing individual interaction and engagement is the most appropriate way of achieving change contrasts with the desire for empowerment expressed by some public participants, which arguably suggests that some public participants would be unlikely to be accepting of such visions. As smart meters were identified by experts as a technology with a key role in any potential change – and one that is mandated to be rolled out in the UK – this has important potential policy implications relating to their acceptance and adoption by public users.

Automation of demand was suggested to be a way of achieving this flexibility, and was argued, particularly by expert interviewees, to be manageable as it enabled components within the home to be externally controlled and automated to aim to synchronise demand with supply, and did not rely upon individual engagement. Indeed, this desire to avoid relying upon participation resonates with Goulden *et al.*,'s (2014) finding of scepticism amongst public interviewees towards future 'smart grids' requiring users to become more conscious and aware of their energy use and the wider role that individual users play within the electricity system. This appeared to be viewed by some as a more acceptable mechanism for change than visions that required users to consciously plan their demand or react to third party signals, even though it was acknowledged that aspects of perceived control and issues relating to the trust of third parties may be problematic. Indeed, public participants did express these concerns, however, some appeared to be open to the idea of home automation on the basis that having an 'override' function would ensure that control could be recovered at specific times if necessary (mirroring Parkhill *et al.*'s (2013) survey findings). Whilst an underlying motivation for automating demand appeared to be to bypass the need for engagement and behaviour change by individuals, instead relying on 'smart' technology to achieve the anticipated change, other visions more readily reflected the desire expressed by interviewees for individuals to play an active role in change and to become more empowered actors within the wider system.

Dynamic pricing was suggested to be used in conjunction with signals on smart meters to give users real time price information that reflected availability of supply, and thus enable people to engage with and react to signals from system operators or plan aspects of their demand (*e.g.* with timers). However, whilst this appeared to be more acceptable to many individuals because it perhaps posed less of a threat to the notions of freedom and control within the very personal home space, and also provided the opportunity for people to feel

empowered and more in control of their own electricity demand, others were less enthusiastic about this vision. Indeed, some felt that having to more carefully plan and be aware of their electricity demand would be annoying and over-complicate life – again demonstrating the range of differing positions referring to possible change, suggesting that all possible change may be met with some opposition. Furthermore, some public participants suggested that most of their demand was perceived to be inflexible, limiting the scope for change, whilst both expert and public interviewees posited that price manipulation may simply not provide sufficient incentive to overcome the more meaningful aspects of behaviour within the home that relies upon electricity. In addition to responses indicating a perceived lack of flexibility of demand, which could potentially be a significant barrier to people's acceptance of the need and viability for change, and appeared to influence views towards automation and alternative imagined scenarios involving a more conscious, participatory means of shifting demand, the specific appliances or technologies that would be targeted within these visions appeared to be crucial in terms of acceptability. Notably, automation of white goods such as washing machines appeared to be met more favourably than things that had more meaning attached to their use, such as ovens. Considered from a social practices perspective, this could suggest that appliances – such as washing machines- that enable practices that do not necessarily have a fixed time within daily routines are perhaps more readily available for flexible management, and as such may be perceived to be more suitable for automation. In contrast, cooking could be argued to be more meaningful than the operation of a washing machine, and also is perhaps more fixed within daily routines, which may help to explain why ovens and other appliances that enable users to perform cooking as a practice, are met with opposition when discussed in the context of automation or other visions involving a reconfiguration of how and when these practices may be performed, which could be argued to threaten the notions of control and convenience within the home (*e.g.* Parkhill *et al.*, 2013) and require a reordering of practices within daily schedules (*e.g.* Southerton, 2006)..

An interpretation and summary of the broad public and expert views towards possible mechanisms for achieving greater demand flexibility could be that visions involving a more active role for individuals in planning their demand appeared to be more acceptable for most participants, however, this approach also appeared to be perceived as less likely to succeed than home automation, which would negate the need for engagement and instead rely upon technology.

7.1.4 How socially acceptable are possible future changes in electricity network provision, and how might this impact future policy, technologies and lifestyles within the home?

This section outlines and summarises key findings relating to research question 4. Amidst discussions on possible future change, a recurring theme involved the notion that any form of significant change to how electricity is used in the home would be likely to negatively impact lifestyles in the home, whilst also potentially encroaching upon people's freedom or desire for perceived control. Moreover, some suggested that change needs to be seen as an improvement, mirroring Demski *et al.*'s (2015) findings. For this reason it could be suggested that implementing change will be potentially problematic as findings appeared to suggest that change would likely be perceived as constraining choice or freedom as opposed to being an improvement from the existing situation. Indeed, as Parkhill *et al.* (2013) and Butler *et al.* (2013) highlight, choice and perceived control are key values that influence perceptions towards - and acceptability of - change, and therefore if people feel that their choice or control relating to how electricity is used in the home is constrained by change, then visions may be unlikely to be seen as an improvement, and as such may be viewed less positively than alternatives that are perceived to be less constraining. This has potentially important implications for policy and communication strategies. Considering this – whilst being mindful that these findings should not necessarily be interpreted in isolation as the basis for policy prescription – perhaps suggests that policies that support technological innovations, whilst also aiming to avoid imparting 'top-down', constraining aspects may perhaps be more readily accepted. Extending this, it could be suggested that communication that aims to highlight the potential improvements that imposed changes may bring should also perhaps be devised. For example, this could perhaps mirror the approach undertaken by the government in setting up 'Smart Energy GB' to provide positive marketing to raise awareness and acceptance (in part by highlighting improvements such as more accurate billing)(Buchanan *et al.,* 2016) of the policy-mandated smart meter roll-out.

An interesting contrast between public and expert interviewees was identified, where public participants appeared to feel that their home electricity demand was less flexible than expert participants perceived them to be. This may be explained in part by the fact that some experts appeared to believe that simply providing people with more information about why they need to change how they use electricity would be sufficient in getting

people to change. This demonstrates the significant assumptions within expert expectations of public acceptance of change, and further highlights the need for more upstream participation from public users as this may help to narrow the gap between public and expert assumptions of acceptable change and how this may be achieved.

A final key finding relating to visions of possible change, and thus the perceived acceptability of these, involved the fact that both public and expert participants struggled to imagine possible future social or behavioural change within visions of the future electricity system. In contrast, most people felt generally (cautiously) optimistic about technology and its potential for having a positive role in societal change, and appeared to be more confident and have greater conviction in their ability to imagine possible technological change. This is interesting and – to the author's knowledge – potentially novel, as Shirani *et al.* (2015) describe the difficulties that people have in imagining general future change, however, the author has been unable to discover published literature that discusses this difference between imagining technological and social change, despite it seemingly being a straightforward and not-all-that-unexpected finding. Henwood *et al.* (2012) discuss the more nuanced understandings of current life that can be obtained through investigating visions and hopes of the future (resonating with literature on the sociology of expectations). As such, this finding could have important theoretical implications, which, the author suggests, could be further developed by investigating more explicitly the ways in which people imagine and talk about the future, to try to understand the difference between technology and more social or behavioural considerations. This finding may also help to explain participants advocating technological mechanisms as the most appropriate solution for achieving both reductions in demand (*e.g.* through energy efficiency) and increasing flexibility (*e.g.* through automation), as they may have felt more confident in explaining and justifying their visions. This may also perhaps explain why there appears to be an implicit desire to maintain the existing situation in terms of how electricity is used within everyday domestic life. As such, this aims to meet the challenge through the application of technology to achieve almost superficial, background changes in demand that have limited conspicuous impact on people's ability to use electricity freely in the home, as opposed to requiring potentially significant behavioural and routine change and tasking domestic users with re-negotiating their relationships with electricity in the home.

7.2 Synthesis of Key Findings and Implications

A number of central, recurring themes throughout expert and public discussions on how and why people use electricity in the home and how changes to this may be achieved were identified. Solutions involving techno-economic framings dominated visions of future change. Indeed, despite evidence from across focus groups and interviews demonstrating the complex, interrelated factors that influence how electricity is used, many suggested solutions aimed to employ technology to bypass the need for user engagement or to drive behaviour based upon the assumptions of 'economic–rationality'. As such, many visions of future change fit within what some would term 'ecological modernisation', where technological and economic solutions to environmental problems are advocated. Wider application of this term is often used in reference to attempting to maintain economic growth and simultaneously protect the environment (*e.g.* Backstrand and Lovbrand, 2007). Visions of technological mechanisms creating a more flexible demand in the home fit this definition, where attempting to align electricity demand with supply reduces the requirement for cuts in electricity consumption, whilst ensuring that greater penetration of renewable generation technologies in the electricity system can occur.

Despite evidence from participants with solar PV panels demonstrating that in specific contexts achieving change through economic mechanisms is possible, many discussions on the meaning attached to why electricity is used in the home – and what it enables people to do – suggested that both public and expert participants generally felt that changing people's behaviour is a complex task that will involve more than the simple manipulation of the financial context and cost of using electricity, even though economic mechanisms were often posited as potential solutions. Other assumptions about behaviour were identified, particularly amongst some expert interviewees. Indeed, some interviews highlighted assumptions of a public knowledge deficit, which involved the belief amongst some participants that providing people with more information and 'educating' users about the need for change will help to make people accept and perhaps adopt changes.

These assumptions of behaviour and marginalisation of sociological and psychological considerations, whilst completely valid reflections of participants' subjective experience and understandings, are interesting and may help to explain the reliance upon and advocacy of technological solutions. Whilst technology inevitably has a pivotal role to play in achieving change, this thesis suggests that more importance needs to be placed on designing innovation around users, as opposed to merely devising technological solutions and then

attempting to persuade users to adopt these appropriately. For this reason, findings suggest that engagement and public participation in research and innovation processes is undertaken further upstream, to ensure that relevant hopes and concerns relating to possible changes are considered, and enabling the desires for participation and empowerment to be, at least in part, fulfilled. This increases the opportunity for concerns to be avoided or overcome in the development of policies and technological developments, which may help to minimise the social amplification of risks relating to possible change, increase support for implemented change, and thus contribute towards the increased likelihood of successful adoption of anticipated change that enables domestic electricity demand to more readily support the transition towards a future more sustainable electricity system.

7.3 Reflections on and Contributions to Theory

The thesis has drawn upon various theoretical concepts and methodological approaches (such as grounded theory) amongst other literature primarily to generate empirical findings that help to understand how and why people use electricity in the home, in addition to visions of how this may change in the future. However, it has not been a central aim of the thesis to generate theoretical contributions *per se*. Nevertheless, some insights that draw and build upon existing theoretical concepts have been obtained and are summarised in this section.

(Greckhamer and Koro-Ljungberg (2005) state that the boundary where empirical description ends and theory begins remains disputed in academic discussions on grounded theory. Indeed, Crotty (1998) refers to early grounded theorists' (*e.g.* Glaser and Strauss, 1967) attempts to differentiate themselves from ethnographers who were perceived to generate 'researched description' as opposed to 'sociological theory'. This thesis has built upon aspects of grounded theory in terms of generating findings that have emerged from and are grounded in the data. Yet the overall thesis also contains commonalities with more ethnographic approaches as the aim has been to investigate the reasons for how and why electricity is used in the home, and therefore involved describing and interpreting how participants talk about their use of and perceptions towards electricity.

A critical reflection on the approach of the thesis could centre on the decision to draw upon insights from literature on social practice theory, other sociological literature and more psychological approaches. For some scholars, attempting to draw together insights from these sets of literature in the context of studying energy consumption would be seen as futile or even inappropriate because some deem these approaches, which have differing units of study (*i.e.* 'practices', 'society' or 'individuals'), to be incompatible (for a brief summary of this debate see Chapter 2). However, the researcher contests that a strategy adopted in parts of participant interviews, which was informed primarily from social practice theory approaches – namely asking people about practices they perform in the home – helped to unlock the meaning of these practices and get people to engage beyond the more mundane aspects of energy use. Reflecting upon the perceived benefits of this approach, which drew upon numerous theoretical and methodological ideas, the researcher suggests that similar approaches that aim to bring together these approaches in a coherent way, rather than being disparaged, should be encouraged.

In addition to the broader theoretical and methodological reflections discussed above, other theoretical contributions were generated in the thesis. The financial framing of various energy-related debates by participants in interviews, and the assertion that economics is the key driver of decision making, shows how imagined 'publics' and future users of electricity were positioned by participants as asocial, economic actors as opposed to being imagined in the context of sociological structures, communities or networks. Indeed, the economic framings of various debates on energy use mirror models of 'rational-economic' action, despite numerous other findings from the thesis demonstrating that there is a more complex interplay occurring between economic, sociological, political, psychological and other factors. Further work could perhaps aim to build upon models of economics and behavioural economics to more appropriately and accurately reflect this sociological complexity. Alternatively, this could be interpreted to suggest that perhaps in the complex context of home, within a wider sociotechnical system, it is impossible to develop theories that are able to adequately explain or predict how and why energy is used. Indeed, this reflection resonates with Kearney's (2007:128) assertion that tension exists between our "*need to create rules of thumb"* and our "*postmodern awareness that the complexity of life can never be fully captured in any theory"*.

Other findings demonstrate that electricity use is complex and suggests that economic theories are often not capable of predicting or indeed influencing behaviour. However,

whilst this appeared to generally be true, evidence from interviewees with solar PV shows that in specific contexts people may alter their energy use for financial gain, further demonstrating the complexity of developing theories that are capable of accurately explaining behaviour relating to electricity use. An additional level of complexity identified from solar PV interviewees centres on the evidence that was found for theories of both behavioural spillover and rebound theory. Spillovers were identified where, following initial acquisition of and engagement with solar PV panels, participants then made more pro-environmental changes such as replacing light bulbs with more efficient models. However, some participants also provided evidence for possible 'rebounds', where they would use more electricity than they previously would have to make the most of 'free' electricity whilst it was being generated during sunny intervals. These findings again show the complex relationship between the theories in the context of economics. This could perhaps further suggest that a better understanding of the dynamics of these theories and the interplay between cost-benefit decisions and other, more immediate desires being fulfilled should be obtained, which may suggest that definitions and approaches of spillover and rebound theories are broadened.

A final reflection centres on and raises possible questions for STS literature relating to the sociology of the future that has been drawn upon within the thesis – namely expectations of the future and sociotechnical imaginaries (see Chapter 2). Participants' struggles and unease with imagining the future could suggest that it may be more appropriate to term such theoretical perspectives as 'hopes' of the future, or perhaps as visions of 'desired' futures. This is proposed because, whilst in some contexts (for example expert interviewees discussing general trends of increased uptake of renewable technologies) participants appeared to discuss visions of the future with reasonable conviction, in others many appeared to be much more speculative and less certain. For this reason it could be suggested that their 'visions' of the future were perhaps more strongly influenced by their hopes or concerns, which in turn could be said to have been influenced by their own personal identities and values. Whilst this in no way invalidates their expectations and hopes of the future, developing theories that more accurately take into account and reflect upon the level of conviction - and indeed the role that hopes or concerns may play - in people's visions may be a valuable endeavour which may enable more accurate and nuanced interpretations of visions to be obtained

Related to this, the term sociotechnical imaginaries in the context of the findings obtained in this thesis may place too much emphasis on the sociological components of imagined futures, as both public and expert participants appeared to imagination technological change more willingly - and seemingly with more conviction – than societal change. Resonating with literature on ecological modernisation, this suggests that technological changes were imagined as solutions which solved issues such as energy security and decarbonisation of the electricity system, and enabled 'lifestyle maintenance' (*e.g.* Kurz *et al.*, 2010) and the current 'status quo' of how electricity is used in everyday life to be maintained. Indeed, the fact that the actual societal 'visions' appeared to remain very much static – and technologically-oriented – suggests that the dominant visions of the future portrayed could perhaps be more accurately described as 'technical imaginaries of future society', as opposed to the more sociologically-focused visions identified by scholars such as Jasanoff and Kim (2009) in their research into sociotechnical imaginaries. Whilst this is not aimed as a critique of the literature on the sociology of the future, but merely as a reflection on how the literature fits within this thesis, it does contribute to the growing body of work within STS on visions of the future and perhaps helps to provide a new perspective that portrays the perceived importance and even dominance of technology within visions of future sociotechnical change.

7.4 Research Limitations and Avenues for Future Research

Within STS studies – and also research into perceptions of risk - there has been much focus on investigating emerging sociotechnical systems or novel technologies. However, the technological subject of this thesis – namely the UK electricity system – is subtly different from many studies because the electricity system is an already well-established system in which various actors have defined roles. Highlighted visions of possible changes to the electricity system – in part shaped by political ambitions or motivations to transition towards a future network that meets the components of the energy trilemma – involve novel technologies that will require people to re-negotiate their existing roles within the wider system, and as such change how and when they use electricity in the home. This is a slightly different dynamic to much research that focuses on new sociotechnical regimes that emerge and create new possibilities for novel behaviours and routines. This arguably comes with different and perhaps more problematic dynamics in terms of potential barriers for change, but also provided the opportunity for a novel approach to be adopted, particularly

in relation to investigating the sociology of expectations and imagined futures. In addition to this, the decision to interview both public and expert participants ensured that the research undertaken would be novel and original, and therefore contribute to the existing literature. To date there has been little in-depth qualitative research investigating visions of possible future electricity system developments, and expectations of how this may impact people's use of electricity in the home. Furthermore, being able to compare aspects of expert and public visions helped to unpick the assumptions embedded within these, which helped to identify components of visions which were perceived to be important. For this reason it is suggested that comparisons between expert and public participants are more commonly conducted in research investigating sociotechnical change as understanding the motivations, hopes and concerns of these stakeholders will always be a key component in such contexts.

The grounded approach adopted in the thesis – where each research phase identified important themes and informed subsequent phases – helped to obtain insights into a range of interesting and important aspects to meet the aims of the project. The approach enabled the research process to move from open-ended questioning to more focused and targeted investigation of specific issues that were deemed to be important by both expert and public participants. However, due to the constraints (*e.g.* time and budget) of PhD research, more insights could have potentially been obtained if the research had been conducted with a greater sample size, range of participants or other considerations. As such, limitations of the research undertaken for the thesis have been highlighted, along with a discussion of the opportunities for further research that have been opened up as a result.

The participant sample selected provided a broad range that helped to address the research questions. However, inevitably, drawing upon a wider sample of experts (such as professionals from energy companies and policy makers), along with public participants from a broader range of backgrounds (particularly participants in energy poverty) would have provided additional insights and enabled assumptions and motivations within visions of change to be further unpicked. An avenue that could be explored to unveil broader and more significant differences in imaginaries could be to conduct a cross-national comparison, drawing upon Jasanoff and Kim's (2009) investigation into different national policy aims for nuclear technology. Whilst this would inevitably be beyond the scope of a PhD project, findings from this thesis that refer to differing imagined roles of smart grids and definitions of technologies within these – depending upon the context in which they

are being discussed – suggest that this research gap could potentially herald interesting findings that could help to better understand the motivations that influence the wider development of electricity systems.

In addition to considerations of a broader sample of participants, a reflection that in hindsight may have helped to delve more deeply into participant understandings centres on whether the dominance of financial framings in thinking about electricity could have been anticipated, and if so, whether more effort could have been put into avoiding and moving beyond these. Whilst extensive efforts were made during the interviews – suggesting that this is a genuine reflection of participants' natural framings and ways of thinking about electricity use – a more strategic way of engaging interviewees in other aspects could have potentially freed up more time for discussions on other related topics. This apparent preoccupation with thinking about energy use in cost terms suggests that perhaps more focus on investigating possible ways of making money less of a dominant aspect in ways of thinking about electricity use would be a valuable, if complex, endeavour.

Whilst the tabloid task was an interesting prompt that stimulated discussion and helped to get people to talk about and be creative with their visions of the future, perhaps more alternative ways of developing materials or methodologies that would enable multi-modal data to be analysed would further add depth to the analysis, rather than purely using these materials to prompt discussion. Although the use of the tabloid and video clips definitely proved to be a successful way of engaging participants in topics and appeared to help some feel more comfortable talking about imagining the future, the use of methodological approaches such as walk-through tours of the home and visual ethnography (*e.g.* Pink, 2006; Pink and Mackley, 2012) may help to further stimulate meaningful insights.

A final reflection on the research undertaken for this thesis involves the debate surrounding public participation in the governance of scientific innovation and upstream engagement. Participatory processes have been critiqued as 'favouring the middle-class and well educated' (Petts, 2008: 826) – a criticism which could perhaps be aimed at this thesis, as participants were from reasonably affluent backgrounds. Additionally, engagement and public participation is sometimes considered to be merely 'tokenism', where engagement is undertaken at such a stage in the process where any implications or relevant considerations that emerge from this engagement are more or less meaningless as developments are already 'locked in' (Rogers-Hayden and Pidgeon, 2007). Potential policy mechanisms and technological developments that were identified and discussed in participants' visions of

possible future change remain as future-oriented possibilities amongst other alternatives. This thereby suggests that decisions relating to possible change are far from being 'locked in'. However, critical interpretations of this research could perhaps suggest that, as there was a large range in expert expectations of possible future change and definitions of the imagined role for specific components of this change, attempting to get public, 'lay' interviewees to meaningfully engage in these visions is a difficult task. Indeed, it is suggested that whilst the insights obtained in the thesis have direct relevance for the development of policy and technological mechanisms for achieving change, asking people to engage with more concrete and consensual visions of possible change may perhaps have enabled them to consider how these may directly influence and impact the way they use electricity in the home in the future, and thus highlighted further considerations relevant to the innovation process.

7.5 Concluding Remarks

The aim of this thesis has been to understand the dynamics of how and why electricity is used in the home, and to investigate public and expert visions of how changes to this – as a result of wider electricity system changes – may occur in the future. As such, findings that demonstrate the complex meanings associated with electricity use may perhaps be pessimistically interpreted as evidence for barriers to possible change. However, merely identifying potential barriers and identifying limitations to visions of change is far from the objective of the research. Moreover, as someone who is motivated to contribute towards finding societal solutions to environmental problems and particularly climate change, the researcher is far from wanting to be perceived as a 'naysayer' to visions of change. Instead, it is hoped that the findings presented in the thesis have been interpreted as evidence of the need for greater consideration of the complex social dynamics of electricity use in the home. Whilst this inevitably makes devising policy mechanisms and technological solutions a complex task, it is hoped that by considering the hopes and concerns of both public and expert actors in relation to visions of change in the innovation process, that implemented future changes will be embraced – rather than merely tolerated – by domestic users, that will ultimately assist and facilitate the transition towards a more sustainable electricity system.

References

Abrahamse, W., Steg, L., Vlek, C. and Rothengatter, T. 2005. A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology* 25, pp 273-291.

Adam, B. 2000. The Temporal Gaze: The Challenge for Social Theory in the Context of GM food. *British Journal of Sociology* 51 (1), pp 125-142.

Adam, B. 2005. *Futurity from a complexity perspective*. Cardiff University Working Paper [online]. http://www.cardiff.ac.uk/socsi/futures/Web%20Complexity%20Futu res.pdf. [Accessed 7 March 2015].

Adam, B. 2009. Cultural future matters: An exploration in the spirit of Max Weber's methodological writings. *Time and Society* 18, pp 7–25.

Adams, G. R. and Huston, T. L. 1975. Social perception of middle-aged persons varying in physical attractiveness. *Developmental Psychology* 11, pp 657-658.

Ajzen, I. 1991. The theory of planned behaviour. *Organisational Behaviour and Human Decision Processes* 50, pp 179-211.

Akcura, E., Haney, A. B., Jamasb, T. and Reiner, D. M. 2011. From citizen to consumer: energy policy and public attitudes in the UK. In Jamasb, T. and Pollitt, M. G. eds *The Future of Electricity Demand: Customers, Citizens and Loads*. Cambridge: Cambridge University Press, pp 231-248.

Albadi, M. H. and El-Saadany, E. F. 2010. Overview of wind power intermittency impacts on power systems. *Electric Power Systems Research* 80, pp 627-632.

Anderson, B. 1991. *Imagined communities: Reflections on the origin and spread of nationalism*. London: Verso.

Andrey, C. and Haurie, A. 2013. *The economics of electricity dynamic pricing and demand response programmes.* ORDECSYS Technical Report, Chene-Bougeries, Switzerland: ORDECSYS.

Arcury, T. A. and Quandt, S. A. 1999. Participant recruitment for qualitative research: a site-based approach to community research in complex societies. *Human Organisation* 58, pp1 28–133.

Asche, F., Osmundsen, P. and Sandsmark, M. 2006. The UK Market for Natural Gas, Oil and Electricity: Are the Prices Decoupled? *The Energy Journal* 27, pp 27-40.

Ashgar, M. R. and Miorandi, D. 2012. A holistic view of security and privacy issues in smart grids. In Cuellar, J. (eds) *Smart Grid Security*. Berlin: Springer Publishing, pp 58-71.

Axelrod, L. and Lehman, D. 1993. Responding to environmental concerns: what factors guide individual action. *Journal of Environmental Psychology* 13, pp 149-159.

Backstrand, K. and Lovbrand, E. 2007. Climate governance beyond 2012: Competing discourses of green governmentality, ecological modernization and civic environmentalism. In Pettenger, M. (eds). *The Social Construction of Climate Change: Power, Knowledge, Norms, Discourses*. Aldershot, UK: Ashgate, pp 123–148.

Balta-Ozkan, N., Watson, T., Connor, P., Axon, C., Whitmarsh, L., Davidson, R., Spence, A., Baker, P., Xenias, D., Cipcigan, L. and Taylor, G. 2014. Scenarios for the Development of Smart Grids in the UK – Synthesis Report. London: UKERC.

Banks, M. 2001. *Visual Methods in Social Research*. London: Sage.

Barbour, R. S. and Kitzinger, J. 1999. *Developing Focus Group Research: Politics, Theory and Practice*. London: Sage.

Barry, A., Born, G., and Weszkalnys, G. 2008. Logics of interdisciplinarity. *Economy and Society* 37, pp 20–49.

Basch, C. E. 1987. Focus Group Interview: An Underutilised Research Technique for Improving Theory and Practice in Health Education. *Health Education and Behaviour* 14, pp 411-448.

BBC. 2013. *Monitoring and responding to the demand for electricity* [television programme]. Accessed [online] 19th September 2013: http://www.bbc.co.uk /learningzone/clips/monitoring-and-responding-to-the-demand-for-electricity/7977.html.

Becker, M. H., Radius, S. M. and Rosenstock, I. M. 1978. Compliance with a medical regimen for asthma: a test of the health belief model. *Public Health Reports* 93, pp 268-277.
Bernstein, S. 2001. *The Compromise of Liberal Environmentalism*. New York: Columbia University Press.

Berst, J. 2012. *Smart grid momentum: Think less about people more about devices*. SmartGridNews.com [online]. www.smartgridnews.com. [Accessed 5 March 2015].

Biesiot, W. and Noorman, K. J. 1999. Energy requirements of household consumption: a case study of the Netherlands. *Ecological Economics* 28, pp 367-383.

Blunt, A. and Dowling, R. 2006. *Home*. New York: Routledge.

Boiteux, M. 1964. Peak Load Pricing. *Journal of Business* 33, pp 157-179.

Bord, R.J., Fischer, A. and O'Connor, R.E. 1998. Public Perceptions of Global Warming: United States and International Perspectives. *Climate Research* (11), pp 75–84.

Borup, M., Brown, N., Konrad, K. and van Lente, H. 2006. The Sociology of Expectations in Science and Technology. *Technology Analysis and Strategic Management* 18, pp 285-298.

Brager, G. S. and De Dear, R. J. 2003. Historical and cultural influences on comfort expectations. In Cole, R. J. and Lorch, R. (eds.), *Buildings, Culture and Environment: Informing local and global practices.* Oxford, UK: Blackwell, pp 177-201.

Brand, R. and J. Fischer. 2013. Overcoming the technophilia/technophobia split in environmental discourse. *Environmental Politics* 22, pp 235-254.

Brandon, G. and Lewis, A. 1999. Reducing household energy consumption: a qualitative and quantitative field study. *Journal of Environmental Psychology* 19, pp 75–85.

Brown, I. 2014. Britain's Smart Meter programme: A case study in privacy by design. *International Review of Law, Computers & Technology* 28, pp 172–184.

Brown, N. and Michael, M. 2003. A sociology of expectations: retrospecting prospects and prospecting retrospects. *Technology Analysis and Strategic Management* 15, pp 3-18.

Brush, A. B., Lee, B., Mahajan, R., Agarwal, S., Saroiu, S. and Dixon, C. 2011. Home automation in the wild: Challenges and opportunities. In *Proceedings of ACM CHI Conference on Human Factors in Computing Systems*. Vancouver: CHI, pp 2115-2124.

Bryman, A. 2008. *Social Research Methods, 3rd Edition*. Oxford: Oxford University Press.

Buchanan, K., Banks, N., Preston, I. and Russo, R. 2016. The British public's perception of the UK smart metering initiative: Threats and opportunities. *Energy Policy* 91, pp 87-97.

Burgess, J. and Nye, M. 2008. Re-materialising energy use through transparent monitoring systems. *Energy Policy* 36, pp 4454-4459.

Butler, C. and Demski, C. C. 2013. Valuing public engagement with energy system transitions: the importance of what lies beneath. *Carbon Management* 4, pp 659-662.

Butler, C., Parkhill, K.A. and Pidgeon, N. 2013. *Deliberating energy system transitions in the UK – Transforming the UK Energy System: Public Values, Attitudes and Acceptability*. UKERC: London.

Butler, C. Demski, C.C, Parkhill, K.A., Pidgeon, N.F. and Spence, A. 2015. Public values for energy futures: Framing, indeterminacy and policy making. *Energy Policy* 87, pp 665-672.

Camerer, C. 2004. Prospect theory in the wild: evidence from the field. In Camerer, C., Loewenstein, G. and Rabin, M. (eds). *Advances in Behavioural Economics*. Princeton, New Jersey: Princeton University Press, pp 148-161.

Camerer, C. and Loewenstein, G. 2004. Behavioural Economics: past, present, future. In Camerer, C., Loewenstein, G. and Rabin, M. (eds). *Advances in Behavioural Economics*. Princeton, New Jersey: Princeton University Press, pp 3-51.

Capstick, S., N. Pidgeon. and Henwood, K. 2015. Stability and change in public discourses about climate change between 1997 and 2010. *Environmental Values*, Forthcoming.

Carpentier, N., Schroder, K. C. and Hallett, L. 2013. Audience/Society Transformations. In

Carpentier, N., Schroder, K. C. and Hallett, L. eds. *Audience Transformations: Shifting Audience Positions in Late Modernity*. New York: Routledge, pp 1-12.

Carrico, A. R. and Riemer, M. 2011. Motivating energy conservation in the workplace: An evaluation of the use of group-level feedback and peer education. *Journal of Environmental Psychology* 31, pp 1-13.

Castoriadis, C. 1987. *The imaginary institution of society*. Cambridge, Massachusetts: MIT Press.

CCC. 2010. *Building a low-carbon economy – the UKs innovation challenge*. London: Committee on Climate Change.

Challis, C. 2004. *A Literature Review of Secondary and Smart Metering Knowledge in Managed Housing*. London: The Energy Savings Trust.

Chappells, H. and Shove, E. 2005. Debating the future of comfort: Environmental sustainability, energy consumption and the indoor environment. *Building Research and Information* 33, pp 32-40.

Chatterton, T. 2011. *An Introduction to Thinking about 'Energy Behaviour': A Multi-Model Approach*. London: DECC.

Cherry, C., Hopfe, C., MacGillivray, B. and Pidgeon, N. F. 2013. Media discourses of low carbon housing: The marginalisation of social and behavioural dimensions within the British broadsheet press. *Public Understanding of Science*. Advance online publication. doi: 10.1177/0963662513512442.

Chester, L. 2010. Conceptualising energy security and making explicit its polysemic nature. *Energy Policy* 38, pp 887-895.

Clemen, R. T. and Reilly, T. 2001. *Making Hard Decisions*. Pacific Grove, California: Duxbury.

Collins, H. M. and Evans, R. 2002. The third wave of science studies: studies of expertise and experience. *Social Studies of Science* 32, pp 235-296.

Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C. and Pidgeon, N. 2011. Nuclear power, climate change and energy security: Exploring British public attitudes. *Energy Policy* 39, pp 4823–4833.

Corner, A., Pidgeon, N. and Parkhill, K. 2012. *Perceptions of geoengineering: Public attitudes, stakeholder perspectives & the challenge of 'upstream' engagement*. Wiley Interdisciplinary Reviews – Climate Change.

Corner, A. and Pidgeon, N.F. 2014. *Geoengineering, climate change scepticism and the 'moral hazard' argument: an experimental study of UK public perceptions*. Philosophical Transactions of the Royal Society A.

Coveney, C. M. 2010. *Awakening expectations: Exploring social and ethical issues surrounding the medical and non-medical uses of cognition enhancing drugs in the UK*. Doctoral Thesis. Nottingham, UK: University of Nottingham.

Cuijpers, C. and Koops, B. J. 2012. Smart metering and privacy in Europe: lessons from the Dutch case. In Gutwirth, S., Leenes, R., de Hert, P. and Poullet, Y. (eds.), *European Data Protection: Coming of Age*. Dordrecht: Springer, pp 269–293.

Crompton, T. 2010. *Common Cause: The case for working with our cultural values*. Surrey: WWF UK.

Crotty, M. 1998. *The Foundations of Social Research: Meaning and perspective in the research process*. Thousand Oaks, CA: Sage.

Darby, S. 2003. Making sense of energy advice. *Proceedings of the European Council for an Energy-Efficient Economy* 6, pp 157.

Darby, S. 2008. Energy feedback in buildings: Improving the infrastructure for demand reduction. *Building Research and Information* 36, pp 499-508.

Davidoff, S., Lee, M., Yiu, C., Zimmerman, J. and Dey, A. 2006. Principles of smart home control. In: Dourish, P. and Friday, A. eds. *Ubiquitous Computing*. Berlin: Springer, pp 19-34.

Deaux, K. and Lafrance, M. 1998. Gender. In: Gilbert, D. T., Fiske, S. T. and Lindzey, G. eds. *The Handbook of social psychology*. 2nd ed. New York: McGraw-Hill, pp 788-827.

de Dear, R. J. and Brager, G. S. 2002. Thermal comfort in naturally ventilated buildings: Revisions to ASHRAE Standard 55. *Energy and Buildings* 34, pp 549-61.

DECC. 2009a. *Smarter Grids: The Opportunity. 2050 Roadmap: Discussion Paper*. London: Department of Energy and Climate Change.

DECC. 2009b. *The UK Low Carbon Transition Plan: National Strategy for Climate and Energy*. London: Department of Energy and Climate Change.

DECC. 2011. *UK Renewable Energy Roadmap*. London: Department of Energy and Climate Change.

DECC. 2012a. *Energy Consumption in the United Kingdom: 2012 - DECC Factsheet URN 12D/291*. London: Department of Energy and Climate Change.

DECC. 2012b. *Smart Meters* [Online]. Accessed: http://www.decc.gov.uk/en/content/cms/tackling/smart_meters/smart_meters.aspx. [12 May 2015].

DECC. 2012c. *The Future of Heating: A Strategic Framework for Low Carbon Heat in the UK*. London: Department of Energy and Climate Change.

DECC. 2013. *The Future of Heating: Meeting the Challenge*. London: Department of Energy and

Climate Change.

DECC. 2014a. *Delivering UK Energy Investment*. London: Department of Energy and Climate Change.

DECC. 2014b. *Smart Metering Implementation Programme: Smart Metering Equipment Technical Specifications Version 1.58*. London: Department of Energy and Climate Change.

DECC. 2015. *Smart Metering Implementation Programme: Smart Metering Rollout Strategy*. London: Department of Energy and Climate Change.

DEFRA. 2007. *Survey of Public Attitudes and Behaviours towards the Environment: 2007*. London: DEFRA.

Demos. 1995. *The Time Squeeze*. London: Demos.

Demski, C., Poortinga, W. and Pidgeon, N. 2014. Exploring public perceptions of energy security risks in the UK. *Energy Policy* 66, 369-378.

Demski, C., Butler, C., Parkhill, K. A., Spence, A. and Pidgeon, N. 2015. Public values for energy system change. *Global Environmental Change*. In Press

Devine-Wright, H. and Devine-Wright, P. 2005. Representing the demand side: 'deficit' beliefs about domestic electricity users. In *Proceedings of ECEEE Summer Study 2005 - What works & who delivers?*
Dickson, D. 2005. The case for a deficit model of science communication. *PCST Working Symposium, Beijing.*

Dobson, A. 2011. *Sustainability Citizenship*. Dorset, UK: Greenhouse.

Douglas, M. 1992. *Risk and Blame*. Routledge: New York.

Eckersley, R. 2004. *Green State: Rethinking Democracy and Sovereignty*. Cambridge, MA: MIT Press.

Eden, S. 1996. Public participation in environmental policy: considering scientific, counter-scientific and non-scientific contributions. *Public Understanding of Science* 5, pp 183-203.

Egbue, O. and Long, S. 2012. Barriers to widespread adoption of electric vehicles: an analysis of consumer attitudes and perceptions. *Energy Policy* 48, pp 717–729.

Emerson, R. M. 1964. Power-dependence relations: Two experiments. *Sociometry* 27, pp 282-298.

Erhlich, P. R. and Erlich, A. H. 2012. Technology: Not a Panacea, Maybe a Poison Pill. In Huesemann, M. and Huesemann, J. (eds). *Techno-Fix: Why Technology Won't Save Us or the Environment*. Gabriola Island, BC, Canada: New Society Publishers, pp xvii-xxi.

Erikson, F. 1986. Qualitative Methods in Research on Teaching. In: Wittrock, M. C. eds. *Handbook of Research on Teaching*. New York: Macmillan, pp 119-158.

European Commission. 2013. *Special Eurobarometer 401: Responsible Research and Innovation (RRI), Science and Technology, Survey Summary*. Brussels: European Commission.

Faruqui, A., Hledik, R., Newell, S. and Pfeifenberger, H. 2007. The power of 5 percent. *The Electricity Journal* 20, pp 68-77.

Faruqui, A. 2010. The ethics of dynamic pricing. *The Electricity Journal* 23, pp 13-27.

Faruqui, A., Sergici, S. and Sharif, A. 2010. The impact of informational feedback on energy consumption – a survey of experimental evidence. *Energy* 35, pp 1598-1608.

Faulkner, W. 2007. 'Nuts and Bolts and People': Gender-Troubled Engineering Identities. *Social Studies of Science* 37, pp 331-356.

Fell, M. J., Shipworth, D., Huebne, G. M. and Elwell, C. A. 2014. Exploring perceived control in domestic electricity demand-side response. *Technology Analysis and Strategic Management* 26, pp 1118-1130.

Fern, E. F. 2001. *Advanced Focus Group Research*. Thousand Oaks, California: Sage.

Fischhoff, B., Watson, S. and Hope, R. 1990. Defining risk. In Glickman, T. S., and Gough, M. (eds.) *Readings In Risk*. Washington DC: Resources for the Future, pp 30-41.

Fishbein, M. and Ajzen, I. 1975. *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Flick, U. 2008. *Managing Quality in Qualitative Research*. London: Sage.

Flick, U. 2014. *The Sage handbook of qualitative data analysis, 5th Edition*. London: Sage.
Foucault, M. 1972. *The Archaeology of Knowledge*. New York, Pantheon.

Forsyth, T. 2009. *Critical political ecology: The politics of environmental science*. London: Routledge.

Foulds, C., Macrorie, R., Franz, B. and Wang, X. 2013. Unpublished Working Paper: The Challenges of Interdisciplinary Research: An Early Career Researcher Perspective on Crossing Disciplinary Boundaries.

Fry, C. and Dwyer, R. 2001. For love or money? An exploratory study of why injecting drug users participate in research. *Addiction* 96, pp 1319–25.

Fudge, S. and Peters, M. 2011. Behaviour Change in the UK Climate Debate: An Assessment of Responsibility, Agency and Political Dimensions. *Sustainability* 3, pp 789-808.

Gamson, W. A. and Modigliani, A. 1989. Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach. *American Journal of Sociology* 95, pp 1-37.

Gaver, W., Michael, M., Kerridge, T., Wilkie, A., Boucher, A., Ovalle, L. and Plummer-Fernandez, M. 2015. Energy Babble: Mixing Environmentally-Oriented Internet Content to Engage Community Groups. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, pp 1115-1124.

Geels, F, W. 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy* 31, pp 1257-1274.

Gershuny, J. 2000. *Changing Times: Work and Leisure in Postindustrial Society*. Oxford: Oxford University Press.

Glaser, B. G. and Strauss, A. L. 1967. *The discovery of grounded theory*. Chicago: Aldine.

Goulden, M., Bedwell, B., Rennick-Egglestone, S., Rodden, T. and Spence, A. 2014. Smart Grids, Smart Users? The role of the user in demand side management. *Energy Research and Social Science* 2, pp 21-29.

Gram-Hanssen, K. and Bech-Danielsen, C. 2004. House, home and identity from a consumption perspective. *Housing, Theory and Society* 21, pp 17–26.

Gram-Hanssen, K., Bartiaux, F., Jensen, O. M. and Cantaert, M. 2007. Do homeowners use energy labels? A comparison between Denmark and Belgium? *Energy Policy* 35, pp 2879-2888.

Gram-Hanssen, K. 2011. Understanding change and continuity in residential energy consumption. *Journal of Consumer Culture* 11, pp 61-78.

Greckhamer, T. and Koro-Ljungberg, M. 2005. The erosion of a method: Examples from grounded theory. *International Journal of Qualitative Studies in Education* 18, pp 729-750.

Greening, L. A., Greene, D. L. and Difiglio, C. 2000. Energy efficiency and consumption – the rebound effect – a survey. *Energy Policy* 28, pp 389-401.

Greenwald, A. G., McGhee, D. E. and Schwartz, J. L. K. 1998. Measuring individual differences in implicit cognition: The Implicit Association Test. *Journal of Personality and Social Psychology* 74, pp 1464-1480.

Gregory, R., Flynn, J. and Slovic, P. 1995. Technological stigma. *American Scientist* 83, pp 220-223.

Grinbaum, A. and Groves, C. 2012. What is 'responsible' about responsible innovation? Understanding the Ethical Issues. In Owen, R., Bessant, J. and Heintz, M. (eds). *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chicester: Wiley, pp 119-142.

Gronow, J. and Warde, A. 2001. *Ordinary Consumption*. Berkshire, UK: Harwood Academic Publishers.

Groves, C., Henwood, K., Shirani, F., Butler, C., Parkhill, K. and Pidgeon, N. Forthcoming. Energy biographies: narrative genres, lifecourse transitions and practice change. *Science, Technology and Human Values*.

Groves, C., Henwood, K. Shirani, F., Butler, C., Parkhill, K. and Pidgeon, N. 2016. *The grit in the oyster: questioning socio-technical imaginaries through biographical narratives of engagement with energy*. Understanding Risk working paper.

Grunwald, A. 2012. Sustainability assessment of technologies – an integrative approach. In Ghenai, C. (eds). *Sustainable Development - Energy, Engineering and Technologies - Manufacturing and Environment*. Rijeka: InTech, pp 35-62.

Gupta, M., Intille, S. S. and Larson, K. 2009. Adding GPS-Control to Traditional Thermostats: An Exploration of Potential Energy Savings and Design Challenges. In Tokuda, H., Beigl, M., Friday, A., Brush, A.J.B. and Tobe, Y. (Eds.) *Pervasive Computing*. Berlin: Springer Publishing, pp 95-114.

Guy, S. and Marvin, S. 1996. Transforming urban infrastructure provision – The emerging logic of demand-side management. *Policy Studies* 17, 137-47.

Hajer, M. A. 1995. *The Politics of Environmental Discourse: Ecological Modernisation and the Policy Process*. Oxford: Clarendon Press.

Halcomb, E. J. and Davidson, P. M. 2006. Is verbatim transcription of interview data always necessary? *Applied Nursing Research* 19, pp 38-42.

Halvorsen, B. 2012. Effects of norms and policy incentives on household recycling: An international comparison. *Resources, Conservation and Recycling* 67, pp 18-26.

Hamilton, B., Thomas, C., Park, S. J. and Choi, J. G. 2012. The customer side of the meter. In: Sioshansi, F. P. eds. *Smart Grid*. Boston: Academic Press, pp 397-418.

Hammersley, M. and Atkinson, P. 2007. *Ethnography: Principles in Practice. 3rd Edition*. Oxford: Routledge.

Hammerstrom, D., Ambrosio, R., Carlon, T. A., DeSteese, J. G., Horst, G. R., Kajfasz, R., Kiesling, L., Michie, P., Pratt, R. G., Yao, M., Brous, J., Chassin, D. P., Guttromson, R. T., Jarvegren, O. M., Katipamula, S., Le, N. T., Oliver, T. V. and Thompson, S. 2007. *Pacific Northwest GridWise(TM) Testbed Demonstration Projects: Part I. Olympic Peninsula Project*. Richland, Washington: Pacific Northwest National Laboratory.

Hand, M. and Shove, E. 2007. Condensing practices: Ways of living with a freezer. *Journal of Consumer Culture* 7, pp79-104.

Hand, M., Shove, E. and Southerton, D. 2005. Explaining Showering: a Discussion of the Material, Conventional, and Temporal Dimensions of Practice. *Sociological Research Online* 10, pp 1-13.

Harding, S. 1991. *Whose science: Whose knowledge: Thinking from women's lives*. Ithaca, NY: Cornell Press.

Hards, S. 2012. Tales of transformation: The potential of a narrative approach to pro-environmental practices. *Geoforum* 43, pp 760-771.

Hargreaves, T. 2011. Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture* 11, pp. 79-99.

Hargreaves, T., Nye, M. and Burgess, J. 2010. Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy* 38 (10), pp 6111-6119.

Hargreaves, T., Nye, M. and Burgess, J. 2012. Keeping energy visible? Exploring how householders interact with feedback from smart energy monitors in the longer term. *Energy Policy* 52, pp 1-9.

Harrison, C. and Popke, J. 2011. "Because You Got to Have Heat": The Networked Assemblage of Energy Poverty in Eastern North Carolina. *Annals of the Association of American Geographers* 101, pp 949-961.

Hartz-Karp, J. 2007. How and why deliberative democracy enables co-intelligence and brings wisdom to governance. *Journal of Public Deliberation* 3, pp 1-9.

Healy, J. D. and Clinch, J. P. 2002. Fuel poverty, thermal comfort and occupancy: results of a national household-survey in Ireland. *Applied Energy* 73, pp 329-343.

Hedgecoe, A. and Martin, P. 2003. The drugs don't work: expectations and the shaping of pharmacogenetics. *Social Studies of Science* 33 (3), pp 327–363.

Heiskanen, E., Rask, M., Mourik, R., Bauknecht, D., Brohmann, B. and Vadovics, E. 2009. *Basic approaches to studying energy-related behaviour change*. Briefing paper for ECFP7 'CHANGING BEHAVIOUR' Project.

Henley, A. and Peirson, J. 1997. Non-linearities in Electricity Demand and Temperature: parametric versus non-parametric methods. *Oxford Bulletin of Economics and Statistics* 59, pp 149-162.

Henwood, K. L. 2008. Qualitative Research, Reflexivity and Living with Risk: Valuing and Practicing Epistemic Reflexivity and Centering Marginality. *Qualitative Research in Psychology* 5, pp 45-55.

Henwood, K. L. and Pidgeon, N. F. 1992. Qualitative research and psychological theorizing. *British Journal of Psychology* 83, pp 97-111.

Henwood, K. and Pidgeon, N. F. 2003. Grounded theory in psychological research. In Camic, P, M., Rhodes, J. E. and Yardley, L. (eds). *Qualitative research in psychology: Expanding*

perspectives in methodology and design. Washington DC: American Psychological Association, pp 131-155.

Henwood, K. and Shirani, F. 2012. *Extending temporal horizons. Timescapes Methods Guide Series, No. 4*. Online. [Accessed at: www.timescapes.leeds.ac.uk/assets/files/methods-guides/timescapes-henwood-extending-temporal-horizons.pdf].

Henwood, K., and Shirani, F. 2013. Researching the temporal. In: Cooper, H. (Eds.). Handbook of research methods in psychology Vol. 2. Washington, DC: APA Publications, pp 209–223.

Henwood, K. L., Pidgeon, N. F., Sarre, S., Simmons, P. and Smith, N. 2008. Risk, framing and everyday life: methodological and ethical reflections from three sociocultural projects. *Health, Risk and Society* 10, pp 421-438.

Hertwich, E. G. 2005. Consumption and the Rebound Effect: An Industrial Ecology Perspective. *Journal of Industrial Ecology* 9, pp 85-98.
Higginson, S., Richardson, I. and Thomson, M. 2012. Energy use in the context of behaviour and practice: The interdisciplinary challenge in modelling flexible electricity demand. *CREST Working Paper,* pp 1-20.

Hinton, E. 2010. Review of the literature relating to comfort practices and socio-technical systems. *Environment, Politics and Development Working Paper Series* 35. London: King's College London.

Hledik, R. 2009. How green is the smart grid? *The Electricity Journal* 22, pp 29-41.

HM Parliament. 2008. *The Climate Change Act 2008*. London: UK.

Hobson, K. 2002. Competing discourses of sustainable consumption: does the rationalisation of lifestyles make sense? *Environmental Politics* 11, pp 95-120.

Hoyer, W. D. and MacInnis, D. J. 2004. *Consumer Behaviour*. New York: Houghton Mifflin.

Huesemann, M. and Huesemann, J. 2012. *Techno-Fix: Why Technology Won't Save Us or the Environment*. Gabriola Island, BC, Canada: New Society Publishers.

Hughes, T. P. 1983. *Networks of Power: Electrification in Western Society 1880-1930*. Baltimore: John Hopkins University Press.

IPCC. 2001. *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press.

IPCC. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva: Intergovernmental Panel on Climate Change.

Ingram, J., Shove, E. and Watson, M. 2007. Products and Practices: Selected Concepts from Science and Technology Studies and from Social Theories of Consumption and Practice. *Design Issues* 23, pp 3-16.

IRENA. 2014. *Renewable Power Generation Costs in 2014*. Bonn: Germany, International Renewable Energy Association.

Jackson, T. 2005. *Motivating sustainable consumption. A review of evidence on consumer behaviour and behavioural change*. London: Policy Studies Institute.

Jamasb, T. and Pollitt, M. G. 2011. *The Future of Electricity Demand: Customers, Citizens and Loads*. New York: Cambridge University Press.

Jasanoff, S. 2003. Technologies of humility: citizen participation in governing science. *Minerva* 41, pp 223-244.

Jasanoff, S. 2005. *Designs on nature: science and democracy in Europe and United States*. Princeton, New Jersey: Princeton University Press.

Jasanoff, S. and Wynne, B. 1998. Science and decision making. In: Rayner, S. and Malone, E.L. (Eds.). *Human Choice and Climate Change: The Societal Framework*. Battelle Press, Ohio.

Jasanoff, S. and Kim, S. H. 2009. Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea. *Minerva* 47(2), pp 119-146.

Joskow, P. and Wolfram, C. 2012. Dynamic Pricing of Electricity. *American Economic Review Papers and Proceedings* 102, pp 381-385.

Kahn, A. E. 1970. *The Economics of Regulation: Principles and Institutions*. New York: John Wiley & Sons.

Kahneman, D., Diener, E. and Schwartz, N. 1999. *Well-being: The Foundations of Hedonic Psychology*. New York: Russell Sage.

Kan, M. Y., Sullivan, O. and Gershuny, J. 2011. Gender convergence in domestic work: discerning the effects of interactional and institutional barriers from large-scale data. *Sociology* 2, pp 234-51.

Kasperson, R. E. 1992. The social amplification of risk: progress in developing an integrative framework in social theories of risk. In Krimsky, S. and Golding, D. (eds). *Social Theories of Risk*. Westport CT: Preager, pp 153-178.

Kearney, M. H. 2007. From the sublime to the Meticulous: The Continuing Evolution of Grounded Formal Theory. In Bryant, A. and Charmaz, K. (eds). *The Sage Handbook of Grounded Theory*. Thousand Oaks, CA: pp 127-150.

Kempton W. 1987. Variation in folk models and consequent behaviour. *American Behavioural Scientist* 31, pp 203-218.

Kempton, W. and Layne, L. L. 1994. The consumer's energy analysis environment. *Energy Policy* 22, pp 857-866.

Kish, L. B. 2002. End of Moore's law: thermal (noise) death of integration in micro and nano electronics. *Physics Letters A* 305, pp 144-149.

Kitzinger, J. 1994. The methodology of focus groups: the importance of interaction between research participants. *Sociology of Health and Illness* 16, pp 103-121.

Kitzinger, J. 1995. Introducing Focus Groups. *BMJ* 311, pp 299-302.

Kleif, T. and Faulkner, W. 2002. Boys and their Toys: Men's Pleasures in Technology. In: Pasero, U. and Gottsburgen, A. eds. *How Natural are Sex and Gender? Gender and the Construction of Nature and Technology*. Wiesbaden: Westdeutscher Verlag, pp 240-255.

Knight, R. L., Lutzenhiser, L. and Lutzenhiser, S. 2006. Why comprehensive residential energy efficiency retrofits are undervalued. *Proceedings of the 2006 ACEEE Summer Study on Energy Efficiency in Buildings* 7, pp 141-150.

Kotchen, M. and Moore, M. 2008. Conservation: From Voluntary Restraint to a Voluntary Price Premium. *Environmental & Resource Economics* 40, pp 195-215.

Kozinets, R. V. 2008. Technology/Ideology: How Ideological Fields Influence Consumers' Technology Narratives. *Journal of Consumer Research* 34, pp 864-81.

Krefting, L. 1991. Rigor in qualitative research: the assessment of trustworthiness. *The American Journal of Occupational Therapy* 45, pp 214-22.

Krishnamurti, T., Schwartz, D., Davis, A., Fischhoff, B., de Bruin, W. B., Lave, L. and Wang, J. 2012. Preparing for smart grid technologies: A behavioural decision research approach to understanding consumer expectations about smart meters. *Energy Policy* 41, pp 790-797.

Krueger, R. A. and Casey, M. A. 2000. *Focus groups: A practical guide for applied research*. Thousand Oaks: Sage.

Kuijer, L. and Bakker, C. 2015. Of chalk and cheese: behaviour change and practice theory in sustainable design. *International Journal of Sustainable Engineering*. Advance online publication. doi: 10.1080/19397038.2015.1011729.

Kurz, T. 2002. The Psychology of Environmentally Sustainable Behaviour: Fitting Together Pieces of the Puzzle. *Analysis of Social Issues and Public Policy* 2, pp 257-278.

Kurz, T., Donaghue, N., Rapley, M. and Walker, I. 2005. The ways that people talk about natural resources: Discursive strategies as barriers to environmentally sustainable practices. *British Journal of Social Psychology* 44, pp 603-20.

Kurz, T., Augoustinos, M. and Crabb, S. 2010. Contesting the 'national interest' and

maintaining 'our lifestyle': A discursive analysis of political rhetoric around climate change. *British Journal of Social Psychology* 49, pp 601-625.

Kurz, T., Gardner, B., Verplanken, B. and Abraham, C. 2015. Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions. *WIREs Climate Change* 6, pp 113-128.

Lapadat, J. C. 2000. Problematizing transcription: Purpose, paradigm and quality. *International Journal of Social Research Methodology* 3, pp 203-219.

LaRossa, R. 1983. The transition to parenthood and the social reality of time. *Journal of Marriage and the Family* 45, pp 579-589.

Latour, B. 2005. *Reassembling the Social*. Oxford: Oxford University Press.

Levine, J. M. and Moreland, R. L. 1998. Small groups. In: Gilbert, D. T., Fiske, S. T. and Lindzey, G. eds. *The Handbook of social psychology*. 2nd ed. New York: McGraw-Hill, pp 415-469.

Li, F., Luo, B. and Liu, P. 2010. Secure information aggregation for smart grids using homomorphic encryption. *IEEE Smart Grid Communication* 10, pp 327–332.

Libet, L. 1985. Unconscious cerebral initiative and the role of conscious will in voluntary action. *Behavioral Brain Sciences* 8, pp 529–566.

Lie, M. and Sørensen, K, H. 1996. *Making Technology Our Own: Domesticating Technology into Everyday Life*. Oslo: Scandinavian University Press.

Littlefield, M. 2009. Constructing the organ of deceit: the rhetoric of fMRI and brain fingerprinting in post-9-11 America. *Science, Technology and Human Values* 34, pp 365–392.

Lo, S. H., Peters, G-J. Y. and Kok, G. 2012. Energy-Related Behaviours in Office Buildings: A Qualitative Study on Individual and Organisational Determinants. *Journal of Applied Social Psychology* 42, pp 227-249.

Lowe, T. D. and Lorenzoni, I. 2007. Danger is all around: Eliciting expert perceptions for managing climate change through a mental models approach. *Global Environmental Change* 17, pp 131-146.

Lucious-Hoene, G. and Deppermann, A. 2000. Narrative Identity Empiricised: A Diological and Positioning Approach to Autobiographical Research Interviews. *Narrative Inquiry* 10, pp

Lund, H. 2006. Large-scale integration of optimal combinations of PV, wind and wave power into the electricity supply. *Renewable Energy* 31, pp. 503-515.

Lutzenhiser, L. 2009. *Behavioural Assumptions Underlying California Residential Sector Energy Efficiency Programs*. Oakland: California Institute for Energy and Environment for CIEE

Behaviour and Energy Program.

Macey, S. M. and Brown, M. A. 1983. Residential Energy Conservation. *Environment and Behaviour* 15, pp 123-141.

Mackay, D. 2008. *Sustainable Energy - Without the Hot Air*. Cambridge, UIT Ltd.

Macnaghten, P. 2010. Researching technoscientific concerns in the making: narrative structures, public responses, and emerging nanotechnologies. *Environment and Planning A* 42, pp 23-37.

Macnaghten, P., Kearnes, M. and Wynne, B. 2005. Nanotechnology, governance, and public deliberation: What role for the social sciences? *Science Communication 27*, pp 1-24.

Malterud, K. 2001. Qualitative research: standards, challenges and guidelines. *The Lancet* 358, pp 483-488.

Mannay, D. 2010. Making the familiar strange: can visual research methods render the familiar setting more perceptible? *Qualitative Research* 10, pp 91-111.

Mansouri-Azar, I., Newborough, M. and Probert, D. 1996. Energy-consumption in UK domestic households: impact of domestic electrical appliances. *Applied Energy* 54, pp 211–285.

Maio, G. R., Olson, J. M., Allen, L. and Bernard, M. M. 2001. Addressing discrepancies between values and behaviour: The motivating effect of reasons. *Journal of Experimental Social Psychology* 37, pp 104-117.

Maio, G. R., Verplanken, B., Manstead , A. S. R., Stroebe, W., Abraham, C., Sheeran, P. and Conner, M. 2007. Social Psychological Factors in Lifestyle Change and Their Relevance to Policy. *Journal of Social Issues and Policy Review* 1*,* pp 99-137.

Maller, C. and Strengers, Y. 2013. The global migration of everyday life: Investigating the practice memories of Australian migrants. *Geoforum* 44, pp 243-252.

Maranta, A., Guggenheim, M., Gisler, P. and Pohl, P. 2003. The reality of experts and the imagined lay person. *Acta Sociologica* 46, pp 150-165.

Marcus, G.E. 1995. *Technoscientific imaginaries: Conversations, profiles, and memoirs*. Chicago: University of Chicago Press.

Marres, N. 2010. Front-staging nonhumans: Publicity as a constraint on the political activity of things. In: Braun, B., Wahmore, S. and Stengers, I. eds. *Political Matter: Technoscience, Democracy and Public Life*. Minneapolis: University of Minnesota Press, pp 177-209.

McCalley, L. T. 2006. From motivation and cognition theories to everyday applications and back again: the case of product-integrated information and feedback. *Energy Policy* 34, pp 129-137.

McCracken, G. 1988. *Culture and Consumption: New Approaches to the Symbolic Character of Consumer Goods and Activities*. Bloomington; Indiana University Press.

McKenna, E. and Thomson, M. 2014. Demand response behaviour of domestic consumers with photovoltaic systems in the UK: an exploratory analysis of an internet discussion forum. E*nergy, Sustainability and Society 4*, pp 1-12.

McKenzie-Mohr, D. 2000. Fostering sustainable behaviour through community-based social marketing. *American Psychologist* 55, pp 531-537.

McLellan, E., Macqueen, K. M. and Neidig, J. L. 2003. Beyond the qualitative interview: data preparation and transcription. *Field Methods* 15, pp 63-84.

Melia, K. 2000. Conducting an interview. *Nurse Researcher 7*, pp 75-89.

Mikecz, R. 2012. Interviewing Elites: Addressing Methodological Issues. *Qualitative Inquiry* 18, pp 482-493.

Miles, M. and Huberman, M. A. 1994. *Qualitative Data Analysis* (2nd edition). Beverly Hills: Sage.

Miller, C. 2000. The dynamics of framing environmental values and policy: Four models of societal processes. *Environmental Values* 9, pp211–233.

Mol, A. P. J. 1997. Ecological modernization: industrial transformation and environmental reform. In Redclift, M. and Woodgate, G. (eds). *The International Handbook of Environmental Sociology*. London: Edward Elgar, pp 138-149.

Mol, A. P. J. and Sonnenfeld, D. 2000. *Ecological Modernisation around the World: Perspectives and Critical Debates*. Ilford, Eng: Frank Cass.

Molyneux-Hodgson, S. and Meyer, M. 2009. Tales of emergence: synthetic biology as a scientific community in the making. *BioSocieties* 4, pp 129–145.

Moore, G. E. 1965. Cramming more components onto integrated circuits. *Electronics* 38, pp 114–117.

Morgan, D. L. 1996. Focus Groups. *Annual Review of Sociology* 22, pp 129-152.

Morgan, M. G., Pitelka, L. F. and Shevliakova, E. 2001. Elicitation of expert judgments of climate change impacts on forest ecosystems. *Climatic Change* 49, pp 279-307.

Moscovici, A. 1984. The phenomenon of social representations. In: Farr, R. and Mascovici, S. (Eds.). *Social Representations*. Cambridge University Press, Cambridge

Narendran, N. 2011. Is solid-state lighting ready for the incandescent lamp phase-out? *Proceedings of the Society of Photo-Optical Instrumentation Engineers 8123*. 812302.

National Grid. 2011. *UK Future Energy Scenarios Report*.

Nelson, R. R. and Winter, S. G. 1982. *An Evolutionary Theory of Economic Change*. Cambridge, MA: Bellknap Press.

Nerlich, B. and Halliday, C. 2007. Avian flu: the creation of expectations at the interplay between science and the media. *Sociology of Health and Illness* 29, pp 46–65.

Newsham, G. R. and Bowker, B. G. 2010. The effect of utility time-varying pricing and load control strategies on residential summer peak electricity use: A review. *Energy Policy* 38, pp 3289-96.

Newsham, G. R., Birt, B. J. and Rowlands, I. H. 2011. A comparison of four methods to evaluate the effect of a utility residential air-conditioner load control program on peak electricity use. *Energy Policy* 39, pp 6376-89.

Nkwetta, D. N., Van Thong, V., Driesen, J. and Belmans, R. 2007. Energy Sustainability in Sub-Saharan Africa. In: *Electrical Power Quality and Utilisation, 2007. 9th International Conference*. IEE, pp 1-5.

Nye, M., Whitmarsh, L. and Foxon, T. 2010. Sociopsychological perspectives on the active roles of domestic actors in transition to a lower carbon electricity economy. *Environment and Planning A* 42, pp 697-714.

O'Hagan, A., Buck, C. E., Daneshkhah, A., Eiser, J. R., Garthwaite, P. H., Jenkinson, D. J., Oakley, J. E. and Rakow, T. 2006. *Uncertain judgements: Eliciting experts' probabilities*. Chichester: Wiley.

Olander, F. and Thogersen, J. 1995. Understanding of consumer behaviour as a prerequisite for environmental protection. *Journal of Consumer Policy* 18, pp 317-357.

Oliver, D. G., Serovich, J. M. and Mason, T. L. 2005. Constraints and opportunities with interview transcription: Towards reflection in qualitative research. *Social forces* 84, 1273-1289.

Ott, M., Slavin, H. and Ward, D. 1980. Behavioural Impacts of Flexible Working Hours. *Transportation Research Record* 767, pp 1-6.

Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E. and Guston, D. 2013. A Framework for Responsible Innovation. In Owen, R., Bessant, J. and Heintz, M. (eds). *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chichester, UK: John Wiley and Sons, pp 27-50.

Owens, S. and Driffill, L. 2008. How to change attitudes and behaviours in the context of energy. *Energy Policy* 36, pp 4412-4418.

OXERA. 2006. *Policies for energy efficiency in the UK household sector*. A report for Defra. Oxford: OXERA.

Pace, M. L., Hampton, S. E., Limburg, K. E., Bennett, E. M., Cook, E. M., Davis, A. E., Grove, J. M., Kaneshiro, K. Y., LaDeau, S. L., Likens, G. E., McKnight, D. M., Richardson, D. C. and Strayer, D. L. 2012. Communicating with the public: opportunities and rewards for individual ecologists. *Frontiers in Ecology and the Environment* 8, pp 292-298.

Paetz, A.G., Duetschke, E. and Fichtner, W. 2012. Smart homes as a means to sustainable energy consumption: a study of consumer perceptions. *Journal of Consumer Policy* 35, pp 23–41.

Palmer, J. and Cooper, I. 2010. *Great Britain's Housing Energy Fact File*. Cambridge: Cambridge Architectural Research.

Parkhill, K. A., Pidgeon, N. F., Henwood, K. L., Simmons, P. and Venables, D. 2010. From the familiar to the extraordinary: local residents' perceptions of risk when living with nuclear power in the UK. *Transactions of the Institute of British Geographers* 35, pp 39-58.

Parkhill, K., Pidgeon, N., Corner, A. and Vaughan, N. 2012. Deliberation and Responsible Innovation: a Geoengineering Case Study. In Owen, R., Bessant, J. and Heintz, M. (eds). *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chicester: Wiley, pp 219-240.

Parkhill, K. A., Demski, C., Butler, C., Spence, A. and Pidgeon, N. 2013. *Transforming the UK energy system: public values, attitudes and acceptability – synthesis report*. London: UK Energy Research Centre (UKERC).

Patterson, W. 2007. *Keeping the lights on*. London: Earthscan.

Paverd, A., Martin, A. and Brown, I. 2014. Security and Privacy in Smart Grid Demand Response Systems. In *Second Open EIT ICT Labs Workshop on Smart Grid Security* - SmartGridSec14.

Peter, P. J. and Olsen, J. C. 2005. *Consumer Behaviour and Marketing Strategy*. New York: McGraw-Hill.

Peterson, R. and Kern, R. 1996. Changing Highbrow Taste: From Snob to Omnivore. *American Sociological Review* 61, pp 900-907.

Petts, J. 2008. Public engagement to build trust: false hopes? *Journal of Risk Research* 11, pp 821-835.

Pickersgill, M. 2011. Connecting neuroscience and law: anticipatory discourse and the role of sociotechnical imaginaries. *New Genetics and Society* 30(1), pp 27-40.

Pidgeon, N. F. 1998. Risk assessment, risk values and the social science programme: why do we need risk perception research. *Reliability Engineering and System Safety* 59, pp 5-15.

Pidgeon, N. F., Demski, C. C., Butler, C., Parkhill, K. A. and Spence, A. 2014. Creating a national citizen engagement process for energy policy. *Proceedings of the National Academy of Sciences of the USA* 111, pp 13606-13613.

Pidgeon, N. F., Hood, C., Jones, D., Turner, B. and Gibson, R. 1992. Risk Perception. In: *Risk: Analysis, Perception and Management*. London: Royal Society, pp 89-134.

Pidgeon, N. F. and Rogers-Hayden, T. 2007. Opening up nanotechology dialogue with the publics: Risk communication or 'upstream engagement'? *Health, Risk and Society* 9, pp 191-210.

Pierce, J. and Paulos, E. 2011. A phenomenology of human-electricity relations. In *Proceedings of the 2011annual Conference on Human Factors in Computing Systems*. ACM, pp.2405-8.

Pierce, J. and Paulos, E. 2012. Beyond energy monitors: interaction, energy, and emerging energy systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, pp. 665-674.

Pink, S. 2006. *The future of visual anthropology: Engaging the senses*. Abingdon, UK: Taylor & Francis.

Pink, S. and Mackley, K. L. 2012. Video and a Sense of the Invisible: Approaching Domestic Energy Consumption Through the Sensory Home. *Sociological Research Online* 17, pp 1-3.

Poland, B. D. 2001. Transcription Quality. In: Gubrium, J. F. and Holstein, J. A. eds. *Handbook of Interview Research: Context and Method*. California: Sage, pp 629-649.

Poortinga, W. and Pidgeon, N. F. 2003. Exploring the dimensionality of trust in risk regulation. *Risk Analysis* 23, pp 961-972.

Popovich, D. and Sahovic, N. 2014. Smart meter and consumer. *Proceedings of Symorg 2014*, pp 1649-1654.

Poudineh, R. and Jamasb, T. 2012. Smart Grids and Energy Trilemma of Affordability, Reliability and Sustainability: The Inevitable Paradigm Shift in Power Sector. *USAEE Working Paper No. 2111643*.

Prins, G. 1992. On condis and coolth. *Energy and Buildings* 18, pp 251-258.

Quiriconi, R. J. and Durgan, R. E. 1985. Respondent personalities: Insight for better focus groups. *Journal of Data Collection* 25, pp 20-23.

Rabiee, F. 2004. Focus group interview and data-analysis. *Proceedings of the Nutrition Society* 63, pp 655-660.

Rahman, S. 2009. Smart grid expectations. IEEE Power and Energy Magazine 7, pp 84-85.

Rapley, T. 2004. Interviews. In Seale, C., Gobo, G., Gubrium, J. F. and Silverman, D. eds. *Qualitative Research Practice*. London: Sage, pp 15-33.

RCEP. 2000. *Energy - The Changing Climate*. London: Royal Commission on Environmental Pollution.

Reckwitz, A. 2002a. Toward a theory of social practices. *European Journal of Social Theory* 5, pp 243–263.

Reckwitz, A. 2002b. The status of the "material" in theories of culture. From "social structure" to "artefacts". *Journal for the Theory of Social Behaviour* 32, pp 195-217.

Rettie, R. 2012. Practice routines: public and private. In *Proceedings of 4S/EASST conference in Copenhagen*. 20 October 2012.

Richards, L. 1999. Data Alive! The thinking behind NVivo. *Qualitative Health Research* 9, pp 412-428.

Richards, L. and Richards, T. 1994. From filing cabinet to computer. In: Bryman, A. and Burgess, R. G. eds. *Analyzing Qualitative Data*. Boston: Routledge, pp 146-172.

Rogers-Hayden, T. and Pidgeon, N. 2007. Moving Engagement 'Upstream'? Nanotechnologies and the Royal Academy of Engineering's Inquiry. *Public Understanding of Science* 16, pp 345–64.

Roscoe, A. J. and Ault, G. 2010. Supporting high penetrations of renewable generation via implementation of real-time electricity pricing and demand response. *IET Renewable Power Generation* 4, pp 369-382.

Rosenberg, D. and Harding, S. 2005). Introduction: Histories of the future. In: Rosenberg, D and Harding, S. (Eds.). *Histories of the future*. Durham, NC: Duke University Press, pp 3-18.

Ross, T. A. and Geil, P. 2010. Healthy Eating on a Lean Budget: Diabetes Meals for Less. *Diabetes Spectrum*, *23*, pp 120-123.

Rubin, P. H. 2003. Folk Economics. *Southern Economic Journal* 70 , pp 157-171.

Ruderman, H., Levine, M. D. and McMahon, J. E. 1987. The behaviour of the market for energy efficiency in residential appliances including heating and cooling equipment. *Energy Journal* 8 , pp 101-124.

Rutten, J. 2013. *Designing Ampul: exploring future prosumer interactions*. Delft University of Technology: Master Thesis.

Sarewitz, D. 1996. *Frontiers of illusion: Science, technology, and the politics of progress*. Philadelphia: Temple University Press.

Schatzki, T. R. 1996. Social Practices: *A Wittgensteinian Approach to Human Activity and the Social*. Cambridge: Cambridge University Press.

Schatzki, T. 2009. Timespace and the organisation of social life. In Shove et al (eds.), *Time, consumption and everyday life: Practice, materiality and culture*. Oxford: Berg, pp 35-48.

Scherbaum, C. A., Popovich, P. M. and Finlinson, S. 2008. Exploring Individual-Level Factors Related to Employee Energy-Conservation Behaviours at Work. *Journal of Applied Social Psychology* 38, pp 818-835.

Shaw, M. E. 1981. *Group dynamics: The psychology of small group behaviour*. 3rd ed. New York: McGraw-Hill.

Shirani, F., Butler, C., Henwood, K., Parkhill, K. and Pidgeon, N. 2013. Disconnected futures: exploring notions of ethical responsibility in energy practices. *Local Environment*, *18*, pp 455-468.

Shirani, F., Parkhill, K., Butler, C., Groves, C. Pidgeon, N. and Henwood, K. Accepted. Asking about the future: Methodological insights from Energy Biographies. *International Journal of Social Research Methodology*. Doi: http://doi.org/10.1080/13645579.2015.1029208.

Shove, E. 2010. Beyond the ABC: climate change policy and theories of social change. *Environment and Planning A* 42, pp 1273-1285.

Shove, E. 2011. On the difference between chalk and cheese - a response to Whitmarsh et al's comments on "Beyond the ABC: climate change policy and theories of social change". *Environment and Planning* A 43, pp 262-264.

Shove, E. and Walker, G. 2014. What Is Energy for? Social Practice and Energy Demand. *Theory, Culture and Society* 31, pp 41-58.

Shove, E. and Warde, A. 2002. Inconspicuous consumption: the sociology of consumption, lifestyles and the environment. In Dunlap et al (eds.), *Sociological Theory and the Environment: classical foundations, contemporary insights*. Lanham, MA; Rowman and Littlefield Publishers Inc., pp 230-250.

Siemiatycki, J. 1979. A comparison of mail, telephone and home interview strategies for household health surveys. *American Journal of Public Health* 69, pp 238-245.

Siero, F., Bakker, A., Dekker, G. and van den Burg, M. 1996. Changing organisational energy consumption behaviour through comparative feedback. *Journal of Environmental Psychology* 16, pp 235-246.

Sierzchula, W., Bakker, S., Maat, K. and van Wee, B. 2014. The influence of financial incentives and other socio-economic factors on electric vehicle adoption. *Energy Policy* 68, pp 183-194.

Silva, P. G. D. and Karnouskos, S. 2012. Using flexible energy infrastructures for demand response in a Smart Grid city. *Innovative Smart Grid Technologies (ISGT Europe), 2012 3rd IEEE PES International Conference and Exhibition,* pp 1-7.

Simcock, N., MacGregor, S., Catney, P., Dobson, A., Ormerod, M., Robinson, Z., Ross, S., Royston, S. and Hall, S. M. 2014. Factors influencing perceptions of domestic energy information: Content, source and process. *Energy Policy* 65, pp 455-464.

Simonson, I. 1993. Get closer to your customers by understanding how they make choices. *California Management Review* 35, pp 68-84.

Sioshansi, F. P. 2012. Introduction. In: Sioshansi, F. P. eds. *Smart Grid: Integrating Renewable, Distributed and Efficient Energy.* Boston: Academic Press, pp xxix-lvi.

Sopha, B., Klöckner, C., Skjevrak, G. and Hertwich, E. 2010. Norwegian households' perception of wood pellet stove compared to air-to-air heat pump and electric heating. *Energy Policy* 38, pp. 3744–3754.

Sopha, B., Klöckner, C. and Hertwich, E. 2013. Adoption and diffusion of heating systems in Norway: Coupling agent-based modelling with empirical research. *Environmental Innovation and Societal Transitions* 8, pp 42– 61.

Southerton, D. 2003. Squeezing time: Allocating practices, coordinating networks and scheduling society. *Time and Society* 12, pp 5-25.

Southerton, D. 2006. Analysing the Temporal Organisation of Daily Life: Social Constraints, Practices and their Allocation. *Sociology* 40 (3), pp 435-454.

Southerton, D., Warde, A. and Hand, M. 2004. The limited autonomy of the consumer: implications for sustainable consumption. In Southerton, D., Chappells, H. and Van Vliet, B. (eds). *Sustainable Consumption: The Implications of Changing Infrastructures of Provision*. Cheltenham: Elgar, pp 32-48.

Sorrell, S. and Dimitripoulos, J. 2008. The rebound effect: Microeconomic definitions, limitations and extensions. *Ecological Economics* 65, pp 636-649.

Spaargaren, G. 2000. Ecological modernisation theory and domestic consumption. *Journal of Environmental Policy and Planning* 2, pp 323-335.

Spence, A. 2005. Using implicit tasks in attitude research: A review and a guide. *Social Psychological Review* 7, pp 2-17.

Spence, A. and Pidgeon, N. F. 2009. Psychology, climate change and sustainable behaviour. *Environment: Science and Policy for Sustainable Development* 51, pp 8–18.

Spence, A., Demski, C., Butler, C., Parkhill, K. and Pidgeon, N. 2015. Public perceptions of demand-side management and a smarter energy future. *Nature Climate Change* 5, pp 550-554.

Spencer, S. 2011. *Visual Research Methods: Awakening Visions*. Oxford: Routledge.

Starks, H. and Trinidad, S. B. 2007. Choose Your Method: A Comparison of Phenomenology, Discourse Analysis, and Grounded Theory. *Qualitative Health Research* 17, pp 1372-1380.

Starmer, C. 2000. Developments in non-expected utility theory: the hunt for a descriptive theory of choice under risk. *Journal of Economic Literature* 38, pp 332-382.

Stephens, N. 2007. Collecting data from elites and ultra-elites: Telephone and face-to-face interviews with macroeconomists. *Qualitative Research* 7, pp 203-216.

Stephens, N. 2010. In Vitro Meat: Zombies on the Menu? *ScriptED* 7(2), pp 394-401.

Stewart, D. W., Shamdasani, P. N. and Rook, D. W. 2007. *Focus Groups: Theory and Practice*. Thousand Oaks: Sage.

Stilgoe, J. 2011. A question of intent. *Nature Climate Change* 1, pp 325-326.

Stirling, A. 2007. Deliberate futures: precaution and progress in social choice of sustainable technology. *Sustainable Development* 15, pp 286-295.

Stirling, A. 2008. "Opening Up" and "Closing Down": Power, Participation and Pluralism in the Social Appraisal of Technology. *Science, Technology and Human Values* 33, pp 262-294.

Stohl, A. 2008. The travel-related carbon dioxide emissions of atmospheric researchers. *Atmospheric Chemistry and Physics* 8, pp 6499-6504.

Stouffer, W. B., Jeffrey, S. and Oliva, M. G. 2004. Making the Strange Familiar: Creativity and the Future of Engineering Education. In: *Proceedings of the 2004 American Society for Engineering Education Annual Conference and Exposition*. Washington: American Society for Engineering Education, session 1615.

Strack, F. and Mussweiler, T. 1997. Explaining the Enigmatic Anchoring Effect: Mechanisms of Selective Accessibility. *Journal of Personality and Social Psychology* 73, pp 437–446.

Stragier, J., Hauttekeete, L. Marez, L. D. 2010. Introducing smart grids in residential contexts: Consumers' perception of smart household appliances. In *Proc. IEEE Conference on Innovative Technologies for an Efficient and Reliable Electricity Supply*, pp 135–142.

Strengers, Y. 2010. Air-conditioning Australian households: A trial of Dynamic Peak Pricing. *Energy Policy* 38, pp 7312-22.

Strengers, Y. 2012. Peak electricity demand and social practice theories: Reframing the role of change agents in the energy sector. *Energy Policy* 44, pp 226-234.

Strengers, Y. 2013. *Smart Energy Technologies In Everyday Life: Smart Utopia?* Basingstoke: Palgrave Macmillan.

Sturgis, P. and Allum, N. 2004. Science in society: re-evaluating the deficit model of public attitudes. *Public understanding of science* 13, pp 55-74.

Sukki, F. M., Ramirez-Iniguez, R., Munir, A. B., Yasin, S. H. M., Abu-Bakar, S. H., McMeekin, S. G. and Stewart, B. G. 2013. Revised feed-in tariff for solar photovoltaic in the United Kingdom: A cloudy future ahead? *Energy Policy* 52, pp 832-838.

Sykes, K. and Macnaghten, P. 2012. Responsible Innovation: Opening Up Dialogue and Debate. In Owen, R., Bessant, J. and Heintz, M. (eds). *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. Chicester: Wiley, pp 85-108.

Tang, K. C. and Davis, A. 1995. Critical factors in the determination of focus group size. *Family Practice* 12, pp 474-5.

Taylor, S. 2001. Evaluating and applying discourse analytic research. In Wetherell, S., Taylor, M. and Yates, S. J. (eds). Discourse as data: A guide for analysis. London: Sage.

Taylor, M. A. P. and Ampt, E. S. 2003. Travelling smarter down under: policies for voluntary travel behaviour change in Australia. *Transport Policy* 10, pp 165-177.

The British Psychological Society. 2010. *Code of Human Research Ethics*. Leicester.

Thogersen, J. and Olander, F. 2003. Spillover of environment-friendly consumer behaviour. *Journal of Environmental Psychology* 23, pp 225-236.

Thogersen, J. and Crompton, T. 2009. Simple and painless? The limitations of spillover in environmental campaigning. *Journal of Consumer Policy 32,* pp 141-163.

Thomas, M. J. 2013. *Public and expert perceptions of sea-level change on the Severn Estuary*. PhD Thesis, Cardiff University.

Toke, D. and Taylor, S. 2007. Demand reduction in the UK – with a focus on the non-domestic sector. *Energy Policy* 35, pp 2131-2140.

Tracy, S. J. 2013. *Qualitative Research Methods – Collecting Evidence, Crafting Analysis, Communicating Impact*. Oxford: Wiley-Blackwell.

Train, K. 1985. Discount rates in consumers' energy-related decisions: a review of the literature. *Energy* 10, pp 1243-1253.

Triandis, H. 1977. *Interpersonal Behaviour*. Monterey, CA: Brooks/Cole.

Tversky, A. and Kahneman, D. 1981. The framing of decisions and the psychology of choice. *Science* 211, pp 453, 458.

Vaclav, S. 2009. U.S. Energy Policy: The Need for Radical Departures. *Issues in Science and Technology* 25 (4), pp 47-50.

Van Bree, B., Verbong, G. P. J. and Kramer, G. J. 2010. A multi-level perspective on the introduction of hydrogen and battery-electric vehicles. *Technological Forecasting and Social Change* 77, pp 529-540.

Van den Ende, J. and Kemp, R. 1999. Technological transformations in history: how the computer regime grew out of existing computing regimes. *Research Policy* 28, pp 833–851.

van Lente, H. 1993. *The dynamics of expectations in technological developments*. Doctoral Thesis, Enschede: University of Twente.

Velthuis, O. 2004. An interpretive approach to meanings of prices. *The Review of Austrian Economics* 17, pp 371-86.

Verplanken, B., Aarts, H., Van Knippenberg, A. and Moonen, A. 1998. Habit versus planned behaviour: a field experiment. *British Journal of Social Psychology* 37, pp 111-128.

Verplanken, B. and Holland, R. 2002. Motivated decision-making: Effects of activation and self-centrality of values on choice and behaviour. *Journal of Personality and Social Psychology* 82, pp 434-447.

Waide, P. 2010. *Phase out of incandescent lamps. Implications for international supply and demand for regulatory compliant lamps.* Paris: France, International Energy Agency.

Walker, G., Cass, N., Burningham, K. and Barnett, J. 2010. Renewable energy and sociotechnical change: imagined subjectivities of 'the public' and their implications. *Environment and Planning A*, pp 931-947.

Wallbridge, R., Smith, G. and Buchs, M. 2012. *"New 'doings and sayings'? Emerging energy saving practices"*. Paper presented at 'Design and Displacement – Social Studies of Science and Technology' Conference, 17-20 October 2012, Copenhagen.

Wang, X. 2010. *UKERC Energy Research Atlas: socio-economic issues*. London, UK Energy Research Centre.

Warde, A. 2005. Consumption and Theories of Practice. *Journal of Consumer Culture* 5, pp 131-153.

Webb, P. and Suggitt, S. 2000. *Gadgets and Necessities: An Encyclopaedia of Household Innovations.* London: ABC-CLIO.

Welch, C., Marschan-Piekkari, R., Penttinen, H. and Tahvanainen, N. 2002. Corporate elites as informants in qualitative international business research. *International Business Review* 11, pp 611-628.

Whitmarsh, L. 2009. Behavioural responses to climate change: Asymmetry of intentions and impacts. *Journal of Environmental Psychology* 29, pp 13-23.

Whitmarsh, L., O'Neill, S. and Lorenzoni, I. 2011. Climate change or social change? Debate within, amongst, and beyond disciplines. *Environment and Planning A* 43, pp 258-261.

Whitmarsh, L., Upham, P., Poortinga, W., McLachlan, C., Darnton, A., Devine-Wright, P., Demski, C. and Sherry-Brennan, F. 2011. *Public attitudes, understanding, and engagement in relation to low-carbon energy: A selective review of academic and non-academic literatures*. London: Research Councils UK.

Whitmarsh, L., Nash, N., Lloyd, A. and Upham, P. 2014. *UK Public Perceptions of Shale Gas, Carbon Capture & Storage and Other Energy Sources & Technologies: Summary Findings of a Deliberative Interview Study and Experimental Survey*. Understanding Risk Research Group Working Paper 14-02, Cardiff University.

Whittemore, R., Chase, S. K. and Mandle, C. L. 2001. Validity in Qualitative Research. *Qualitative Health Research* 11, pp 522-537.

Wilhite, H. and Ling, R. 1995. Measured energy savings from a more informative energy bill. *Energy and Buildings* 22, pp 145-155.

Wilkie, A. and Michael, M. 2009. Expectation and mobilisation: enacting future users. Science, *Technology and Human Values* 34, pp 502–522.

Willott, S. 1998. An outsider within: A Feminist doing research with men. In Henwood, K., Griffin, C. and Phoenix, A. eds. *Standpoints and differences: Essays in the practice of feminist psychology*. London: Sage, pp 174-190.

Willott, S. and Griffin, C. 1999. Building your own lifeboat: Working-class male offenders talk about economic crime. *British Journal of Social Psychology* 38, pp 445-460.

Wilsdon, J. and Willis, R. 2004. *See Through Science: Why Public Engagement Needs to Move Upstream*. London: Demos.

Wilson, C. and Dowlatabadi, H. 2007. Models of decision making and residential energy use. *Annual Review of Environment and Resources* 32, pp 169–203.

Wilson, C. and Chatterton, T. 2011. Multiple models to inform climate change policy: A pragmatic response to the 'beyond the ABC' debate. *Environment and Planning A* 43, pp 2781-2787.

Winzer, C. 2011. Conceptualising Energy Security. *EPRG Working Paper 1123*. UK: University of Cambridge.

Wittneben, B. B. F. 2012. The impact of the Fukushima nuclear accident on European energy policy. *Environmental Science and Policy* 15, pp 1-3.

Wookey, R., Bone, A., Carmichael, C. and Crossley, A. 2014. *Minimum home temperature thresholds for health in winter – A systematic literature review*. London: Public Health England.

Wynne, B. 1991. Knowledges in Context. *Science, Technology and Human Values* 15, pp 111-121.

Wynne, B. E. 1992. Misunderstood misunderstanding: social identities and public uptake of science. *Public Understanding of Science* 1, pp 281–304.

Zepeda, L. and Deal, D. 2009. Organic and local food consumer behaviour: Alphabet Theory. *International Journal of Consumer Studies* 33, pp 697-705.

Zimmerer, K. S. 2011. New Geographies of Energy: Introduction to the Special Issue. *Annals of the Association of American Geographers* 101, pp 705-711.

Appendices

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Appendix A Recruitment Poster (Public Focus Groups)

Would you like to take part in a new research project?

What is the project about?

The research aims to investigate the ways in which consumers use, relate to and interact with electricity in the home. Understanding the opinions, behaviours and lifestyles that influence people's electricity consumption is important in helping to design informed, relevant policies to attempt to reduce electricity consumption and demand.

Who is undertaking the research?

This PhD project is being undertaken by Sam Hubble, a postgraduate student at Cardiff University. He is supervised by Professor Nick Pidgeon (School of Psychology, Cardiff University) and Professor Karen Henwood (School of Social Sciences, Cardiff University). The research is being funded by the Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC).

What will participation involve?

We are looking for people to take part in focus group discussions. The discussions will take the form of an informal conversation between you, other participants and the researcher. We will discuss topics such as: electricity in the home, typical daily routines, and energy consumption.

Discussions are likely to last around 1 hour 30 minutes and you will be offered **£10** as a thank you for your involvement.

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

If you are interested in participating or would like further information about the project, please contact Sam Hubble on 02920 870836 or hubblest@cardiff.ac.uk

Appendix B

Consent Form (Public Focus Groups)

School of Psychology, Cardiff University

Consent Form – Use of Data

I understand that my participation in this project will involve taking part in a group discussion. I understand that this will involve participating in discussions about how I, and others, use electricity in the home, which will last for approximately 1.5 hours.

I understand that I may be contacted after the focus group requesting that I participate in a follow-up interview 6-12 months after the focus group discussion. I understand that the group discussions will be recorded with audio equipment and transcribed.

I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time (up until the date when data is anonymised) without giving a reason and without loss of the monetary gift I will receive.

I understand that I am free to ask any questions at any time. I am free to withdraw or discuss my concerns with postgraduate student Sam Hubble. I agree that data obtained in the session may be utilised in discussion with other researchers, in any ensuing presentations, reports, publications, websites and broadcasts.

I understand that the information provided by me will be held anonymously, using pseudonyms, so that once the audio recording of the discussion has been transcribed into a written transcript no-one except the experimenter (Sam Hubble) and his supervisors (Professor Nick Pidgeon and Professor Karen Henwood) will be able to trace my information back to me. I understand that in all publications any information provided will be made anonymous with only pseudonyms and generic identifying features (e.g. gender and age) used as identifying features.

I also understand that at the end of the focus group I will be provided with additional information and feedback about the purpose of the study.

I have been provided with sufficient information on the project to give *informed* consent to the interview session.

I, _____**(PRINT NAME)** consent to participate in the study led by Professor Nick Pidgeon, School of Psychology, Cardiff University.

Signed: Date:

School of Psychology, Cardiff University

Consent Form – Participant Database

I am willing for my name and contact details to be held in a list (database) so that I may be contacted in future and asked further questions (for the purposes of reviewing/clarifying issues and elaborating on themes), as agreed below.

I understand that I am consenting only to receive a request to answer further questions, and that I am under no obligation to answer these questions.

I understand that this list will be used only for the purpose described here and will not be made available to anyone beyond those agreed below.

I understand that the contact details provided by me will be held confidentially, such that only the experimenter (postgraduate student Sam Hubble) and his supervisor team (Professor Nick Pidgeon and Professor Karen Henwood) can trace this information back to me individually.

I understand that I may remove my name from the list at any time by emailing Sam Hubble (HubbleST@cardiff.ac.uk).

I, _____ **(PRINT NAME)** consent to enter my contact details onto the list held by _____ postgraduate student Sam Hubble, Professor Nick Pidgeon and Professor Karen Henwood.

Signed: Date:

Appendix C

Participant Information Sheet (Public Focus Groups)

Information for Participants

Project description and research aims

The project is being undertaken by Sam Hubble, a postgraduate student at Cardiff University. Broadly, the research aims to investigate the ways in which consumers relate to and interact with electricity in the home. Understanding the perceptions, behaviours and ever-changing lifestyles that influence people's electricity consumption could be vital in helping to design informed, relevant policies to attempt to reduce electricity consumption, and, ultimately, demand.

What will your participation involve?

Should you decide to take part in the research, your participation will involve a discussion with other members of a focus group. There will be some topics that the researcher will aim to cover – by providing prompts and questions – but the direction of the discussion will also be determined by answers and responses that you and other participants provide. The focus group discussion will last approximately 1 hour. The focus group discussion will be recorded with audio equipment.

If at any point you change your mind about taking part in the research you can withdraw at any time by contacting the researcher on the details provided below. You may also withdraw in person during the focus group or at any other time, up until the point that the data is fully anonymised.

You will be paid £10 to thank you for your participation.

You may be asked if you would be willing to take part in a follow-up interview later in the study, to review or clarify issues and elaborate on themes identified in the focus groups.

Who is participating?

The researcher intends to hold focus group discussions with members of the public from a range of different backgrounds. Each individual focus group will comprise of participants with similar circumstances – in particular their living arrangements (e.g. one group may comprise of participants who live in single occupancy dwellings, or a group of participants

who live in shared accommodation). As electricity consumption is influenced by people's lifestyle and living arrangements, this study will investigate the opinions of a range of different participants with the aim of obtaining an insight into a range of different electricity-related opinions, behaviours and practices.

Anonymity and confidentiality

The information and responses you provide will be held confidentially, in accordance with British Psychological Society (BPS) 'Ethical principles for conducting research on human participants', such that only the project team (postgraduate student Sam Hubble, Professor Nick Pidgeon and Professor Karen Henwood) can trace this information back to you individually. Actual names will be changed to pseudonyms after transcription, making the transcript data used in analysis anonymous. In addition, the pseudonyms will be used by the project team in day to day discussion of the research. In all related publications, participants' quotes will be anonymous. In that context, only non-identifying generic terms (e.g. gender, age) and the pseudonym will be used to describe participants. The audio recordings and original transcripts with identifying links will be stored at Cardiff University in a locked location until any necessary follow-up discussions are complete. At this point, the data will be anonymised and kept indefinitely.

Who will have access to the data?

The audio recordings and transcripts will be shared among the researcher and his supervisory team, and with their permission, with other relevant researchers. Participants may ask to see the data or request that it be destroyed at any time, up until the date that the data is anonymised.

How will the data be used?

The data will be used in academic research and will be used to produce reports, presentations, conference papers, and academic publications. The data and/or subsequent publications may also be used for teaching purposes.

Who is funding the research?

The funding for this project is provided by the Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC).

The Research Team

Principle Investigator: Postgraduate student Sam Hubble (HubbleST@cardiff.ac.uk).

Supervisory Team: Professor Nick Pidgeon (PidgeonN@cardiff.ac.uk) and Professor Karen Henwood (HenwoodK@cardiff.ac.uk).

Contact:

Sam Hubble (postgraduate student), 51A, Park Place, School of Psychology, Cardiff Univeristy, CF10 3AT Tel: 02920 870836.

Appendix D

Public Participant Profiles

Pseudonym	Age	Occupation	Own/Rent/Other
Student Group			
Kirsty	20	Student	Rent
Fiona	20	Student	Rent
Michael	19	Student	Rent
Richard	20	Student	Rent
Annabel	20	Student	Rent
Gemma	19	Student	Rent
Young Professionals			
Josie	25	University Researcher	Rent
Erica	27	Environmental Researcher	Rent
Dave	26	Computer Programmer	Rent
Ben	23	Teaching Assistant	Rent
Mark	24	Accountant	Own
John	23	Care Home Worker	Rent
Solar PV Group			
James	63	Retired Oil Worker	Own
Sue	53	Pharmacist	Own
Anne	53	Teacher	Own

William	53	Property Renovator	Own
Sophie	56	Administrator	Own
Paul	41	Software Technician	Own

Retired Group

Emma	64	Retired Social Worker	Own
Christina	64	Retired Teacher	Own
Lorraine	68	Retired	Own
Charles	64	Retired	Own
Robert	64	Retired Chef	Own

Mothers Group

Judy	43	Stay at Home Mum	Own
Holly	29	Health and Social Care Tutor	Own
Clare	35	Stay at Home Mum	Own
Beth	33	Stay at Home Mum	Own

Appendix E

Focus Group Protocol

Discussions to loosely follow this structure:

Thinking about electricity *(10 mins)*

Icebreaker:

1. Write down the first 3 things that you think of when you hear the word electricity.

2. Do you ever think about electricity in your everyday life? (**How? Why?**)

3. Where does electricity come from?

4. Can you think of any specific times or events when you have thought about electricity use?

5. Has electricity ever been an important consideration or had an influence on any decisions you have made or actions you have taken?

Daily Routines *(10 mins)*

6. Are the ways in which you use electricity influenced by other members of the household? (**How?**)

7. Are there ever any discussions about electricity in your home?

8. Are there ever any conflicts or disagreements in your household over the ways in which electricity is used? (**Probe for reasons why**)

9. What do you do wake up? (r**outine**)

10. Do you have any routines that you do every day?

Change over time *(5-10 mins)*

11. Do you think the way in which you use of electricity in your home has changed over time? (**How?**)

12. Is the way you use electricity in your home different to the ways you have used it in other settings? (**e.g. previous homes, workplaces?**)

Electricity as a product *(15 mins)*

13. What kind of things do you do in your home to make it feel like 'home'? Can you write down some of these things? (**Get group to sort cards in order of importance/discuss**)

14. Do you think of using electricity in the same way that you think of using other utilities? (**e.g. water, gas**) (**prompt on communication – e.g. internet**)

15. Are there any things you like doing or are important to you that are dependent on electricity?

16. Have there ever been times when you have been without electricity? What impact did this have?

17. Are there things you do, or appliances you use, that you simply couldn't live without? How does this impact your life? What does this mean to you?

18. Are there any you could live without? (prompt on intermittent/changing supply)

Awareness of electricity consumption *(15 mins)*

19. Are you aware of the amount of electricity that you use? (**Prompt on doubly-invisible aspect of electricity**)

20. Do you think your households' electricity consumption is typical?

21. Can you think of reasons why other people may use different amounts to you?

22. What do you think about people being asked to reduce the amount of electricity they use? (**Why?**)

23. Can you think of ways in which reducing electricity consumption could be encouraged?

24. What are the obstacles to reducing people's electricity consumption?

25. Do you think it is possible to change people's routines, lifestyles or behaviour to change the times and patterns in which they consume electricity?

(Prompt about shifting demand to reduce peaks.)

Reducing Consumption *(10 mins)*

26. If you were tasked with having to reduce the amount of electricity you use in the home. How would you do it? (**What impact would this have on your lifestyle?)**

27. Do you have any products that give you information on the amount of electricity that you use?

28. Do these have any effect on what you do?

29. Do you have an energy monitor in your house?

(If yes: Has it had any impact/made any difference? How? Why?)

(If no: Probe for reasons why e.g. not available, not interested etc. Do you think a smart meter would have any impact in your home? Why?)

Future + Role of Technology *(15 mins)*

30. Do you ever buy products that are advertised as being energy efficient?

31. Do you think developments in technology have influenced your lifestyle?

32. How do you imagine your lifestyle may change in the future?

33. Do you think the way you use electricity may change in the future?

(How?)

Appendix F

Recruitment Letter (Expert Interviews)

Sam Hubble
PhD Researcher
51a Park Place
School of Psychology
Cardiff University
CF10 3AT

Dear ,

I'm writing to request your participation in a short interview as part of the Top and Tail-linked research that I am undertaking as part of my PhD project (within work package 2.1.1). Enclosed is a full description of the project, including the study aims and broad research questions.

My project is supervised by Professor Nick Pidgeon (School of Psychology) and Professor Karen Henwood (School of Social Sciences).

Your views would be invaluable to my project and I would be very grateful if you would undertake this short interview of approximately 60 minutes. I hope that you will be able to participate in this study as your insights would make an important contribution to this research, and enable me to develop accurate materials that can be used to help achieve the aims of both the Top and Tail network and my own research project.

If you wish to discuss any aspect of the project further before agreeing to an interview please contact me on the details provided below and I will be happy to respond to any queries you may have.

Should you decide you can afford to lend some of your time and expertise to this research, the next step would be to try to find a suitable time and place to do the interview. My telephone number is 02920870836, and my email is hubblest@cardiff.ac.uk should you have any questions that you would like me to answer directly. If there is a good time for me to ring you please do let me know.

Thanking you in anticipation.
Yours Sincerely,

Sam Hubble (postgraduate student)

Address: 51a Park Place, School of Psychology, Cardiff, CF10 3AT
Email: hubblest@cardiff.ac.uk Phone: 02920 870836

Supervisory team: Prof. Nick Pidgeon (pidgeonn@cardiff.ac.uk)
Prof. Karen Henwood (henwoodk@cardiff.ac.uk)

Appendix G

Consent Form (Expert Interviews)

School of Psychology, Cardiff University

Consent Form

I understand that my participation in this project will involve taking part in a semi-structured interview which will take approximately 1 hour of my time. I understand that I may be contacted after the interview to review, validate and clarify issues or elaborate on themes. I understand that the interviews will be recorded with audio equipment.

I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time (up until the date when data is anonymised) without giving a reason. I understand that I am free to ask any questions at any time. I am free to withdraw or discuss my concerns with postgraduate student Sam Hubble. I agree that data obtained in the session may be utilised in discussion with other researchers, in any ensuing presentations, reports, publications, websites, broadcasts, and in teaching.

I understand that information provided by me will be held confidentially, such that only the researcher (Sam Hubble) and his supervisors (Professor Nick Pidgeon and Professor Karen Henwood) can trace this information back to me individually.

I understand that my responses will remain anonymous within this research and that once any follow-ups have been carried out, information will then be anonymised and held indefinitely. Following this all publications and discussion of the research all information I give will be made anonymous with only pseudonyms and generic identifying features utilised for identification.

I understand that I can ask for the information I provide to be deleted/destroyed at any time up until it is anonymised and I can have access to the information at any time until it is anonymised.

I have been provided with sufficient information on the project to give *informed* consent to the interview session.

I, _____ **(PRINT NAME)** consent to participate in the study being undertaken by postgraduate student Sam Hubble (supervised by Professor Nick Pidgeon, School of Psychology, and Professor Karen Henwood, School of Social Sciences).

Signed: Date:

Appendix H

Participant Information Sheet (Expert Interviews)

Information for Participants

Project description and research aims – Phase 2

The project is being undertaken by Sam Hubble, a postgraduate student at Cardiff University. Broadly, the research aims to investigate the ways in which consumers relate to and interact with electricity in the home. This Phase 2 research follows on from Phase 1 focus groups that were conducted with members of the public to understand the perceptions, behaviours and ever-changing lifestyles that influence people's electricity consumption. It is anticipated that the insights gained from the Phase 2 interviews with Top and Tail partners will help to develop accurate, meaningful scenarios that describe possible future electricity system changes and the associated impacts these may have. These scenarios will then be used in follow-up public interviews to identify perceptions towards the scenarios being presented and attempt to gauge the acceptability of possible future changes in the UK electricity network.

What will your participation involve?

Should you decide to take part in the research, your participation will involve a one-on-one interview with postgraduate research student Sam Hubble. There will be some topics that the researcher will aim to cover – by providing prompts and questions – but the direction of the discussion will also be determined by answers and responses that you provide. A copy of the interview protocol/questions will be provided beforehand. The interview will last approximately 1 hour, and will be recorded with audio equipment, before being transcribed.

If at any point you change your mind about taking part in the research you can withdraw at any time by contacting the researcher on the details provided below.

You may be asked if you would be willing to be contacted later in the study, to review or clarify issues identified in the interview.

Who is participating?

The researcher intends to conduct interviews with various members of the Top and Tail network, to get a broad range of the visions and motivations that network partners have for the electricity system in the future.

Anonymity and confidentiality

All data will remain confidential in accordance with British Psychological Society (BPS) 'Ethical principles for conducting research on human participants'. The option to remain anonymous within this research will be offered to all participants. If this option is selected, actual names will be viewed only by the project team. In addition, all participants will be given an alias which will be used by the project team in day to day discussion of the research. In all related publications, participant's quotes will be made anonymous. In that context, only non-identifying generic terms (e.g., gender, profession) and the alias will be used to describe participants. The interview recordings will be stored in a secure location at Cardiff University.

Who will have access to the data?

The audio recordings and transcripts will be shared among the researcher and his supervisory team, and with their permission, with other relevant researchers. Participants may ask to see the data or request that it be destroyed at any time, up until the date that the data is anonymised.

How will the data be used?

The data will be used in academic research and will be used to produce reports, presentations, conference papers, and academic publications. The data and/or subsequent publications may also be used for teaching purposes.

Who is funding the research?

The funding for this project is provided by the Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC).

The Research Team

Principle Investigator: Postgraduate student Sam Hubble (HubbleST@cardiff.ac.uk).

Supervisory Team: Professor Nick Pidgeon (PidgeonN@cardiff.ac.uk) and Professor Karen Henwood (HenwoodK@cardiff.ac.uk).

Contact details

Sam Hubble (postgraduate student)
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School of Psychology, Cardiff, CF10 3AT
Email: hubblest@cardiff.ac.uk
Phone: 02920 870836

School of Psychology Ethics Committee
Address:
School of Psychology,
Cardiff, CF10 3AT
Email: psychethics@cardiff.ac.uk
Phone: 02920 870360

Appendix I

Expert Interview Protocol

Discussions to loosely follow this structure:

Ice Breaker and Personal Motivation

1. What would you say are your main research areas of expertise and interest?
2. How did you get into this field? (What motivated you?)
3. Why does the UK's electricity system need to change?

Top and Tail

4. How would you describe the Top and Tail network?
5. How would you describe **your role** within Top and Tail?

Future Change

6. How do you **think** the UK's electricity system will change in the future? (And what impacts do you think this may have on users?).
7. How do you **hope** the UK's electricity system will change in the future? (And what impacts do you think this may have on users?).
8. If there were no constraints in the way, what changes to the UK's electricity system would you like to see implemented?
9. If you had to describe the future changes that you think are likely to occur to the UK's electricity system to a consumer layman, how would you go about it?
10. If you had to describe the possible impacts of these changes, how would you go about it? (Prompt on lifestyle changes, cost, technical changes, safety).
11. Imagine being at home in the future (i.e. 2030 or 2050). What is different about the way you use electricity?
12. What role do you think electricity will play in the future UK energy mix?

People Within the Electricity System

13. Do you think electricity will become increasingly important in people's lifestyles in the future? (Why? How?)
14. What social, ethical and other issues need to be considered in developing future changes to the UK's electricity system?
15. In terms of social research into electricity systems, what do you think is important?

Personal Relationship with Electricity

16. As a consumer, do you ever have any frustrations with your electricity supply, or the wider network?
17. Has electricity ever been an important consideration or had an influence on any decisions you have made or actions you have taken in your life outside the work environment?

Open-Ended Invitation for Relevant Topics

18. Is there anything I've missed out here, or something you feel is important to your work and/or the work of Top and Tail that we haven't covered?

Appendix J

Consent Form (Public Follow-Up Interviews)

School of Psychology, Cardiff University

Consent Form – Use of Data

I understand that my participation in this project will involve taking part in a semi-structured interview which will take approximately 75 minutes of my time. I understand that I may be contacted after the interview to review, validate and clarify issues or elaborate on themes. I understand that the interviews will be recorded with audio equipment.

I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time (up until the date when data is anonymised) without giving a reason and without loss of the monetary gift I will receive.

I understand that I am free to ask any questions at any time. I am free to withdraw or discuss my concerns with postgraduate student Sam Hubble. I agree that data obtained in the session may be utilised in discussion with other researchers, in any ensuing presentations, reports, publications, websites, broadcasts, and in teaching.

I understand that the information provided by me will be held anonymously, using pseudonyms, so that once the audio recording of the discussion has been transcribed into a written transcript no-one except the experimenter (Sam Hubble) and his supervisors (Professor Nick Pidgeon and Professor Karen Henwood) will be able to trace my information back to me. I understand that in all publications any information provided will be made anonymous with only pseudonyms and generic identifying features (e.g. gender and age) used as identifying features.

I understand that I will be paid £10 for my participation in the study. I also understand that at the end of the interview I will be provided with additional information and feedback about the purpose of the study.

I have been provided with sufficient information on the project to give *informed* consent to the interview session.

I, _____**(PRINT NAME)** consent to participate in the study led by Professor Nick Pidgeon, School of Psychology, Cardiff University.

Signed: Date:

Appendix K

Participant Information Sheet (Public Follow-Up Interviews)

Information for Participants

Project description and research aims – Phase 3

The project is being undertaken by Sam Hubble, a postgraduate student at Cardiff University. Broadly, the research aims to investigate the ways in which people relate to and interact with electricity in the home. This Phase 3 research follows on from Phases 1 and 2. Phase 1 involves focus groups that were conducted with members of the public to understand the perceptions, behaviours and ever-changing lifestyles that influence people's electricity consumption. Phase 2 involved interviews with engineers to help develop accurate, meaningful scenarios that describe possible future electricity system changes and the associated impacts these may have. It is anticipated that Phase 3 follow-up interviews will help to identify perceptions towards the scenarios being presented, elaborate on themes from Phase 1, and attempt to gauge the acceptability of possible future changes in the UK electricity network.

What will your participation involve?

Should you decide to take part in the research, your participation will involve a one-on-one interview with postgraduate research student Sam Hubble. There will be some topics that the researcher will aim to cover – by providing prompts and questions – but the direction of the discussion will also be determined by answers and responses that you provide. The interview will last approximately 1 hour 30 minutes, and will be recorded with audio equipment, before being transcribed.

If at any point you change your mind about taking part in the research you can withdraw at any time by contacting the researcher on the details provided below.

You may be asked if you would be willing to be contacted later in the study, to review or clarify issues identified in the interview.

Who is participating?

The researcher intends to conduct interviews with various members of the public who participated in focus groups earlier in the project.

Anonymity and confidentiality

All data will remain confidential in accordance with British Psychological Society (BPS) 'Ethical principles for conducting research on human participants'. The option to remain anonymous within this research will be offered to all participants. If this option is selected, actual names will be viewed only by the project team. In addition, all participants will be given an alias which will be used by the project team in day to day discussion of the research. In all related publications, participant's quotes will be made anonymous. In that context, only non-identifying generic terms (e.g., gender, age) and the alias will be used to describe participants. The interview recordings will be stored in a secure location at Cardiff University.

Who will have access to the data?

The audio recordings and transcripts will be shared among the researcher and his supervisory team, and with their permission, with other relevant researchers. Participants may ask to see the data or request that it be destroyed at any time, up until the date that the data is anonymised.

How will the data be used?

The data will be used in academic research and will be used to produce reports, presentations, conference papers, and academic publications. The data and/or subsequent publications may also be used for teaching purposes.

Who is funding the research?

The funding for this project is provided by the Engineering and Physical Sciences Research Council (EPSRC) and the Economic and Social Research Council (ESRC).

The Research Team

Principle Investigator: Postgraduate student Sam Hubble (HubbleST@cardiff.ac.uk).

Supervisory Team: Professor Nick Pidgeon (PidgeonN@cardiff.ac.uk) and Professor Karen Henwood (HenwoodK@cardiff.ac.uk).

Contact details

Sam Hubble (postgraduate student)
Address: 51a Park Place,
School of Psychology, Cardiff, CF10 3AT
Email: hubblest@cardiff.ac.uk
Phone: 02920 870836

Psychology Ethics Committee
Address:
School of Psychology,
Cardiff, CF10 3AT
Email: psychethics@cardiff.ac.uk
Phone: 02920 870360

Appendix L

Public Follow-Up Interview Protocol

Introduce Tabloid Frontpage. Ask participants to fill in spaces.

Since taking part in the focus group have you experienced any changes or has anything happened that has led to a change in the way you use electricity in the home?

Have there been changes to your day-to-day routine?

Focus Group Theme Follow-Up

A theme that emerged from the focus groups was the idea that lifestyles in the home are becoming more individualised. Would you agree with this? Why do you think this is the case? Do you think this will continue in the future? How do you think this may influence the way electricity is used within households?

Another theme involved the notion of non-negotiable consumption, where performing tasks or undertaking certain activities was deemed so important and meaningful that they would be undertaken – even if changes in policy (such as changing price tariffs) made this less convenient or more expensive. How do you think the way you live within the home will change in the future, and are any of the things you do in your home non-negotiable?

Money and cost was suggested to have a large influence on behaviour, and how electricity is used within the home. However, this was often contradicted with people suggesting other things were more important. Do you have any thoughts on this? (prompt on comfort, leisure, meaning)

Electricity was perceived by some as something that assists with or liberates people from performing difficult or dirty domestic practices (e.g. cleaning, needing a log fire etc.). Are there any other aspects of current lifestyles you imagine may be influenced by technical developments, or electrical products that may offer new services?

Question for Retired + Solar PV groups

A theme that emerged from the focus groups involved parents' suggesting that their heating demand increased whilst their children were living at home. Some also suggested that once their children had flown the nest the house temperature (and therefore heating demand) was reduced. Did you experience this? Why do you think this is the case? Was this a deliberate change or did it occur naturally? Did you have to make any changes to the way you live in the house to achieve this? (prompt on maintain comfort, clothing)

Engineering Themes Follow-Up

Historically, as technology develops the energy efficiency generally improves. However, despite efficiency improvements, electricity use in the home has increased. Why do you think this is the case?

When I spoke to electrical engineers on how they thought electricity use in the home could be reduced in the future, many responses referred to technological solutions and efficiency measures. Do you have any thoughts on why this may be the case? (prompt on limited consideration of behaviour change).

Introduction to why system needs to change:

To help reduce Carbon Dioxide emissions and meet climate change targets, as well to try to ensure future security of energy supply there are likely to be changes to the UK's electricity system. If electricity generated from fossil fuels is reduced, and supplies from renewable sources (such as wind) are increased this may create a more fluctuating supply. As a result, more management of the demand side (i.e. the end users of electricity) may be required to help balance the demand and supply. For this reason some suggest that either automation of some demand (e.g. some of your appliances within the home) or a more 'active' role for consumers within the electricity system may be required.

Some people advocate using 'smart' meters to provide feedback and enable two-way communication between the electricity system and consumers. For this reason, some speculate that people may become more 'active' participants in the system (e.g. you may have to plan what electricity you use by planning when to use certain appliances, you may receive information and signals from the grid referring to 'good' and 'bad' times to use electricity). How do you feel about this? Can you see any problems with this? (prompt on planning washing/laundry practices, electric vehicle charging etc.)

How do you feel about some appliances within your home working automatically? (prompt with example)

In the focus groups some people said that they rarely thought about electricity and how they used it in their everyday lives. Do you agree with this? Do you think this may change in the future? (prompt on increasing costs, visions of a more 'active' role for consumers in future system, and concerns over energy security)

Heating demand accounts for a significant proportion of the UK's domestic energy use. In addition to attempting to reduce usage, many advocate moving away from fossil-fuel and gas based systems. One way of achieving this is to move towards electric heating systems. Do you have any experience of/views towards electric heating? (prompt on comfort, heating individual rooms/whole house, and focal points of heat etc.)

Show participants videos.

Video 1

> What did you think of the video? What stood out?
>
> The commentators discussed market opportunities of smart meters, but didn't really discuss possible impacts on people. How do you think they may affect the way you live in the home?
>
> One commentator mentioned that some people may be excited to connect devices in their home. Do you think that applies to you?

Video 2:

> What did you think of the video? What stood out?
>
> The video depicted a high energy consuming, technological vision of the future. What do you think about this? What do you like/not like about it? What are the differences/similarities to how you live now?
>
> Clearly we will not simply 'arrive' at this future way of life (i.e. there will be a journey from 'today' to 'future'). What do you see your/governments /technology's role in achieving this future? If you wanted to achieve a different future, how would this be borne?

Future-Oriented Questions

Expectations and visions of the future can have real impact on current activities today. How do you think this may occur? (prompt on prospective sportsperson behaviour)

What kind of visions of the future do you think policy makers have, bearing in mind what you see and hear in the media?

When trying to think of and imagine how the future may look, do you draw upon aspects of the past?

Are there any particular life changes/events you expect to make in… (i.e. the future/next 5 or 1 years/further on)? What lifestyle changes might this prompt?

Do you believe that for future society to be sustainable we need to change the way we live in the home? If so, what changes would you suggest? Do you think this is realistic and/or desirable?

How do you think lifestyles might be different for your children/grandchildren when they become adults? What would you like to see change/stay the same? Why?

Ask participants to explain how and why they filled in the tabloid.

Appendix M

Transcript of Film Clips Used (Public Follow-Up Interviews)

Film Clip 1 – Smart Meters and Smart Homes

The film clip takes the form of a description of what smart meters are and their possible role in future smart homes. The clip is comprised of a presenter giving a brief introduction, followed by quotes from three contributors who the presenter describes as industry experts. The film was selected as it presented some topics that were relevant to the themes expected to emerge from the interviews, and would provide the opportunity for interviewees to respond to and interpret the ideas being presented.

The film clip used in the interview was edited (to reduce the length) from the original YouTube video entitled *'Digital Futures: What Can We Expect from the Smart Home of the Future?'* The original video was produced and uploaded by 'Digital Futures: Powered By Telefonica' and can be viewed at: https://www.youtube.com/watch? v=4en5xVPzq58.

Transcript

Intro (0:00 – 0:19):

> *"Smart meters give us the power to track and hence control the daily energy usage in our homes. It also helps us make informed decisions about which suppliers to use, which in turn makes the market more competitive. We've lined up three industry experts who are passionate about the subject to paint this picture for us."*

Expert No. 1 – Sarwant Singh [Author] (0:19 – 0:41):

> *"So one of the key drivers, with technology coming in and smartphones coming in, and also that the price of energy is going up – and will be almost double in the next 10-15 years – there's a real business case to have smart homes."*

Expert No. 2 – Svetlana Grant [Smart Cities] (0:41 – 0:51):

> *"Smart meters are going to be a crucial element of the smart home because they are going to create a government mandated link to every home in the UK."*

Expert No. 3 – Scott Cain [Technology Strategy Board] (0:51 – 1:19):

> *"So I think smart meters are really important because actually they're becoming a product and service of scale, and so when they were only a concept or when only a few people had them they were much harder for everyone else to relate to, but when the home next door has one or when whole streets are receiving smart meters you can then begin – you can almost imagine the discussions that are taking place: 'oh crikey I didn't realise, so I put the tumble dryer on and actually I can see that the energy use massively spiked'."*

Svetlana (1:19 – 1:25):

> *"I think to derive the most value from the smart home the devices absolutely must connect and share data with each other."*

Scott (1:25 – 2:03):

> *"There will be some people who are just excited about connecting everything. The television, the fridge, you know whatever it might be, and being able to control services from their smartphone wherever they are, for some people – the really fast adopters – that will be very powerful and exciting. I suspect that the far greater market opportunity, and the thing that will really become prevalent in all of our homes, is the really in some ways quite mundane stuff, you know things like smart meters, like managing our energy bills which are rising, in a way that saves everybody money, but actually they do so in a way where they take away control of the service from the provider."*

[End of clip].

Film Clip 2 – Walk-through of Futuristic Home

The film takes the form of a walk-through of the 'Living Tomorrow' model future home. The clip is comprised of a presenter giving a brief introduction, and then – alongside a voiceover – walking through the home and interacting with various technologies within the very 'futuristic-looking' home. The film was selected as it presented some topics that were relevant to the themes expected to emerge from the interviews, and would provide the opportunity for interviewees to respond to and interpret the ideas being presented. Furthermore it was anticipated that providing an actual vision of future living would perhaps help participants to think more deeply about what they hope or expect to happen, and enable them to critique the aspirational portrayal, assumptions and visions outlined in the clip.

The film used in the interview was edited (to reduce the length) from the original YouTube video entitled 'Living Tomorrow: House of the Future'. The original video was produced and uploaded by 'WannaHaves' and can be viewed at: https://www.youtube.com/watch?v=9DJr8QwgLEA.

Transcript

Voiceover (0:00 – 0:11):

> *"Living tomorrow is what we'll all be doing and this house shows you what to expect with this fun and fast paced demonstration of technology that's only five years from the market."*

Presenter [Suzanne] (0:11 – 0:28):

[walking towards camera outside building]

"How cool would it be to have a house where you could control everything out of your bed? Never have to make a grocery list again, or lose your keys, and have the coolest gadgets in your own place. Today I'm in Brussels at Living Tomorrow and I'm able to experience the house of the future."

Voiceover (0:28 – 0:46):

[with panoramic shots of very futuristic kitchen]

"The kitchen is often the heart of the house, at least that's where I spend most of my time. The Living Tomorrow house looks very futuristic, but it's designed to have all the comfort and functionality of what you'd expect in a modern kitchen. You'll find everything you need in this kitchen, a built in LED TV, a music player, and of course every other piece of equipment you need to have for cooking."

Voiceover (0:46 – 1:43):

[presenter in bedroom]

"We know Suzanne, you like your showers hot. [Presenter turns on shower from switch in bedroom before walking to bathroom]. *So while that's heating up, she can start brushing her teeth in front of the intelligent mirror. Now on this mirror you can look at the news to see what's happening in the world, you can listen to your favourite songs, or you can see what the weather's going to be like today.* [Presenter uses mirror with embedded computer display]. *You can even work on your tan and at the same time warm your towel on the very modern looking towel heater.* [Presenter stands in front of tanning machine and hangs up towel]. *This house really is all about comfortable living."*

Voiceover (1:43 – 2:09):

[panoramic shots of futuristic living room]

"The entire house works via home automation. [Presenter presses icons on touchscreen on living room wall]. *Every electrical appliance or apparatus you have in your home is controlled by one easy to use system, it's all about living more efficiently and at the same time being a bit more environmentally friendly.* [Presenter sat on sofa]. *In this house, you can control everything by touchscreen, you literally have everything at your fingertips. Now that's what I call easy living!"*

[End of clip].

Appendix N

Blank Energy Tabloid Front Page