Diversity, Dynamics and Domestic Energy Demand

A Study of Variation in Cooking, Comfort and Computing

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Abstract

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This thesis contributes to an understanding of domestic energy demand and its basis in social practice. To date, energy consumption and everyday life have mostly been characterised and connected, if at all, through general trends. Yet attention to diversity within everyday practices, and to the diverse relations to energy consumption, is crucial to the development of nuanced, practice-specific understandings that could inform demand reduction policies. By investigating variations in, and the nature of connections between, energy consumption and practice this thesis reveals and compares the distinctive dynamics of demand in cooking, comfort and computer-use.

The method combines qualitative interviews and energy measurement in a small-scale, detailed study at a site where sources of variation are limited and can thus be compared: student halls of residence. This shows that frequency and type of meal are important in cooking-related energy consumption. The latter reflects diversification in the practice of cooking, which is also linked to a general decline in associated energy use. With respect to thermal comfort, indoor climatic conditions are adjusted in relation to clothing but the operation and energy consumption of heating systems are largely detached from other activities of daily life, even whilst indirectly enabling them. This presents an opportunity for thermal expectations to escalate and converge. Finally, substantial variations in energy use were observed in the diverse and inter-connected practices, services and hardware relating to information, communication and entertainment. This suggests that macro patterns of energy consumption may not simply be increasing but diverging.

In analysing these findings, the thesis discusses the conceptualisation of variation within social practices, the varied roles of materials and the notion of 'service' in analysing how practices connect, vary and change. It concludes by outlining new lines of investigation at the intersections of energy, material culture and social practice research.

Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is my own work and has not been submitted in any form for the award of a higher degree elsewhere.

Janine Morley
May 2014

This thesis is based on collaborative research undertaken with other researchers in the School of Computing and Communications, who

- procured, configured and deployed home sensors and energy monitoring systems,
- communicated with participants and helped to seek consent from some of them,
- helped to secure permission to conduct research on the University campus,
- conducted analysis on the data, and
- wrote several co-authored publications (listed below).

I am primarily responsible for overall design of this research (excluding the specification of energy and home monitoring), for the recruitment of participants, and for the qualitative aspects of the empirical work (interviews and diaries). This thesis is based on my own analysis of the data collected. It draws on some prior data-processing conducted for the joint publications but it pursues different questions and theoretical concerns. It does not directly reproduce any text or content from these publications, other than the data itself.

Janine Morley
May 2014

Confirmed by Mike Hazas
Supervisor
May 2014

Collaborative Publications

Bates, O., Clear, A., Friday, A., Hazas, M., & Morley, J. (2012). Accounting for Energy-Reliant Services within Everyday Life at Home. In J. Kay, P. Lukowicz, H. Tokuda, P. Olivier, & A. Krüger (Eds.), *Pervasive Computing* (Vol. 7319, pp. 107–124). Berlin: Springer-Verlag.

Bates, O., Hazas, M., Friday, A., Morley, J., & Clear, A. K. (2014). Towards an holistic view of the energy and environmental impacts of domestic media and IT. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*, 1173–1182. New York, USA: ACM.

Clear, A. K., Hazas, M., Morley, J., Friday, A., & Bates, O. (2013). Domestic food and sustainable design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*, 2447–2456. New York, New York, USA: ACM.

Clear, A. K., Morley, J., Hazas, M., Friday, A., & Bates, O. (2013). Understanding adaptive thermal comfort. In *Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing - UbiComp '13*, 113–122. New York, USA: ACM.

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Table of Contents

List of Tables

List of Figures

1. INTRODUCTION: SOCIAL SCIENCE AND ENERGY DEMAND

What is energy demand? The question can be surprisingly controversial even after many decades of research. It has even been claimed that energy researchers and policy makers have largely failed to appreciate "the nature and causes of 'energy demand'", even though that is the apparent object of their specialism (Wilhite et al., 2000: 109). This is a bold claim, but it is arguably as true today as it was over a decade ago when it was formulated by a number of social scientists in response to what they saw as the dominant but "strikingly asocial conceptualisations of the energy problem" (Shove, 1997: 263). Then, as now, a "physical-technical-economic model" of consumption dominated energy research and policy making (Lutzenhiser, 1993: 248). Yet during the last decade, the political visibility of climate change soared and the urgency of carbon savings became much more apparent. As such, any ongoing failing in the conceptualisation of energy demand is just as, if not more, poignant today. It is therefore important that researchers and policy-makers continue to appraise their definitions of energy demand and the boundaries by which they define their work. This thesis explores some of the territory that has to date been left outside of energy related enquiries. But it does so in a way that remains firmly rooted in conventional understandings of measured energy consumption. In so doing, it also demonstrates how 'energy' research might be extended and diversified, not only in the variety of methods used but also the variety of questions asked.

In particular, the thesis revolves around two pivotal concerns, puzzles if you like, about the relationship between domestic energy demand and everyday life. The first relates to the framing of energy demand in terms of social practices, a theoretical perspective that has been emerging over the last decade. It suggests that energy demand can be usefully understood through studying the social organisation of what people do. Some research has already been conducted within this framework, but it is limited; especially if the value of such a framing is to generate detailed understandings of how particular social practices are changing in relation to national energy consumption patterns. More work is required to determine what such understandings might look like and how they might be achieved. The second pivotal concern

arises from evidence of energy consumption data which shows that household consumption can vary hugely within a country, even when climatic and physical infrastructural differences in buildings are excluded. In other words, it appears that energy consumption does to some extent depend upon how people live in their homes, and that this varies considerably between households. But in what ways? And how should these differences be interpreted?

This thesis explores the points of connection between diversity in what people do, the associated patterns of energy use and change over time. The fact of variation in consumption, and the implied variation in everyday practices, poses a challenge to practice-theoretical investigations of energy, which have tended to focus on general patterns of change. In pursuing these questions I show that studying variation can provide a platform for revealing aspects of social practices that are especially significant for analysing patterns of energy consumption. Simply by studying differences in what people do, in relation to variations in energy consumption, I open up lines of enquiry into diverse facets of social life, which would not conventionally feature in 'energy' research. Although these features of demand extend beyond the 'moments' of energy consumption in the home, they remain firmly consequential for a fuller understanding of domestic energy demand, how it might be changing and how it might be shaped.

In this chapter, I set out the premises on which this thesis builds. The first is that domestic energy demand should be analysed in relation to social practices. To explain why, I first chart the emergence of a societal framing of energy demand in terms of the services that energy provides. I then describe how this facilitated an increasingly prominent focus on ordinary, everyday practices. This leads me to the second premise: that such a framing calls for detailed understandings of specific practices, especially if the purpose is to support policy and other interventions. However, there has currently been very little research into practices that is relevant to both understanding change and to analysing differences and detailed patterns of energy consumption. In particular, the dramatic variation in energy consumption between households suggests that practice-specific understandings, if they are to be detailed and energy-relevant, must also be nuanced and differentiated. That is, at least, in so far as the differences in energy use do reflect differences in practices. I briefly review current evidence of variable household consumption and the extent to which it is attributable to differences in

what people actually do. This leads me to outline three broad, related lines of investigation: the development of energy-relevant and dynamic understandings of practices, the nature of diversity in practice as related to energy use, and the relationship between energy and practice. I conclude the chapter by briefly introducing the research approach and outlining the structure of the thesis.

1.1 From Energy to Services: Towards a Social Science of Demand

The management and reduction of energy demand has been a topic of research interest, policy and industry initiatives since the 1970s. Throughout this time, the role of social science research has been much discussed, with repeated calls for greater involvement matched by disparate agendas and, at times, a relatively sparse body of research (Lutzenhiser, 1993; Wilhite et al., 2000; Sovacool et al., 2012). This is problematic because, as social scientists have argued, the demand for energy, how it changes and how it might be shaped is fundamentally *societal* (Wilhite et al. 2000; Shove, 1997; 2004; 2010). To understand how, it is necessary to consider the nature of energy consumption. The focal point of this debate, and of this thesis, is domestic energy use.

Domestic energy demand has two 'sides': efficiency and demand for the services that energy makes possible, which in the home include "cleaning, cooking, lighting, heating and so on" (Shove and Chappells, 2001: 48). In other words, since energy, as a resource, is not purchased or used in its own right or for its own sake, like we might imagine of other resources such as food, clothes, radios and so on, energy itself is not the 'object' of consumption and demand: "[p]eople do not consume energy. They consume the services it makes possible" (Wilhite et al., 2000: 118). Thus, overall energy demand is comprised *both* by the resource-efficiency of the ways in which services are provided *and* by the demand for those services. The implication is that to understand the nature and scale of energy use, beyond changes in efficiency, it is necessary to understand what constitutes the demand for services.

The recognition that the demand for energy in the home is essentially a derived demand, incurred in the pursuit of other outcomes, is far from recent (Lovins, 1978; Reister and

Devine, 1981). Indeed, the concept of 'energy services' or 'end-use services', such as heating and lighting, is used in energy research and even in official statistics. For example, in the UK, domestic 'service demand' is modelled in the Department of Energy & Climate Change's (DECC) annual energy use report, Energy Consumption in the UK (ECUK). These figures show that service demand has risen since 1990, dominated by apparently growing demand for space and water heating, whilst total final consumption has declined as a result of increased efficiency (DECC, 2013). In addition, those whose models inform energy forecasts, also find it useful to distinguish final consumption from service demand. For example, Haas et al. (2008) even propose a distinction between short-term (temperature settings, miles driven) and long-term (size of homes, number of light fittings) components of service-demand. At the very least, this means that changes in energy-service demand are included as important 'factors' in such models. Implicitly, it also means that energy-service demand reduction, that is, the idea that people might drive less, live in smaller homes, or in different indoor climates can be explored as a means of managing and reducing final energy consumption.

However, despite inclusion in some quantitative models, understandings of how and why the components of service demand change or might even be shaped remain radically under-developed within energy research. For example, in modelling approaches, levels of service demand (as indicated by miles driven, number of light fitting etc) are seen to vary primarily as an economic function of price and income (Haas et al. 2008; Kesicki and Anandarajah, 2011). Those who are less convinced that social change is an outcome of price modulations, however, might look towards a more thorough "social science of energy service consumption" (Wilhite et al., 2000: 115). Indeed, such an agenda, focusing on "how and why the demand for these services is growing" has been proposed (Wilhite et al., 2000: 115). But, with a few important exceptions, and despite a recent expansion in social scientific interest in energy and consumption, much of this research has remained firmly fixated on obvious 'energy' topics.

Socially-orientated enquiries tend to adopt an instrumental goal of identifying ways to encourage reductions in domestic energy consumption. I suggest this leads to a limited focus on explicit energy topics. Discussions about pricing, visibility, knowledge and attitudes

towards energy as a commodity continue to dominate. For example, the purchase of more efficient devices (Crosbie and Baker, 2010), the decision to fit extra insulation or renovate (Bartiaux et al., 2011; Fawcett, 2013), attitudes towards efficiency and conservation (Owens and Driffil, 2008; Gadenne et al., 2011), and responses to smart meters and displays of all kinds (Darby, 2006; 2010; Strengers, 2008; Pierce et al., 2010a; Hargreaves et al., 2012) are all popular themes. Arguably, such insights are important, especially for policy approaches that focus on promoting change by means of price and persuasion. However, by focusing on energy topics per se, such approaches risk neglecting what energy is being used *for*, overlooking relevant changes and differences in areas like those of the methods of cleaning, cooking and lighting. Taking the demand for such services for granted, takes it "out of the equation" which, some argue, contributes to sustaining and legitimising current and even growing levels of demand (Shove, 2004: 20; Wilhite et al., 2000; Shove, 2010; Shove and Spurling, 2013). Moreover, if demand for the services that energy provides is shifting, and if demand responds to changes in efficiency (e.g. the rebound effect (Herring, 2006)), then it is very important to understand how and why (Shove, 2004). In other words, to the extent that energy is not itself the object of demand, a focus on energy per se continues to offer, at best, a partial understanding of energy demand.

Thus, it appears that Wilhite et al.'s (2000: 109) claim that "the nature and causes of 'energy demand' have been oversimplified, reduced or ignored in the community of energy research and policy" still holds true today. This is problematic as a more thorough understanding of the demand for energy and how it is changing seems ever more important. In particular, there is increasing acknowledgement that technical efficiency measures, even if widely adopted, are unlikely to be sufficient to meet the scale of reductions implied by climate targets, such as the UK's 80% reduction in carbon emissions by 2050 (Calwell, 2010; Darby, 1997; Wilhite and Norgard, 2003). Such targets seem infeasible if the demand for services continues to escalate (Wilhite et al., 2000).

But if not limited to or defined by obvious energy issues such as efficiency, cost and awareness what does an understanding of energy demand, that is, the demand for the services that energy provides, imply? And what kinds of questions should researchers ask if they are to develop these understandings? In the first place, such an approach would

evidently focus on understanding the many and various services that energy provides, such as heating, lighting, cooking and cleaning (Shove and Chappells, 2001). It might explore the cultural role of particular services such as ways of washing, eating and keeping warm (e.g. Wilhite et al., 1996) but it would also go beyond descriptive accounts, to show how these features of everyday life have evolved, how they became normal and, thus, how demand for them and the particular forms of energy use on which they depend has become embedded in society (Shove, 1997; Wilhite et al., 2000; Shove and Chappells, 2001; Shove, 2003). These are clearly not questions of energy efficiency, nor are they behavioural questions of the attitudes, motivations and choices of individuals (Shove, 2010). Rather they are distinctly societal questions concerning the evolution and change, that is, the social dynamics, of very ordinary forms of consumption in all their diverse forms. These are questions that still need to be asked and explored in depth. In the next section, I will outline how this agenda has unfolded over the last 10 years or so.

1.2 From Services to Practices: The Ordinary Consumption of Energy

The challenge of understanding the social dynamics of domestic energy consumption helped to engender a new theoretical approach to the study of consumption in general. The focus on services highlighted the need to understand customary and inconspicuous routines and habits and how they are held in place by and evolve alongside collective norms and sociotechnical systems (Shove, 2003; 2004). In this, the "practice of everyday life" may serve as a starting point but neither is it the exclusive focus nor is it to be conceived as the aggregate of individual behaviours and choices (Wilhite et al., 2000: 120). Rather, what people do from day to day is seen to be deeply intertwined with "the development of markets, the social and technical construction of needs and the steady evolution of expectations about what constitutes a 'normal' way of life" (Wilhite et al., 2000: 117). This draws us "like it or not, into an analysis of the inter-dependent practices of producers, providers and utilities and governments" (Wilhite et al., 2000: 118). In other words, an understanding of the nature and causes of energy demand implies not only going beyond a focus on efficiency and energy behaviours, but also developing theories of ordinary and co-evolving consumption.

The most notable work in this vein is Elizabeth Shove's book Comfort, Cleanliness and Convenience (2003). It focuses on the construction and co-evolution of conventions, products and industries, exploring how energy-intensive versions of normal domestic practice have come to be as they are. Shove presents several broad models of different types of co-evolving relationships she identifies in the areas of comfort, bathing, laundry and convenience. The cases are historic yet highlight the highly dynamic nature of what people take to be normal ways of life, and how converging conventions have been associated with escalating energy-intensity. This marks out an agenda, however, which is not limited to convergence and escalation, and which is, by nature, ongoing and unfinished. To understand patterns of resource consumption in the home:

> "involves tracking what have become routinized and inconspicuous practices. It means thinking about the definition and appropriation of *services*, rather than discrete objects, and trying to understand both the convergence and divergence of everyday *practice*." (Shove, 2003: 4)

In this account, the idea of 'service' is developed and extended beyond direct energy services or end-uses, like lighting and heating, to refer to the collective composites of convention, expectations and the means of attaining them, for example, comfort and cleanliness. Wilhite et al. (2000: 115) suggest that these can be thought of as "meta-energy services". The re-definition of services in this way further distances energy use, itself, from the focus of enquiry. It also shifts the focus from that which is used to the outcomes or "composite accomplishments" in which use is embedded, whether that be the use of products, energy, or direct energy services (Shove, 2003: 165). Yet despite the central role of '*services',* indicated here, the concept is subsequently overshadowed in much of the research that follows. Through an increasing interest in ordinary consumption, of which the book is part, a focus on practices becomes more and more apparent.

The call for an alternative, social science of energy demand (Wilhite et al., 2000; Shove, 1997) can be seen as part of a more general turn in consumption studies towards theories of ordinary and inconspicuous consumption (e.g. Gronow and Warde, 2001; Shove and Warde, 2001). Previously, consumption studies, especially in sociology, had tended to focus on the symbolic aspects of consumption, often equating it with purchase. In contrast, the challenges

of analysing domestic energy and water consumption, as resources that are not purchased or used for their own sake provided an important site of enquiry through which a theory of consumption framed in terms of social practices emerged (Spaargaren, 1997, 2003; Chappells et al., 2000). Based on Giddens' (1984) theory of structuration, this approach developed and applied an alternative understanding of human activity, compared to attitude-behaviour approaches (Spaargaren, 1997) and it helped to flesh out the context within which objects and resources are used: as "part of mundane, routine social practices that are collectively organised, socially constrained and normatively regulated" (Harvey et al., 2001: 8). Over the subsequent decade, the framing of everyday life, ordinary consumption and social change in terms of social practices has helped to change the focus of consumption studies and generated a range of more subtle theoretical accounts (e.g. Reckwitz, 2002; Warde, 2005; Røpke, 2009; Shove et al., 2012).

A social practice framing of consumption expands the idea that people do not *consume* energy, or anything else for its own sake. As Harvey et al. (2001: 44) explain: "People do not consume. They travel, go to a show, wear a dress, eat dinner. Mobility, entertainment, adornment and eating are practices of everyday life". Thus, people are not understood as 'consumers'. Instead consumption - whether of energy or other goods - is addressed indirectly through exploring the social organisation of what people do. This achieves much of the thrust of the agenda of understanding demand that was set out by Wilhite et al. (2000): it de-centres the rational decision maker and focuses instead on the meaningful activities in which people engage and which comprise everyday life, such as cooking, bathing, watching TV, cleaning and going to work. Such activities then form the units of enquiry into consumption and, in theory, they also constitute the 'unit of intervention' for policy making. I will introduce practice theories in more detail in the next chapter.

For now, the key point is that by framing energy consumption in terms of practices, levels of energy demand are identified as the *outcome* of interdependent practices and technical systems (Shove, 2004: 295). Such a framing further shifts focus away from the study of energy use itself, even as part of everyday activities. It suggests that tracking changes in those activities (and technical systems) will inform us about changes in energy demand, since the latter is an

outcome of the former. I will argue below that it is also important to know about the nature of the relationship between practices, technical systems and energy consumption, especially given that this varies significantly from practice to practice. Moreover, in the shift to focusing on practices, I ask what has happened to the concept of 'service'? How do practice approaches, for example, speak to changes in service demand? And is energy demand as outcome the only or best way to conceive of energy use within a practice framework? These are important conceptual questions. But if a practice approach is to inform policy and help shape other initiatives to reduce energy demand, these questions are of practical significance as well. They help to shape and define the kind of knowledge and research that is called for.

1.3 From Practices to Policy: Formulating Energy-Relevant Research

The case for analysing the demand for energy in terms of social practices has been outlined above. To re-iterate, because energy is not purchased or used for its own sake but rather in the pursuit of what people take to be ordinary and everyday activities, analysis of how the demand for energy changes and may be shaped by policy requires analysis of how those activities themselves change and may be shaped. This should provide a much broader understanding of how demand for energy in the home is actually constituted, which, in principle, includes more opportunities for intervening and insight into more radical forms of change than would be possible from a focus on efficiency and energy behaviour alone (Shove, 2004; Shove et al., 2012). As such, a practice-orientated approach to energy demand policy holds much promise. However, exploring and fulfilling that promise depends on understandings of social practices that do not, I shall argue, currently exist.

Shove et al. (2012: 145) make several suggestions about how process-based, practice-orientated policy might proceed when "anchored in and never detached from the details and specificities of the practices in question". In other words, a more developed practice-based understanding of domestic energy consumption will be necessarily specific to the many practices that constitute everyday life. As noted above, it will also develop understandings of change within those practices rather than being only descriptive. But how can we ensure that the detailed knowledge of practices will remain relevant to understanding patterns of energy

consumption? In other words, in shifting the focus away from energy, and from the direct services which energy makes possible, there is more of a challenge to structure a programme of enquiry into practices that is nevertheless relevant from an energy demand and policy perspective.

Although not large in volume, there is already some empirical research into domestic energy consumption that has adopted a practice-theoretical approach. These studies tend to fall into one of two main camps, each representing a different strategy for connecting with an energy agenda. The first focuses on how everyday life has changed in concert with technical systems, devices and conventions (e.g. Shove, 2003; Hand and Shove, 2005; Shove et al., 2007; Røpke and Christensen, 2012; Spinney et al., 2012). Connections to patterns of energy consumption are made on the basis of obvious features, for example, the frequency and duration of directly energy-consuming activities or a change in the type of devices involved. The general aims are to develop accounts and theories of social change and consumption, and this indeed is the more prominent genre within energy research. The second strategy is to start with obvious energy 'problems', such as heating, keeping warm, air conditioning, standby consumption, energy conservation, retrofitting or ways of living with efficient devices or homes, and to describe and consider the implications of what people do by drawing on concepts from theories of practice (Gram-Hanssen, 2009, 2010, 2011; Bartiaux et al., 2011; Hitchings and Day, 2011; Foulds et al., 2013; Hards, 2013).

In moving towards the kind of detailed understandings of specific social practices that could potentially inform future policy-making, both approaches arguably have pitfalls. In the latter, a focus on 'energy' issues may exclude important aspects of everyday life that are less directly yet nevertheless importantly implicated in patterns of energy consumption. Also, focusing on what people currently do may neglect how that 'doing' is socially organised, dynamic and emerges through the integration of diverse elements with distinctive histories and systems of provision. As Watson suggests a "microfocus, while foundational, risks missing the radical implications and potential of the concept" of social practices, that is, as the site at which society is organised and, by implication, changes (Watson, 2012: 489; Shove and Spurling, 2013).

In contrast, approaches which foreground these very social dynamics may risk assuming too much about the energy implications of the patterns of practice on which they focus. As with the initial agenda concerning the consumption of and the demand for services (Wilhite et al., 2000; Shove, 2003) such approaches, for the most part, are based on an assumption of 'escalation'. A decade ago in the UK, this was a sound assumption and supported by modelled energy data (e.g. DECC, 2012). Accordingly, social enquiries were framed by the problem of understanding and explaining an escalation in service demand.

However, I suggest that this framing now needs more careful attention. Firstly, how does a practice-centric understanding speak to the "service demand" associated with something like cleaning or cooking? At this point, the distinction between the consumption of energy and the consumption of services is potentially important: it allows differentiation of energy consumption patterns based on more efficient devices as opposed to changing patterns of use. Whether service demand in any particular area (as distinct from total energy consumption) is stable, declining or still growing is an important empirical question. Secondly, overall energy use by the domestic sector in the UK is no longer escalating. Since about 2006, aggregate households statistics indicate a decline in total consumption whilst service demand per household, a variable dominated by space heating, has been more or less level (fluctuating only in line with winter temperatures) (DECC, 2013). Thirdly, it is important that the connections made between social practices and energy consumption patterns are specific to the practices in question since the trends in energy consumption are also likely to be specific. Certainly as far as end-use statistics suggest, some are still growing whilst others are declining (DECC, 2013). Research needs to attend to and understand how energy-consuming devices fall out of use, that is, how practices decline and become less energy-intensive as well as how they normalise and become more intensive.

Furthermore, general consumption trends could in principle be poor indicators of the nature of change that is taking place, if that change is, itself, not general but emerging in a differentiated pattern. In particular, it would be quite possible for a general growth in consumption in a given end-use category to relate to changes (possibly radical ones) in only a minority of households. If energy consumption varies substantially between households, we

might need to be cautious if using general consumption trends to frame enquires into social practices. In such circumstances, it is important to make more direct connections between features of practices and their implications for energy use.

As it happens, energy use does appear to be highly varied between households. This raises a further question when relating social practices to energy consumption patterns: why are levels of energy consumption between households and, by inference, the associated practices, so extremely diverse? As I will outline in the next section, there are large variations in household energy consumption within a society which some evidence suggests is not simply a matter of differences in household composition, buildings, heating efficiency or climate. But to what extent are these differences actually related to differences in what people do? And to what kind of differences? And what does this mean for the kinds of research into and understandings of practices that are required if they are to be relevant to a detailed account of energy demand?

1.4 Putting Diversity on the Agenda

This thesis questions how diversity can be reflected in, and help to frame, research into the analysis of specific practices that are important in generating and sustaining energy demand. I do not use the term diversity, here, to refer to people's differing characteristics and backgrounds; rather, I am referring to the diversity of what people *do*. I begin this section by outlining evidence of the scale and nature of variation in household energy consumption. I then consider how such evidence poses a conceptual challenge for practice theoretical framings, especially if they are to go beyond descriptive accounts of differences in performances and to provide a persuasive account of the broader social trajectories of practices and, indeed, energy consumption.

Interpreting Variations in Energy Consumption

The variations in household energy consumption seen within-country and within-region monitoring studies are "extreme" (Lutzenhiser and Bender, 2008: 192). There can be huge differences between the higher and lower ends of consumption, for example, in 1,627

northern Californian households the lowest- and highest-consumers of electricity differed by a factor in excess of 40 (Lutzenhiser and Bender, 2008). Within these ranges, household consumption figures can be widely distributed with "huge standard deviations" as observed by Gram-Hanssen et al. (2004: 76) in electricity consumption figures gathered from over 50,000 Danish homes in the same city. Even when categorised by dwelling-type (detached, semi-detached, apartment) there was a coefficient of variation[1] (CV) of 48-50%. Similarly, Guerra Santin et al. (2009) report large variations in energy demand for space and water heating in 15,000 Dutch homes with CVs of 40-53% for each dwelling-type group. To put this in context, a coefficient of variation of 50% means that even when excluding households at the extremes of consumption, the lowest- and highest-consumers of the middle majority (68%) of households differ in their energy use by a factor of 3. In other words, it would appear to be quite 'normal' for one household to use 2 or 3 times the electricity or heating energy as another home of roughly the same type (e.g. semi-detached). This variability is not restricted to aggregate household consumption but is also evident in disaggregated, end-use monitoring studies. Recent developments in end-use measurement methods have facilitated larger samples than ever before; yielding results with huge between-household variations by end-use category and by single device (e.g. Zimmermann et al., 2012).

In so far as these variations in consumption can be attributed to what people do, such evidence implies that this can be highly diverse. In fact, there has been ongoing debate about the extent to which this attribution can be made. Such variations may also reflect physical differences in buildings and local climates, after all semi-detached properties come in different shapes, sizes, ages, states of repair, and spatial orientations, just as do other types of residential building. Yet evidence of two different kinds indicates that there is more to variations in household consumption than such physical properties alone. Firstly, statistical regression analyses of heterogeneous samples of homes, like those above, often show a residual variability once such physical features, and even the broad socio-demographic characteristics of the occupants, such as age and income, have been accounted for (Gram-Hanssen et al., 2004; Guerra Santin et al., 2009; Kristrom, 2008). Thus, most authors suggest that, amongst other factors, this residual variability reflects the role of the occupant in

1 The coefficient of variation is the ratio, expressed here as a percentage, of the standard deviation to the mean.

'determining' consumption. Yet the percentage of unaccounted variability varies and with it, opinions concerning the significance for energy consumption of what people do. Even if there was agreement, such analyses still fail to elaborate the basis of such differences or show how levels of energy demand and patterns of consumption emerge through what people do.

The second type of evidence that links variations in energy consumption to the occupants rather than built infrastructure comes from studies in which the physical characteristics of buildings are highly similar. An early and widely-cited example, is a major study in the 1970s known as the Twin Rivers programme (e.g. Socolow, 1978; Sonderegger, 1978). In a sample of 205 similar houses, they found considerable variation in energy consumption, with a factor of difference of at least 2 (or 200%) between the highest- and lowest-consuming homes. This was true both for winter gas consumption and electricity consumption in the summer. Further analysis focusing on 45 of the houses which changed hands during the study, suggested that most (71%) of this variation in winter heating was indeed attributable, in some way, to the occupant rather than small, non-obvious physical differences (Sonderegger, 1978: 4).

Other studies have made more direct connections between what people do and variations in energy consumption. From interviews, Hackett and Lutzenhiser (1991) conclude that differences in electricity consumption in a sample of 476 similarly designed flats, which varied by a factor of 3, were related to air conditioning-use which reflected cultural differences consistent with countries of origin. In contrast, Gram-Hanssen (2010) attributed differences (of a factor of up to 3.7) in heat consumption amongst a handful of families living in the same housing development in Denmark, to differences in 'heat comfort practices', representing a complex mix of variable understandings, activities in and out of the home, working patterns, concerns about health and money and ideas about comfort. But such studies, which combine energy measurement and interviews at sites with naturally occurring controlled conditions of infrastructurally identical homes, are rare. As such, the extent and nature of the potential differences in everyday practice that underlie differences in energy consumption remain unclear, particularly for non-heating and cooling consumption. If connections between the differences in what people do and differences in domestic energy

use can be illustrated, the case for analysing the latter in terms of the former would be strengthened.

However, it would then be important for such practice theoretical framings to incorporate a better understanding of variation than has hitherto been developed with respect to any specific practice. If there is a close connection between practices and energy use "consumption at the household level is neither homogeneous nor normal" (Lutzenhiser, 1993: 249). This seems to stand in contrast to the agenda developed by Shove (2003), which explicates the normalization of energy-intensive concepts of service. Intuitively, 'normal' and 'everyday' are concepts that imply a certain convention and shared-ness. In fact, commonality and shared-ness are central to the definition and recognition of practices as social. Some similarity between different sites and times, in this case households, is the very pre-condition of practice theories, one on which their value in analysing the detailed dynamics of consumption depends. So how much can a practice vary in its performance? And how can this be reconciled with the concept of a practice as a fundamentally shared entity?

In fact, the idea of internal variation within a practice is quite consistent with a practice theory approach: "social practices do not present uniform planes upon which agents participate in identical ways but instead are internally differentiated on many dimensions" (Warde, 2005: 138). I shall discuss the conceptualisation of variation in practices in the next chapter. For now the point is that, with few exceptions (e.g. Gram-Hanssen, 2010; Strengers, 2009), researchers have not explored such variations empirically in the context of domestic practices, nor in relation to patterns of energy consumption.

In principle, however, a practice framing may actually help to make sense of variations in energy consumption, compared to individualist, behavioural approaches (Morley and Hazas, 2011). For example, recent research commissioned by DECC (Fell and King, 2012) investigated variations in heating consumption in relation to accounts of how occupants manage their heating. The findings point to a complex mix of many differences in what the households do and what they expect, but do not highlight any particularly distinctive differences that characterised high or low-consuming households. Instead, a variety of differences appeared to underlie high consumption, as it did for low consumption. In other

words, there was no single continuum of consumption-defining difference between high and low consuming households. By recognising both the diversity of activities that take place in the home and the diverse ways those activities can be performed, a practices approach offers cross-cutting units of analysis that could help to unpick some of this complexity. For instance, some of the participants discussed the need for a certain kind of thermal environment because of illness, others referred to children and others to pets. A practices approach might focus on understanding the doings and sayings attached to each of these, how they have changed and how and when they vary. Furthermore, through the concept of a social practice, it is conceptually possible to connect the micro-patterns in what people do to the macro- or entity level changes in practice. If so, such an understanding may better help to identify whether and how variations in energy consumption between households indicate opportunities for change (Lutzenhiser, 1993).

Dynamics, Divergence and Convergence

Another reason for paying closer attention to variation in energy consumption is the potentially close connection between variation and change. Social practices are inherently dynamic. Even when they appear at their utmost everyday-ness, that is, broadly universal, taken for granted and stable, they contain the seeds of change (Warde, 2005; Røpke, 2009). This is because practices must be performed in order to persist. Simplistically, then, variations in performance, whether contemporary or over time, are the very means through which practices change. Moreover, there is also a sense shared by several authors, that the variations individuals introduce, not only perform change but to some extent generate it. I shall say more on this in the next chapter. Here, my point is that research designed to develop a better understanding of the dynamics of specific practices ought to consider variation in performances. Practices may become more or less diverse; and as they do, they may split and even re-converge (Southerton et al., 2012).

A similar case can be made for tracing patterns of energy consumption over time. When describing and interpreting trends in consumption levels, it is helpful to differentiate the patterns that might be hidden within aggregated and averaged data. As well as overall growth, stability and decline energy consumption may also be diverging or converging. Both

convergence and diversification in practices and socio-technical systems have been linked to an escalation in demand (Shove, 2003; Røpke et al., 2010). Understanding how these patterns are related to the convergence or divergence, diversification or narrowing down of practices promises to develop subtle and sophisticated understandings of the dynamics of energy consumption. These are the challenges on which this thesis focuses.

1.5 Approach and Outline

In the context of the huge variations in household energy consumption within a society, a number of questions are raised for a practice-theoretical framing of energy demand. After considering the implications of the theoretical framing in more detail in the next chapter I will elaborate a series of more specific research questions and the research design I adopted to address them. In this section, I briefly outline the approach this thesis takes: introducing the empirical research undertaken, the contributions this makes, and how this is presented over the chapters that follow. Let me start by re-iterating the three broad, overlapping lines of enquiry that have so far emerged:

1) The development of detailed, practice-specific understandings of energy use patterns
2) The study and interpretation of diversity in practice and energy use
3) The nature of the relationship between what people do and energy use

In simple terms, these themes can be addressed by investigating how differences in everyday practice relate to differences in energy consumption. This was something I pursued in a context in which a comparable number of similar people occupy a structurally similar space. I chose university halls of residence where individuals of a similar age occupy single rooms that are of highly similar size and design, and are part of flats with highly similar appliances and maintenance arrangements.

This standardised environment allowed me to explore diversity in what people do within it. To this end, I investigated and compared three practice / end-use domains. For a variety of reasons I chose to focus on cooking, thermal comfort and computing. I choose cooking, and

I start with it, because it is an archetypal social practice, and one that involves a high-power device. I choose thermal comfort because space heating-related energy consumption is the most significant portion of domestic energy demand and a particular concern for energy policies, but it is less clear which social practices are implicated, and how. Finally, I consider the case of computing, analysed in terms of the broader category of ICE (information, communication and entertainment) devices, because of the huge variations in consumption indicated by my preliminary research.

To explore energy consumption in each area - how it varies, how it is or is not embedded in what people do, and how this relates to longer term patterns of change - I used a mixture of methods. To gain insight into the nature of the practices in each domain I use semi-structured interviews. To understand differences in energy consumption I used a variety of techniques adapted to the constraints and possibilities of each domain. This empirical research revealed differences in each area, which provide insight into the nature and dynamics of the practices involved. I then consider this material with reference to longer term, macro-dynamics of practice-based energy use.

In combination, these methods show that the demand for energy is embedded in a diverse array of elements that are integrated in daily life on an ongoing basis through what people and material arrangements do, and that are themselves the outcome of much broader social processes both within everyday life and beyond. Specifically, my research shows how energy demand in the home is co-constituted by the food industry, the 'competence' of contemporary clothing systems and the complex interplay of differentiated ways of owning and using information technologies. This contributes to the understanding of energy use in these domains and points to ways in which this might be further developed. It also allows me to explore the relationship between what people do and energy use, which I argue varies depending upon the nature of the practice and the balance between human and machine 'work'. In all cases, even where the relationship between energy use and what people do is indirect, as in heating, and where it inheres between groups of devices and groups of practices, as in ICE, it is still possible to trace the connections between performances in the home and energy use.

In taking this approach, I also argue that diversity is a particularly useful platform for framing energy-relevant enquiries into the social organisation of everyday life, which can serve in contrast and in complement to more generic historiographical accounts of the intensification of everyday practices. Importantly, such an approach, in which energy use and performances are studied alongside one another, does not need to assume much *a priori* about the growth or otherwise of energy consumption. In addition, taking a comparative approach, even in a sample selected specifically for its homogeneity, can offer insight into the contingency of everyday life (e.g. Shove and Spurling, 2013). As Wilhite et al. (2000: 120) note "better knowledge of the differences in the organization and management of energy demand at home and work also promises to illuminate the different ways in which similar services might be provided". In particular, I argue that differences in the ways services are provided are of consequence for how related practices evolve.

Thesis Outline

In the next chapter, Chapter 2, I introduce the key practice-theoretical concepts by which I frame energy consumption and the research that follows. I consider the problems of conceptualising energy use in these terms and develop a framework that helps to clarify a series of questions related to each of the broad lines of enquiry identified in this section. I then consider the type of research this calls for and outline the research design that I adopted.

Chapter 3 begins the series of chapters that focus on the three domains of energy demand and practice in turn. For each domain, there are two chapters (three chapters in the case of comfort), the first of which focuses on the details of the empirical research, the next taking a broader and more theoretical view of the implications. I begin with the practice of cooking. In Chapter 3, I describe the particular methods used to investigate cooking performances and energy use in the halls of residence. I go on to describe the variations between the participants and between different types of meal and modes of cooking over time. This highlights the inter-related importance of frequency, oven use, and types of food products in the constitution of cooking-related energy demand.

In Chapter 4, I take the analysis of cooking further: I consider the direct relationship between energy use and performances. Energy consumption is embedded in the practice of cooking and thus the level of consumption is heavily contingent on how people cook. I then explore the nature of this activity, and specifically the different types of variation observed within the practice of cooking. I conclude by considering these insights alongside evidence of an apparently dramatic decline in the performance of cooking and related energy consumption since the 1970s. I suggest this is associated with a diversification in cooking, facilitated by convenience products in the context of changing social organisation of work; that also, importantly, makes the future of cooking-related energy demand more uncertain than it may at first appear.

In Chapter 5, I turn my attention to comfort. Again, I outline the particular methods used in this part of the research and explain how performances of comfort varied between the participants. This takes the form of a detailed comparison between four participants and focuses on the role of clothing. I demonstrate how clothing, and the relative degree of insulation it offers, varies from person to person in line with the temperatures recorded in their rooms. On the basis of differences in the control of climate, I suggest that this relationship is just as plausibly one in which clothing co-constitutes the demand for differential thermal conditions and that it is not only or simply a matter of adapting to those conditions.

In Chapter 6, I explore the relation between clothing and climate over the longer term. This analysis suggests that styles of clothing had already changed dramatically to include lighter and more casual combinations by the time that central heating systems in the UK became widespread. I go on to discuss some aspects of clothing - the t-shirt, underwear and loungewear - that are important in this story of lighter clothing and were also implicated in the differences observed in the empirical research. This leads me to suggest that, whilst different types of clothing could feasibly contribute to a reduction in the level of demand for heated domestic spaces, the popular notion of achieving this through wearing an extra jumper is too simplistic. Rather, it is important to consider the 'thermal competence' of clothing in a more systemic way, and possibly develop new forms of seasonal wear, consistent within the current logics of how clothes fit in and fit together.

In Chapter 7, I consider the theoretical implications of my investigation of comfort. In exploring how demand for heat is constituted, I find there is no easy or direct connection to overt social practices, as was the case in cooking. This leads me back to the concept of service, for which I find it helpful to distinguish between the 'specific' or 'energy' service that heating provides and a wider, more composite notion of service as an outcome (or meta-service). This helps to describe and analyse the connections between the loose bundle of elements through which comfort is defined and achieved. Within this, I explore the connection between heating and being heated, asking whether it is useful to consider the latter as a 'passive' practice. Putting this all together, I relate the escalation and convergence in indoor winter temperatures to the characteristics of this particular variety of consumption: namely, the dissociation of a machine-provided service (central heating) from the focus of human activities which at the same time remain implicitly dependent on that service.

In Chapter 8, I turn to the third domain, ICE-related consumption and practices. As with the other cases, I describe the methods for this part of the research and outline the findings: they reveal a huge variation in energy-use related to differences in the number and nature of devices that participants own and how they use them. To understand why, it is necessary to explore the various practices in which ICE devices are used: I focus on watching, listening, gaming and computing. Whilst watching and listening were common, technical computing projects were only undertaken by a few, who also happened to be the most energy-consuming. Those who engaged in technical computing used more devices, even when watching and listening, and they also tended to participate in all ICE-related practices more frequently.

In Chapter 9, I consider what this relationship between a diverse set of ICE devices, their energy use and a set of practices, implies for the interpretation of larger patterns of change. Within the complex of inter-related practices through which energy demand emerges, it becomes clear that differentiated patterns of engagement in social practices are amplified via differential acquisition of ICE products, resulting in large variation in energy use. In other words, there is an iterative relationship between 'having' and 'doing'. In a wider context, I suggest that diversification in methods of providing specific information and entertainment services, and the associated concepts of service, are heavily implicated in the ongoing

dynamics of ICE-related energy demand but again in ways that are less predictable than might first appear.

Finally, in Chapter 10, I reflect on the cross-cutting implications of these cases for the conceptualisation and analysis of energy demand in terms of social practices, and for the conceptualisation of the practice-specific dynamics of energy consumption in each domain. This leads me to conclude by considering how such insights might eventually be developed as a basis for energy demand-reduction interventions, and by identifying the kinds of questions and research that could help in furthering these understandings.

2. CONCEPTUALISING AND INVESTIGATING VARIATIONS IN DEMAND

In the previous chapter, I outlined the emergence of a research agenda that conceives of energy demand as an outcome of social practices. I argued that in order to take this agenda further, in particular, to a point where it may prove informative for policy, there is a need for detailed empirical understandings of practices that are a) specific to particular practices, b) relevant to the analysis of energy consumption patterns and c) not simply descriptive but also offer insight into how and why energy demand changes. I proposed that a focus on variation in practices and energy consumption could help to frame this research. In this chapter, I develop that argument in greater detail, outlining the conceptual framework of a 'practices approach' and, within this, the problematic conceptualisation of energy demand. This leads me to a set of specific questions that concern the empirical understanding and the conceptual framing of the dynamics of domestic energy demand in relation to social practice. This highlights the need for a particular type of study that can explore co-variations in energy use and practice in fine detail and, importantly, make close connections between them. I outline the research design that aims to do this.

2.1 A Practices Approach: Key Concepts

The words 'practice' and 'practices' are common language terms. One sense, which can only be singular, is allied to the term 'praxis' and denotes what actually takes place (i.e. 'in practice'), as a contrast to 'in theory' or 'in anticipation'. This sense of practice refers to "the whole of human action" (Reckwitz, 2002: 249) and it essentially concerns extension in time. A 'practice', used in a sense that can be plural, is different: it refers to a particular way of doing something. Social theories that identify themselves, or have otherwise become known, as practice theories refer to both senses: they are theories of human action (or practice) which is seen to be constituted by many different practices. In other words, a practice approach supposes that much of what people do (practice) is organised by practices: "that in the continual flow of activities it is possible to identify clusters or blocks of activities where coordination and interdependence make it meaningful for practitioners to conceive of them

as entities" (Røpke, 2009). Thus, practices are resources for practice (Pickering, 1995) and, accordingly, they are shared focal points, or units of analysis, in theories of practice(s).

In such theories, a 'practice' is given a special, technical definition. Since there are a variety of theories, definitions vary but most share an idea of a practice as an organised pattern of activity that repeats and is recognisable when performed by different people at different times and places. Thus, "a practice is a social phenomenon in the sense that it embraces multiple people" (Schatzki, 2012: 13). Since practices are, by definition, social, some of the common-language meanings of a practice as a way of doing are excluded, specifically when in reference to an individual's or family's particular habits and routines.

In this thesis, I explore everyday life through a practice approach, that is, through a focus on day-to-day practices such as cooking, working and watching TV. Empirically, my primary concern is practice, simply what people do, limited by a concern for domestic energy consumption. But my analysis of such practice is informed by theories of practice, and as such I am looking to understand more about what people do than just detailing the actual activities that take place: by conceiving of activities as practices (at least, potentially), I am looking to understand something of how they are organised, that is to say, socially. It is important, therefore, to say a little more about the concept of a practice, and what it might mean for the related conceptualisation of variation and energy demand. Beyond this, the thesis does not aim to make any explicit theoretical contribution by developing and refining theories of practice per se. Accordingly, this following review focuses on the key concepts and distinctive features of a practices approach that are necessary to define the problematic (detailed understandings of energy demand), and to outline the research design. This draws most heavily on Shove et al.'s (2012) 'elemental' theory of practices, with key contributions from Warde (2005), Reckwitz (2002) and Schatzki (1996, 2002, 2012).

Recognisable Entities, Diverse Performances

A tension resides at the heart of a practice theory perspective. The significance of practices lies in the statement that they are co-ordinated entities that are distributed across time and space. It is in this clustering, this patterned-ness, in the flow of activity by which practices are seen to be ontological units that are both meaningful for practitioners and social analysts

alike. An entity is a recognisable conjunction that can be spoken about (Shove et al., 2012). Thus, properly, in practice theory, the term 'practices' refers to such entities and stands in distinction from practice (praxis) through which practices are performed. Performance presupposes the practice (Schatzki, 2012; Warde, 2005). Thus, the tension arises that although we distinguish practices-as-entities from performances, practices do not exist unless they are performed.

Performances are necessarily localised and situated and as such they can be diverse (Shove et al., 2012). In this way, multiple ways of performing a practice co-exist but must still comprise or fill-out a recognisable 'something'. Accordingly, the 'units' supposed by practice theories are not always easy to identify empirically. The identification of practices can therefore be contentious. Some suggest that in the recent boom of empirical research into 'consumption practices', practices have been overly identified at the level of performance (Shove and Spurling, 2013). In such cases, for example, "the practice of standby consumption" (Gram-Hanssen, 2009), there are clear questions over whether it would be more appropriate to consider a particular phenomenon as part of a(nother) practice. But even in more classic examples, such questions are almost always unavoidable. For example, driving is a common exemplar practice (Warde, 2005; Shove et al., 2012), but in some cases driving is a means of working (chauffeurs and lorry drivers) or is itself a sport (rally driving). Either way, there is clearly not one way to drive.

Schatzki (1996; 2002) and Reckwitz (2002), in fact, identify practices as ways of doing something like driving, not as driving itself: "Examples are cooking practices, voting practices, industrial practices, recreational practices and industrial practices" (Schatzki, 1996: 89, quoted in Warde, 2005); "A practice - a way of cooking, of consuming, of working, of investigating, of taking care of oneself or others" (Reckwitz, 2002: 249-250). In a sense, then, they identify different categories or families of practice, composed of differentiated practices. They see variations in the ways of doing something like cooking, as themselves, potentially recognisable 'blocks' or types. With regard to the conceptualisation of diversity within practice theory, this is significant: it counters an idea that variation exists exclusively in local performances. Rather, variation and differentiation amongst entities in what may be highly related or similar categories of practice, seen as the same practice by others, can also be

important. Whether these are called variants (Spurling et al., 2013) or practices in their own right, perhaps, matters less. An analyst can make choices depending on the types of question they are asking. To ask how car driving became normal and embedded into a variety of other practices, for example, suggests that some general features of driving are held constant. Other research may query the emergence of particular forms of driving such as off-road and with kit cars; in such cases the differentiation from other forms of driving becomes important.

The tension between commonality and diversity, I suggest, pervades both the theory and empirical articulation of a practice perspective. As such, I do not anticipate finding any hard-and-fast answers when defining practices in this thesis. I will be guided by a notion of appropriate scale and what I shall call 'everyday recognisability'. This is based on the idea that practices are not only recognisable to analysts but also to some extent to those who do them, and even those within the same culture, who don't. As Røpke states "practices are meaningful to people, and if asked about their everyday life, they will usually describe the practices they are engaged in" (2009: 2490).

Elements and Integrations

If a practice is a recognisable pattern, a co-ordinated entity, of what does it consist? Whilst most theorists give slightly different answers, they share a view that it is interdependent relations that define practices (Shove et al., 2012). To Schatzki, practices consist of a set of doing and sayings organised by understandings of how to proceed, by rules, and by teleoaffective structures (which articulate purposes or ends of an activity). Practices exist in bundles or nexuses together with material arrangements, which include humans, artefacts, things and other organisms (Schatzki, 2002; 2005). Reckwitz in summarising an 'ideal type' of practice theory based on the work of Bourdieu, Giddens, late Foucault, Garfinkel, Butler, Latour, Taylor and Schatzki, takes the step of including materials and their use as part of the practice, which he describes as:

> "a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz, 2002: 249).

The practice, here, is still very much a human activity (behaviour) but one which itself consists of different types of elements. This 'elemental approach' is developed by Elizabeth Shove, Mika Pantzar and colleagues (e.g. Shove and Pantzar, 2005; Shove et al., 2012). They suggest that practices consist primarily of a conjunction of "elements that are integrated when practices are enacted" (2012: 21). These elements are of three different types: materials, meanings and competence. This foregrounds the relations between elements as the distinctive and recognisable features of practices rather than human activities per se, which are understood instead as integrations.

The subtle differences between formulations of what comprises a practice offer different analytical routes. Shove et al. (2012) are particularly keen to develop a theory of practice that understands social change, as well as stability. Previous theories were criticised on this account (Warde, 2005). In Shove et al.'s (2012) approach, since a practice is defined by the relations between elements, change occurs as links between elements are made and broken, or as elements themselves evolve. I will say a little more on these dynamics in a moment; for now, the point is that distinguishing elements from localised integrations recognises that elements have a life of their own and can circulate independently. This helps to conceptualise commonality, through the circulation of various elements, but also opens up lines of enquiry into "the life of elements" (Shove et al., 2012).

The explicit inclusion of materials as an element of a practice with (one must assume) equal weighting to shared cultural understandings, forms of know-how and skilled action is also significant. Such materials include bodies, objects, infrastructures and tools. Doing is, amongst other things, a material process, and hence inextricably intertwined with the flows of goods in society.

Practitioners and Logic

In an approach that centres on practices, people feature primarily as carriers of practices. They 'carry on' the practices, through their actions they integrate elements, sustaining or transforming the relations between them. They are practitioners. This presents a radically different view of human subjectivity than is common in other social theories and in lay thinking. Since a practice includes a set of meanings, as well as physical activities it is also a

way of knowing, understanding and desiring (Reckwitz, 2002). As a person performs a practice, they also perform its practice-specific interpretative perspective: "wants and emotions thus do not belong to individuals but - in the form of knowledge - to practices" (Reckwitz, 2002: 254). Thus, what people do or want is neither a simple matter of personal choice nor of conformity to social norms, but oriented with respect to the way practices are organised. This means that changes in behaviour are a product of the development of practices (Warde, 2005).

This raises another point, which is worth emphasising: that practices, as organised patterns, have a logic of their own (Harvey et al., 2001). This logic inheres in the organisation of related understandings, wants, experiences and habits and, importantly, it is specific to the practice in question. Thus, a research agenda that articulates consumption in terms of everyday practices, and aims to develop an understanding that is capable of supporting sustainability policy, is one that is rooted in detailed understandings of particular practices (Shove et al., 2012). Generic 'models' of change are essential to guide this research, but the opportunities and impacts of interventions may be highly specific to the particular way of understanding and acting that a practice represents. If, for example, there are very many different practices to consider, this could be a very extensive research agenda.

Dynamics

Practices are always provisional, always dynamic (Shove et al., 2012). Because they exist in doing, there is a sense of constant 'motion' in practices, even if this is invested in sustaining and re-producing a practice in its current form. But since "enactment always differs slightly" (Røpke, 2009: 2491) and since elements of a practice are, to an extent, mutually constituted through these enactments, there is the ever-present possibility of re-formation. Practices change as the elements and the relations between them change. This might happen in a number of ways: through the 'internal' dynamics of the practice, following its own developmental logic, or through an 'external' change in the nature and distribution of elements. Thus the form of a practice develops but the trajectory of a practice is also comprised by its distribution, how widespread it is. The term trajectory, which usually denotes the path of an object already in motion, reflects the idea that practices, as units, follow their own lines of development.

Variation: Performance and Entity

On re-framing the sociology of consumption in terms of practices Warde (2005) noted that the ideas of uniformity across a practice that are present in philosophical theories of practices, are inconceivable in terms of a sociological research agenda. That is, defining practices as fundamentally shared patterns of doing and understanding runs the risk of obscuring important questions about how they might also be differentiated, contested and dynamic. In response, Warde's articulation of practices was inflected with the idea of internal variation: "social practices do not present uniform planes upon which agents participate in identical ways but are instead internally differentiated on many dimensions" (2005: 138). This is not just a question of varying performances of uniform elements either: "it seems highly likely that… agents vary in their understandings, skills and goals and that the relationship between these three components also varies" (2005: 139). Warde sees no reason why elements of a practice cannot be "shared, yet differentiated" suggesting that "patterns of similarity and difference… within and between groups of people… may thus be seen as the corollary of the way the practice is organized, rather than as the outcome of personal choice" (2005: 137). In this sense, variations in practice precede as well as emerge from differences in performances. This builds on Schatzki's insight that "both social order and individuality… result from practices" (1996: 13). Reckwitz in further emphasising the latter point, which he suggests is much under-treated, relates the development of individuality to the diversity of social practices in which each individual is a "unique crossing point" (2002: 256).

In theory, the internal differentiation within a practice can be an important part of how it develops. Firstly, since we can differentiate between practitioners, as for example, long standing practitioners and novices, the highly knowledgeable and the relatively ignorant, the enthusiast and the reluctant (all of which are encompassed by the resources and logic of the practice), we might follow the contribution of different 'groups' to the dynamics of the practice (Warde, 2005). Secondly, practices change in relation to the inherent variability of performances: "as people in myriad situations adapt, improvise and experiment" (Warde, 2005: 141). These are not only translations into performance of the generalised pattern of a practice, but, in principle, also the means by which the practice as an entity is itself transformed. Precisely how is another much under-explored question. At the very least, we

can say that variety and stability, as defined by repeatedly similar performances, exist in some form of tension, and are thus an important part of the dynamics of social practices.

Multiplicity

This outline has thus far focused on defining the core features of a practice approach, and what this means. In developing the concept of a practice, it can be easy to forget that there are many, many possible units of practice to follow. Some even suggest that the number of practices is growing as practices become more specialised and diversify (Warde, 2005; Røpke 2004). If so, and if practices consist of distinctive materials, there could be important implications for the flow of goods. In so far as these goods require power to make and to operate, this might also have implications for energy demand.

In summary, a practices approach takes what people do, including the diversity within that, to be organised in relation to social practices-as-entities. These entities form the unit of analysis. Diversity in what different people do may arise through engaging in different practices and engaging in similar practices in different ways. As both diversity and change in what people do emerge through variations in performances I have suggested that studying such variations across people may provide some insight into the features of practices that have varied in the past and may vary in the future. In the next section, I consider how such an analysis of the dynamics of social practices relates to patterns of energy consumption.

2.2 Energy Consumption and Social Practice

In the previous chapter I suggested that closer attention was needed to how energy is conceptualised and empirically related to practice-centric analyses. Specifically, I argued that when interpreting trends in energy consumption, attention to detail is important: this includes distinguishing between service demand and energy demand, determining whether or not consumption is growing in the specific end-use in question and establishing the extent to which changes in consumption are generalised or highly differentiated. It is not only energy consumption patterns, however, that are complex. A practice framing suggests that patterns of performances can change in several ways: 1) the distribution of a practice amongst

practitioners may grow or decline, as new or different people take-up or give-up the practice, 2) performances amongst current practitioners may become more frequent and 3) performances may become more energy-intensive. In principle, these forms of change could be happening all at once and with different implications for energy consumption, even within a single practice. In this section, I consider some of the further theoretical implications of framing energy consumption in relation to practice.

Varieties of Consumption

Since there are manifold practices, each with different histories, elements and patterns of recruitment, a shift to analysing energy consumption in terms of practices foregrounds and should help to elaborate the distinctive character of the many forms that energy consumption takes. Experience tells us that doing the cooking is simply not the same thing as doing the laundry or watching TV or getting ready to go to work in the morning and these again are nothing like refrigeration or lighting or heating. Although all entail energy consumption these aspects of daily life differ not only in terms of meaning and timing, but also in the levels of active involvement.

In contrast, in much energy research and policy, there has been a tendency to conceptualise energy as a uniform resource (Shove and Chappells, 2001). Each area of consumption is treated in a similar way. For example, generic programmes to improve energy efficiency involve legislation, standards and schemes for rating products, along with campaigns to persuade consumers to save energy. To an extent, this approach has had important dividends in terms of reduced consumption (e.g. for cold appliances (DECC, 2012)), and no doubt, this will continue. On the other hand, an indifference to the varieties of consumption and to the many different practices involved is hugely problematic, especially in the context of the burgeoning possibilities for demand management related to smart metering. To electricity providers seeking to 'shift' loads to off-peak times, it doesn't matter if that load was helping to provide cosy living rooms, hot evening meals or entertainment. By contrast, considering end-use energy consumption in relation to practices, calls for a much more subtle and meaningful account of the distinctive characteristics of these varieties of consumption.

Energy as an Element

To formulate an agenda that aims to better understand energy demand by not focusing on energy as such requires something of an imaginative leap that must negotiate the tension between energy and the new focus on what energy is for. As Shove (1997: 271) notes "when energy is in the spotlight, the services it provides are in the shadow; when services are highlighted, the energy dimensions fade". A similar tension remains when practices are in the spotlight. But conceptually it also becomes possible to think of energy use as integral to practices, that is, an element in them (Strengers and Maller, 2012).

However, to conceive of energy as an element in practice raises questions as to where to draw the boundaries around the elements of a practice. Are gas rigs, tankers, power stations, pylons, cables and carbon emissions all material elements of doing the laundry, for example? Perhaps we could say yes and no. 'Yes', in the sense that current laundry is now dependent on these 'materials'; but 'No' in the sense that they are neither particular to laundry, nor are they materials that are 'integrated' by the practitioner when laundry is done. These material elements, necessary though they are, are distant from the performance in both time and location. The same is not necessarily true for energy consumption. It may take place both in the home and at the time of doing the laundry. But on the other hand, energy itself is not actively integrated by the practitioner; energy is not directly used. In so far as energy consumption is invisible and implicit within practices, and in so far as practices are taken to be 'entities' which are recognisable and meaningful to practitioners, energy appears to be less of an element of practice. At least, it is just as much a part of particular practices as is the food and cell biology that sustains practitioners.

Energy as the Trace of Practice

Is there an alternative way to conceptualise energy use within a practice-theoretical framework? I suggest that energy can be considered as a kind of infrastructure. From the practitioner's perspective, the energy that is a necessary input for devices is very much in the background, perhaps best considered as a part of objects' functioning, rather than an object subject to active integration or use in its own right. This is a distinction between the foreground and explicitly recognisable components of particular activities, and the more

backgrounded and invisible components, on which the activities still depend but are not especially distinctive to any particular practice.

Yet, just as Schatzki (2002) recognises that materiality is necessarily bundled with practices, so too is infrastructure. This concept of infrastructure is akin to that articulated by Susan Leigh Star (1999): a much broader term than the more common reference to large, material infrastructures such as the road systems, sewers and power-grid. The key difference is that these large material infrastructures are often taken to be enabling of but indifferent to the precise variety of usage that takes place. Rather, in Star's conception, infrastructure is bound up with and defined specifically in relation to practices: it is that which enables practices yet remains itself invisible to them, and is not valued as part of them. The term applies just as much to human functions as to that of machines. When studying infrastructures, Star suggests that one option is to treat them as a trace of the practices they support. In this light, energy consumption data can inform us about the practices that take place. Indeed, there are security and privacy concerns over the potential for smart meters to do just that (Molina-Markham et al., 2010; Buchmann et al., 2013).

To conceive of energy consumption as a trace of practices suggests a kind of knowledge about energy that is reconcilable with pursuing in-depth, largely qualitative understandings of practices. The potential tension between energy use and practices is lessened if the former can be treated as a way of improving understanding about the latter. But equally, knowing about energy consumption, as a potential trace of practices, also helps connect everyday life to the broader energy research agenda.

A Role for Services?

When it comes to the social analysis of energy consumption, the concept of service has been pivotal. In particular, distinguishing the demand for services from the efficiency of delivering them is a simple but significant step that helps to clarify the difference between demand and final consumption. It also demarcates the unique and important contribution that social science approaches can make to understanding energy demand. Yet, an equivalent translation into the 'demand for practices' would seem to in-advisably externalise demand from the practice itself. In fact, as I will argue below, the conceptualisation of energy demand within a

practice-framing needs careful attention: it is quite different compared to other forms of consumption. As such, services and their consumption may still offer a useful way to think about energy.

So how do services relate to practices? The answer to that may depend on the particular service in question and also what we take to be a service. 'Energy services' are usually conceived as those utilities that energy directly enables, such as heating and lighting. These can be valued parts of everyday life that vary distinctly from culture to culture (Wilhite et al., 1996). But a broader notion of services has also been developed: as "composite accomplishments generating and sustaining certain conditions and experiences" (Shove, 2003: 165). Understood in this way, the notion of services is extended beyond the functions of specific devices "to the achievement of more encompassing services like those of comfort and cleanliness" (Shove, 2003: 166). The concepts of services that prevail are considered to be the outcomes of integrative processes, a "blend of method, meaning and hardware" (Shove, 2003: 166), the specification, reproduction and co-evolution of which, at least in part, take place through normal practice. In this analysis, the nature and qualities of services are not so much a part of practices, as an outcome of them.

Within a practices-based framework, 'concepts of service' may be considered as a form of meaning, a social understanding, for example, expectations of what counts as a comfortable temperature or a clean item of clothing. But we must not lose sight of those states or experiences themselves, and the insight that these are composite achievements of the "orchestration of devices, systems, expectations and conventions" (Shove, 2003: 165). In this sense, they are not simply an element of meaning within practices, but also fundamentally material. Moreover, they are not simply an outcome of practices, and the elements (devices, expectations, conventions) that are integrated in doing but are also constituted by processes of integration across systems, such as those of provision and everyday life. This idea of services, then, offers something that a framework if reduced only to practices does not readily. Firstly, the articulation of conditions and experiences, contrasts with that of processes, on which practices would appear to focus. Secondly, it is rooted in an idea of systems, thus service may be grounded in a number of different practices and devices and in related processes of commercial provisioning and institutional regulation.

Perhaps, too, the different varieties of energy consumption may require a different blend of conceptual tools. As Røpke and Christensen suggest, different forms of consumption may draw more or less directly on a basic (direct) or accomplished and composite (indirect) notion of service: "From a consumer perspective, electricity is used to obtain services either in the form of lighting, or more indirectly as input to the processes of preparing food, for example or washing clothes" (2012: 1765).

Defining Energy Demand and Consumption

As Warde notes, the term consumption, as it is commonly used in everyday and much scholarly language denotes a "chronic ambivalence between two contrasting senses, of purchase and of using-up" (2005: 137). A 'practices approach' re-frames consumption, in general, in terms of the ongoing and ordinary use of material goods in social practices. So although 'doing' may be related to acquisition, or 'having', (Shove et al., 2007) consumption from Warde's perspective "cannot be reduced to demand" (2005: 137). Here, he refers to a concept of market demand, related to economic exchange.

Energy, however, is a very particular and odd kind of product. As an infrastructural good (Summerton, 2004), it is acquired and used in quite a different way than most other goods. Economic exchange follows consumption (at an interval of several months in the case of quarterly billing), whilst demand is simultaneous, if not quite synonymous, with consumption. That is, electricity is used at the same time as it is supplied. And since, in the first instance, electricity and gas are used by machines rather than directly by people, the relation of energy to practices may not be as direct as for the machines themselves. Thus, it seems that the framing of 'energy' consumption in terms of practices may be different to the consumption of other materials. I will need to define the terms "energy demand" and "energy consumption" and their conceptualisation within an everyday practices-based framework.

Energy consumption (or use) is situated within networks of devices, but it is distinguished from energy demand, which is a product of practices and inter-acting conditions as expressed through those devices. This emphasises the notion of demand as a request. When I refer to 'energy demand' I refer to the demand for energy. The level of this demand may be

quantifiable but the nature of it is not. In this way, I take demand to be a broader concept, with 'origins' or constitutional components that exist beyond moment-by-moment consumption. Viewed as such, the technical efficiency of networks of devices in delivering services or supporting practices is a *modulator* rather than a *source* of demand. In this sense, demand is a more temporally extensive notion: it can be said that demand for energy extends into the near-future in a relatively knowable way, whereas the consumption required to meet that demand has not yet been incurred, and, if there are problems with the supply of energy, may not be. For the purposes of this thesis, energy demand and consumption can almost be used interchangeably but I try to maintain a distinction wherein consumption is the aspect of energy that is only ever localised. Consumption is what energy meters measure. Demand is the sense of request engendered in everyday life.

This framing of energy demand and consumption differs from other common uses of the terms within energy research. From a technical perspective, the term 'energy demand' is often used to refer to the instantaneous electrical load or power of a particular device or of all the devices across an entire grid. Here demand equates to the power drawn *at any one time*, and differs from the total consumption, which is the quantity of energy consumed *over a given time*. Thus kW is a measure of power and kWh a measure of consumption. These different 'dimensions' of energy have different 'problems' attached to them. Demand management strategies deal with total power, and peak loads, in order to avoid the further, costly expansion of maximum generation capacity even if it is only need for an hour or half an hour a day (Shove and Chappels, 2001). Thus, demand management is not necessarily about reducing carbon emissions: the volume of consumption may remain the same, so long as it is more temporally distributed. But since the carbon intensity of supply varies over the day depending on load, shifting consumption to non-peak periods can also lower carbon emissions. This notion of demand as power is significant in the management of the overall systems of supply and consumption. But since it prioritises power over total consumption, it is a partial notion of demand. I suggest it is important to retain a notion of demand as the total quantities of energy required and requested by society. Accordingly, I use the term 'power' in reference to the instantaneous electrical load.

In sum, based on the conceptualisation of practices within theories of practice, and on an earlier demarcation of a social science of service, I have set out a framework for the investigation of domestic energy demand. This stipulates that such energy demand originates in everyday life, which is itself comprised primarily of practices and composite conditions and experiences. Measurements of energy use can be treated as a trace of those practices. This sets out a working definition of the relationship between energy and social practices. But it is tenuous. As noted, energy is a very particular kind of 'object' and in light of the different practices in which it is consumed it is a highly diverse one. By exploring this basic framework through the empirical analysis of a variety of practices, it should be possible to develop more nuanced and varied accounts of the many relationships that link energy-use and everyday practice.

2.3 Research Questions

Based on a conceptualisation of energy consumption in terms of social practices, I have suggested that there is a need for detailed and practice-specific understandings of what people do, and how this is organised, which, crucially, are relevant to understanding patterns of energy consumption. Thus, this thesis explores three broad, overlapping themes: the first concerns the empirical development of practice-specific, energy-relevant understandings of energy demand. I have argued that variation is also an aspect of these dynamics, and that the diversity of what people do and of the energy consumption that follows deserves attention as a topic in its own right. This is the second theme. The third concerns the conceptualisation of energy demand in terms of social practices that I have argued requires some further attention. I can now develop some more specific questions grouped under each line of enquiry.

1) Developing Detailed, Practice-Specific Understandings of Energy Use Patterns

- In relation to specific practices, how is domestic energy demand constituted and how does it change?
- Are particular features of practice implicated in changing patterns of energy consumption?

- If so, does this provide clues about how these practices and energy demands may change in the future, or may be shaped through interventions?

2) Understanding Diversity

- Can variation in energy demand be studied as an outcome of the performances of different practices?
- What features of specific practices vary in ways that are reflected in energy use?
- How are variations in what people do socially organised?
- In what ways does the nature of variations in performance differ between practices?
- How are variations in performance implicated in processes of change?
- How do changes in practice relate to the convergence and divergence of energy demand?
- How should we interpret the differences in consumption between households?

3) Conceptualising Relationships Between Practice and Energy Use

- How closely are levels of energy consumption related to what people do in their ordinary lives, and how is that organised by social practices?
- How should the concept of 'service' feature in practice-centric analyses? And how do such analyses account for changes in the demand for 'services'?

In specifying and addressing these questions, my aim is primarily empirical: to build understandings of practices of a kind that reflect how the demand for energy varies and changes. In other words, I am asking about how the relationships that constitute demand vary in order to learn more about how energy demand is comprised, and thus how it can be better conceptualised, learnt about and potentially shaped.

2.4 Research Design

Conceptualising energy demand in terms of social practices raises questions, as outlined above, and this calls for a particular type of research. Firstly, if I am to explore how variations in energy use can be linked directly to differences in performances of specific practices, I

must be able to explore and differentiate those performances in some detail and combine this with energy use measurements. This calls for a study that combines different methods. Secondly, if the variations in energy use are to be connected to variations in the performance of specific practices, other non-performance sources of variation in energy use, such as the efficiency of devices and characteristics of buildings, need to be minimised. This calls for a very particular type of comparative study. Thirdly, since part of the diversity I wish to explore is that between different practices, I need to study more than one. This calls for comparison between different varieties of energy consumption. Finally, if I am to use variation as a platform to investigate the dynamics of energy consumption over time, and to explore the social organisation of what people do, I will need to put the empirical findings concerning variations into some historical context. This calls for the inclusion of some secondary research. In this section, I outline this research design and rationale.

Multiple Methods

In order to explore the relationship between domestic energy use, what people do, and how that is organised in the form of practices as entities, this research will need to collect data about these different phenomena. This data will need to be sufficiently detailed as to allow me to detect differentiations between varieties of performances and energy use. This data will also need to be directly connected to the same points of observation, i.e. the same practitioners or households. This implies a micro-level study that directly collects data on energy and on the enactment of a range of practices from a sample of households. Putting these findings into a broader context to consider their relevance for understanding change, requires reference to secondary data. I discuss the methods for connecting and collecting all these forms of data in more detail below. Here, it is worth explaining how this multi-method design draws on and distinguishes itself from previous studies of this kind.

Within energy research, there have been numerous calls over many years for trans-, inter- and cross-disciplinary research to better understand patterns of household energy consumption through integrating different types of data, methods and disciplines (e.g. Vine, 1986; Lutzenhiser, 1992; Hitchcock, 1993; Crosbie, 2006; Kierstead, 2006). In more recent years, various programmes of research have been developed along these lines (e.g. Lomas, 2010; Stephenson et al., 2010) and whilst there is clear interest in integrating large data-sets into

quantitative models of domestic consumption (Kierstead, 2006; Lutzenhiser et al., 2010, 2012), there is broad acknowledgement that micro- and qualitative inquiry also offers a distinctive understanding of 'why' energy is consumed (Crosbie, 2006; Lutzenhiser et al., 2010). Of particular relevance to my research are a number of studies that combine qualitative methods such as interviewing with energy monitoring; sometimes referred to as a 'socio-technical' approach or perspective (Stokes et al., 2006; Wall and Crosbie, 2009; Coleman et al., 2012). Studies designed along these lines tend to work with small sample-sizes and they are usually comparative (if only implicitly), using the differences in the accounts people give to make sense of differences in energy consumption.

While studies which combine interviews and monitoring can address a wider range of questions, they have not tended to focus on how the practices of everyday life themselves constitute the demand for domestic energy. For instance, to Crosbie (2006: 748) the value of qualitative research is to "inform the introduction of technically proved energy efficient technologies into appropriate social practices". For example, in a study of lighting with 18 UK households, Wall and Crosbie (2009) monitored the use of light fittings with light sensors, and from this data and an inventory of the bulbs estimated energy use. In interviews, householders were asked about "what influenced their lighting choices and awareness of efficient lighting technologies" (Wall and Crosbie, 2009: 1024). Data on the use of lighting was also used as a prompt in interviews to explore the social influences on lighting patterns, but the aim was to outline the potential for energy savings by further adoption of efficient bulbs. In my research, I am interested primarily in what people do at home and how this depends on and integrates energy-consuming material systems.

Along these lines, other studies which combine energy monitoring with interviews have focused more on the use of specific devices, such as information, communication and entertainment (ICE) technologies (Coleman et al., 2012) or building infrastructures, such as heating (Gram-Hanssen, 2010) and even whole buildings such as new Passivhaus homes (Foulds et al., 2013). The latter two examples also used a social practice framework to describe and analyse what people do, that is, to consider the performance of "indoor climate regulation" (Gram-Hanssen, 2010: 184) and "everyday life" within a Passivhaus (Foulds et al. 2013). My research shares much in common with the methods used in each of these studies:

as with Wall and Crosbie (2009), Coleman et al. (2012) and Foulds et al. (2013), I use energy consumption and other forms of monitoring (e.g. temperature and lighting) to provide insight into what people do and I used this data in interview discussions. In this sense, I use monitoring data as a trace of activity. And as with Gram-Hanssen's (2010) study, I also use qualitative accounts from interviews to explore and compare energy use in infrastructurally similar settings.

In their own right, qualitative investigations of energy demand can address questions of how energy-consuming technologies are purchased, used and integrated into daily life (e.g. Hand and Shove, 2005; Crosbie, 2008; Crosbie and Guy, 2008; Røpke et al. 2010; Hitchings and Day, 2011; Spinney et al., 2012) and how energy-saving considerations do and do not enter into these processes (Pierce et al., 2010b; Strengers, 2011a, 2011b, 2012; Hargreaves, 2012). Such investigations of the performances of social practices are usually not comparative but instead interested in general features of these practices. These features may then be linked to historical changes in practice, which in turn are linked to evidence of changing patterns of energy consumption from monitored and modelled data. Otherwise, inferences about energy consumption are made on the basis of what people report. However, such estimates may not be accurate and when it comes to comparing performances with reference to energy, the details of what people actually do, and how much energy is actually used, matter.

Similarly, energy monitoring studies in their own right can be very informative about the range and scale of consumption for households as a whole or for particular end-uses. Drawing on such data, quantitative analyses are able to explore aspects of the social patterning in energy demand such as the way that consumption co-varies with income, social class and lifestyle across large samples (Lutzenhiser and Bender, 2008; Sanquist et al., 2012). However, such approaches do not necessarily provide much insight into how or why consumption varies. Recent research into water consumption also suggests that quantitative analysis of survey data may be able to make some connections in this respect, that is, between patterns of what people report doing and what is consumed (Browne et al., 2014). But they are still distanced from the precise processes by which energy (or water) is consumed and from how the demand for it is constituted.

Comparing and Connecting Performances And Energy Use

Given that I wish to explore performances and their relation to energy use as directly as I can, how can I ensure the relationship between these two types of data is as close as possible? In other words, how can I ensure that the variations in what people do are not concealed by non-related variations in the energy efficiency of devices and systems that are used? How can I analytically abstract demand for energy that emerges through performance from variable degrees of energy-efficiency?

In broad terms, I use a similar method to Gram-Hanssen (2010) who interviewed families living in identically designed houses, supplied by the same district heating system, in a development in Denmark. The heat consumed by each household was already monitored and used as a basis for billing. These figures were used in the study which found that the annual heat consumed in these remarkably similar domestic structures could differ by up to 300%, that is, by a factor of 3. The differences in the "indoor air regulation practices" of a selection of 5 of the families were described and compared in a framework based on an attempt to operationalise the elements of social practices. However, there are important differences in the type and range of performance I have examined and in my aim, which is to explore the relation between variation and change over time.

My study is designed to compare practices in very similar settings, and be able to relate these comparisons to measured energy consumption. It is based in the structurally similar setting of student halls of residence. I selected this site of study because of the even greater 'control' it affords over the relation between practice and energy consumption: the practitioners are more homogeneous than either Gram-Hanssen's (2010) or Hackett and Lutzenshiser's (1991) samples. Firstly, single practitioners or groups of the same numbers can be compared. Whilst families naturally vary in number, even in identically designed houses, self-catering student halls are organised into numbers of flats (or apartments) of the same design, housing the same number of residents, each with their own study-bedroom. Secondly, since undergraduate students at this particular UK university tend to be mostly from the UK, there is a high probability of finding respondents with the same nationality. Thirdly, undergraduates are also mostly at similar points in their lives: they are of similar ages and

enact their day to day lives within similar constraints and opportunities related to studying and living on campus, a relative bubble in a much wider world of possible 'lifestyles'.

My interest is not in students as a group of particular interest for energy-related practice or vulnerability. Neither is my aim primarily to compare or contrast students to other more 'typical' households or people. At the same time, I do not seek to generalise from the students studied either to students as a group or to the rest of the population. I am not seeking a representative sample of individuals. What I am aiming for is a window into particular areas of everyday practice and energy demand. I cannot know in advance whether this will be in any way 'representative' of the practice as a whole, but I am not concerned with this. Rather, I expect that a small group of intentionally homogeneous practitioners will provide an exceptionally particular insight into the broader practices in question. Whilst this won't necessarily be representative of the total population of performances nor of the careers of practitioners, I would still argue that as an instance of a social practice, performances at this site would nevertheless reflect something of the logic of the practice as a whole.

Indeed, limiting the sources of diversity in practice may appear a curious way to seek to foreground and study diversity. But I am not aiming to detail and describe all the forms of variation: instead, I am looking to identify variations in practices that are significant enough to appear even in a relatively homogeneous sample. To compare more diverse, single practitioners, such as those from different cultures or a retired couple, with a group of young male co-sharers with a single professional would potentially reveal more of the variability that is present within any given practice. But I might be unable to relate these variations directly to energy consumption due to very different structural conditions. Also, the very different social situations in which such diverse practitioners find themselves, would much more readily explicate different ways of doing a practice, than any aspect of the practice itself. Thus, a narrow focus allows for a discussion of the variation that arises in what similar people do in a similar setting.

Comparing Varieties of Energy Consumption

Following a practice approach, I take practices as the key unit of analysis in this research. In theory, what people do, and how that varies and changes, is organised in relation to social

practices. Moreover, based on this conceptualisation, we should expect these variations and changes in practice to also be related to variations and changes in energy use. Since aggregate household energy use should vary and change in relation to multiple practices and since these practices may have distinctive characteristics it is important to study more than one. However, because my analytical units are social practices, and not aggregate energy use, I am not looking to 'explain' total consumption figures by disaggregating them into the many varieties of consumption and associated practices. Instead, I am looking to explore the energy consumption that is associated with particular practices.

Unfortunately, this is complicated. There are different forms of energy and many devices through which it is used. That which can be measured - the end-use category or single device - is not necessarily synonymous with or limited to single practices. In selecting sites for enquiry therefore I did not entirely focus on recognisable practices. Domains were selected through a mixture of considerations, including the substantive significance of a particular area of energy use, as previously known and as emerged through the study. I chose one site of enquiry which is a practice (cooking), one which is an end-use service (heating) and one centred around a type of device (computers). I refer to these as domains of energy demand (or cases). I explore variations in practice and energy consumption *within* these domains. But I also compare and contrast them, one to another, and in this light, I settled on three domains: to include examples of what appear to be different forms of practice and energy use but not to select so many as to be un-manageable.

The first domain I focus on is cooking. This is because it is often cited as an exemplar social practice. If, as following the conceptual framework that I have set out, everyday life is comprised of social practices, cooking should offer a good place to explore what this means and how social practices can constitute the demand for energy. Moreover, eating cooked food is an important part of everyday life, and there is a considerable wealth of sociological literature that explores the role of meals and cooking, from many different angles. However, cooking is rarely ever considered as a topic for energy research despite the fact that it clearly depends upon energy consumption. In particular, in the student flats selected for the current study, the cooker was one of the few, large electricity consuming appliances that was

provided by the university. At this site, then, it was anticipated to be an important component of overall electricity consumption.

The second area I focus on is thermal comfort, for almost opposite reasons. Residential space heating is a significant component of total national energy consumption (DECC, 2012). It also makes a greater contribution to carbon emissions than the electricity consumed in the home. Accordingly, there is a wealth of research and policy that concerns the specification, design and operation of buildings and heating systems from an energy perspective. In addition, thermal comfort has also received a substantial slice of attention from social scientists (e.g. Shove, 2003; Chappels and Shove, 2005; Shove et al., 2008; Hitchings, 2008, 2009; Strengers, 2011). In particular, it is one of the key cases in Shove's (2003) examination of how certain concepts of service become normal. As such, it is an interesting case through which to explore the conceptual tensions between services and practices. In contrast to cooking, thermal comfort is not an obvious example of a social practice.

The third area I focus on is defined by use of a particular set of technologies: computing and media (or ICE) technologies. This is neither an obvious case of a single practice (like cooking), nor has it already been addressed in terms of the service such energy-use provides (like heating in thermal comfort research). There is, however, some relatively sparse interest in this as a growing area of energy demand (e.g. Gram-Hanssen, 2005; Coleman et al., 2012; Røpke et al., 2010; Spinney et al., 2012). One of the main reasons, however, that I choose to focus on ICE-related practices was because of some initial, exploratory research at the university halls of residence conducted in December 2010. In a small set of interviews, it was evident that computing and entertainment were diverse activities, especially in terms of their material instantiations (Morley and Hazas, 2011). This was confirmed in the subsequent research, where this domain of energy consumption was seen to account for a significant portion of the variation in overall consumption between flats. Because of this variability I selected it as my third and final domain.

Connecting Variable Performances and Dynamic Practices

When focusing directly on what people do, I have mentioned the importance of attending to the social organisation of such doing. Framed in terms of social practices, this means considering the relationship between performances and practices-as-entities. This, of course, is a question that applies to any research taking a practice approach. Yet despite the recent growth of interest in such approaches within consumption studies (especially of energy) there is relatively little in the way of methodological debate over how to interrogate practices, and make these connections. This is perhaps surprising given the conceptual implications: practices do not have the kind of singular presence that individuals do; they are dispersed entities that are not located at any single time or place. Of course, doings and sayings can be 'sampled' empirically and analysed with familiar social research methods to draw out themes and commonalities. But such an approach can be overly descriptive (Shove and Spurling, 2013) and neglect how practices are organised, something which, by definition, precedes performance. So how can I develop an understanding of variations in what people actually do that is also contextualised within broader forms of social organisation and change? My answer is to combine different types of data about performances and practices, including interviews, sensor-based 'observations', other research into the practices in question, data on trends in energy consumption and other indicators such as time use.

Most researchers who investigate practices depend on what people say in interviews. For insight into the nature of performances and what I refer to as the 'logic of practice' I, likewise, use interviewing. I recognise that interviews are performances in their own right, and both the sayings about the practices and the reports of activity that arise in interviews require caution and interpretation. But whilst sayings might 'belong' to the interview itself, I assume that they are drawn from and reflective of practices-as-entities in some way. For example, even if self-reports of activities are biased and inaccurate, they still provide data about what is perceived to be socially acceptable to do and say.

At the same time, just depending on reports of activities from interviews may end up with a more homogenous view of those activities than is really the case. In so far as I am interested in variations in performances themselves, this is potentially problematic. As Strengers (2009) warns, respondents may report similar expectations with regard to a certain state of

cleanliness but actually achieve this in very different ways. Whilst I do not assume that a performance of a particular practice is an entirely observable event (meanings for example are difficult to observe yet are an integral part of performance), some form of observation of what people actually do is important in pursuing the connections between energy use, performances and the dynamics of social practices. It is especially valuable for revealing the temporal nature of performances (duration, timing, frequency). I discounted direct participant observation on account of the private nature of the domestic spaces to be studied and the temporal extension (over a course of days) of the qualities of performances (of cooking, comfort and ICE) that I was interested to explore. Instead, I considered ways that sensors could capture something of the activities as they took place. For each domain, the opportunities for this were different. In the kitchen, a space that I had experienced in my preliminary research as relatively public-facing, I used a motion activated wildlife camera mounted over the cooker to observe cooking activities (the hobcam). For studying comfort-related performance, temperature, motion, door and window sensors were used including temperature sensors on the inlet and outlet pipes to the radiator to indicate when it was in use. For ICE-use, electricity consumption was measured at the sockets in the private study-bedrooms and provided an indicator of when computers and other electronic devices were in use.

In the case of ICE-use and comfort this sensor data was used as a prompt for discussion, thereby helping to interpret the differences that emerged in this data, and add detail to the interviews. This also meant that accounts of activities based around this data were more accurate than would have been otherwise recalled. The ability to discursively recall and reflect upon past and habitual performance has been of some concern to researchers. For example, Hitchings (2012) found that people were able to talk about such activities as dressing for the office, where they take breaks, and how they keep themselves warm in winter even though they were not used to thinking or talking about such topics. Hitchings (2012) argues that serial interviews are particularly helpful in this context providing both reassurance that the interviewer was genuinely interested in such details, as well as time for the interviewee to reflect upon and pay attention to them. In addition, in their research into older people's winter warmth, Hitchings and Day (2011) gave respondents diaries to complete between the two interviews. These served as input to the interviews and also as data sources in their own

right. A similar approach (diary and photographs) was taken by Halkier and Jensen (2012) in their investigations of food practices. In other research into the everyday practices associated with comfort and cleanliness, Strengers (2009, 2011a) supplemented her single interview with a tour of the home. My research includes some aspects of all of these techniques, in order to supplement the interviews, especially for comfort, where a more detailed and in-depth approach was taken to examine the subtle, habitual and not necessarily purposeful activities that contribute to thermal experience.

In summary, to study performances, I used interviews and a combination of sensors. I also used the interview data to explore the meanings of practices-as-entities, as reflected in what people said and the distinctions they made. This helped me connect the observations and accounts from this site with previous research into the practices in question and build a wider understanding of the practices-as-entities and the processes of social change associated with them. More specifically, by identifying the features of practices which vary in accordance with the demand for energy, the 'lives' of these energy-relevant features over time and space can be explored. Both as a step towards developing more thorough understandings and as a way of contextualising the social organisation of the differences observed in my own research, I made use of secondary sources: notably energy consumption trends, data from other energy monitoring studies and time-use research.

A small-scale, qualitative comparative study

As a result of these design considerations, the study is small in terms of participant numbers. This is to allow for the integration and comparison of detailed data concerning performances and energy use within domains (of practice and consumption) and across them. Although this incorporates quantified data, both as an indicator of energy use and as a trace of performances, the design is in fact distinctly qualitative. As with other qualitative research, there is not so much of a concern about the generalisability of findings, as characterises quantitative approaches. That said, I expect the activities that take place, even in student residences, to be connected to and built out of social practice entities; that is, out of the combinations of various elements that are in common circulation. Even the doings and sayings of students instantiate much broader social phenomena: practices do not 'belong' to these individual in the way that hair colour or height do. Since I take practices as my primary

unit of analysis, even when comparing individuals, even highly specific instantiations can be studied in the context of broader entities. Practices provide a conceptual framework for making these connections, and for linking the micro and specific to the macro or more general.

Some qualification concerning the nature of the variations in energy consumption that I aim to explore will also be helpful at this point. Firstly, as is consistent with my focus on everyday practice, rather than energy per se, I am not explicitly looking to sample or to compare those who are explicitly green, environmental or otherwise trying to save energy. Secondly, and relatedly, although this research is based on comparisons of practices that depend on relatively low or high levels of energy consumption, and the assumption that understanding these differences is potentially informative for energy policy and other interventions, it is not an explicit goal to identify especially low-energy forms of organisation or to consider how these might be achieved more generally. Rather, in this work, I am more concerned with understanding how variations in the demand for energy may arise as a consequence of ongoing transformations of everyday life. Thirdly, although I am not aiming to decompose variations in aggregate household energy use into composite practices in this research, it is worth noting that I did make use of aggregate level consumption data to help select the participating flats in the cooking and ICE part of the research. It was my original intention to include such comparisons between flats (Morley and Hazas, 2011), but I revised this on account of the more tenuous relationships on which this would depend (between the multiple practices of multiple residents). However, the result is that the sample of cooking and ICE practitioners most likely includes some of the highest and lowest consuming performances in the hall of residence. There was no element of energy-based selection for the comfort part of the research.

2.5 Research Method: An Overview

In the following chapters, I will present the findings of my research in each of the three domains, starting with cooking as the exemplar social practice, moving to comfort as an important site of energy-use but less obviously associated with a single social practice, and

finally to ICE-devices at the centre of a more complex mixture of multiple practices and diverse forms of energy consumption. The precise methods used to research performances and energy-use varied significantly in each domain. So in the first chapter that addresses each, I outline these methods in more detail, followed by the findings (Chapter 3 covers cooking, Chapter 5 covers comfort and Chapter 8 covers ICE). In each case, the subsequent chapters then draw in further secondary sources of information in order to explore the wider dynamics of energy demand indicated by the co-variations established in the empirical research (Chapter 4 for cooking, Chapters 5 and 6 for comfort, and Chapter 9 for ICE). In the current section, I outline how I organised and undertook this research.

The research was conducted over three stages (preliminary, I and II) between December 2010 and June 2012. It was located in two different halls of residence (called here Hall A and B) on the campus of Lancaster University, and involved 37 undergraduate student participants (ages 18-25). As summarised in Table 2.1, 23 participants took part in a sensor deployment which monitored use of electronic devices and environmental conditions in their study-bedrooms. Of these participants, 16 were interviewed. A further 2 participants were interviewed but did not participate in the sensor deployment stages, and 12 participated in the kitchen and aggregate electricity monitoring only.

Table 2.1 Summary of participant numbers in each part of the research

	Participants					Domain		
	Interviewees	Interviews	Bedroom Monitoring	Kitchen Monitoring	Unique Participants	Cooking	Comfort	ICE
Preliminary	4	4	-	-	4	X	-	X
Stage I	11	11	19	31	29	X	-	X
Stage II	4	10	4	-	4	-	X	-
Total	**18**	**25**	**23**		**37**			

The preliminary stage involved 4 interviews with participants in Hall A. This helped to develop the style of questions and explored the nature of the context into which the sensor-based monitoring was introduced. The interviews were semi-structured and designed to explore participants' everyday routines, with a specific focus on the activities that took place

in their flat that were likely to relate to energy consumption. This included an open-ended question on the previous day's activities, supplemented with pre-planned topics (cooking; working; leisure; grooming; cleaning). These were largely successful and the style did not change greatly between this and Stage 1; thus, this data is included in the analysis. It contributes to the cooking and computing case studies.

Stage 1 took place between February and April 2011 in Hall A. It involved two of the same participants as in the preliminary stage and 29 others. They were the residents of four 8-person flats (one of which actually had 7 people at the time of the study). Stage 1 was designed to study electricity consumption and related practices, including cooking and ICE consumption, each of which were monitored for a minimum period of three weeks in March 2011. Participants were recruited through the flat in which they lived. Invitations were based on prior knowledge of relative overall energy consumption of the flats that ensured that one was amongst the highest-consuming flats in the hall and one was amongst the lowest, with the other two in between. Consent was granted by all the residents in each flat to permit use of aggregate consumption data and additional monitoring in the kitchen, where the socket monitors, light sensors and the hobcams were subsequently installed (see Bates et al. (2012) for details). Residents were also invited, on a further opt-in basis, to take part in the more detailed part of the research. This included socket monitors, light, temperature and motion sensors in their private bedrooms and the possibility of taking part in an interview. Of the 31 residents, 25 agreed to this stage, out of which 22 rooms were actually fitted with sensors (where residents were unavailable at the time of deploying the sensors). Of these rooms, I excluded 3 due to the poor quality of the data collected. Of the remaining 19 participants, 11 were interviewed towards the end of the month. The interviews were similar to the preliminary stage but also included presentation and discussion of the socket power data that had been collected in the study-bedrooms.

Stage II took place between February and May 2012 in Hall B. It involved 4 further student residents, from different flats, and focused on comfort. As with Stage I, it included a range of monitoring sensors deployed in the study-bedrooms, but these were not fitted elsewhere in the flat. This stage was designed to be more detailed in order to explore the less obvious and habitual activities that relate to thermal comfort. It included serial interviews, which were

held in the study-bedrooms, one at the start of the study and one after several weeks of data collection. With two of the participants, a third interview was conducted towards the end of the study, giving opportunity to collect data on and to discuss the contrasts between colder and warmer periods. In addition, participants completed a diary task.

Due to the greater depth sought by these methods and in order to integrate and compare these more detailed accounts, a smaller sample of participants was planned for this stage. Since participants were not selected on any prior knowledge of differences in energy consumption the intention was actually to recruit more than 4 (about 8 was the intention). Unfortunately, it did not prove possible to do this and to also conduct the study during the winter heating season and before the end of term. Fortuitously, the respondents included in the sample took very different approaches to thermal comfort, and the smaller number of participants allowed for each to be effectively treated as a case study in comfort-management in his/her own right.

In stages I and II, the data from the socket electricity monitors and the door, window, motion and environmental sensors (temperature / humidity / light) was wirelessly logged by a data collection computer placed in situ. Over the university network, it was also possible to periodically back-up this data and to check if sensors were working. This was not possible for the hobcams and some of the temperature sensors, which logged their data on integrated storage.

Conducting the Study in Collaboration

It is necessary to make it explicitly clear that I carried out this research in collaboration with other researchers. My project to compare performances of practices on grounds of energy-use depended on a combination of qualitative research with energy monitoring and this would not have been possible without the technical skills to deploy, log and decipher this fine-grained sensor data. Since I did not possess these skills, it would have taken me much longer to pursue this aim without the involvement of the other researchers. Fortunately, a collaboration transpired between three research projects: my own, another undergraduate/PhD project and an EPSRC-funded project. This gave me the help I needed to bring sensor monitoring into my research. Two other researchers in the School of

Computing and Communications procured, configured and deployed the sensor networks and the hobcam. In Stage II, I was more involved with this deployment, was present at all contacts with participants and removed the sensors. However in Stage I, my co-investigators deployed the sensors without my help.

However, the design of this research is my own. I also interviewed the participants, and, with the exception of one flat in Stage 1, recruited them. The analysis in this thesis also represents my own work. It depends and builds on the data that was collected in the collaborative project. To visualise and explore some of the data, I have used MATLAB code that others have written. I have also co-authored a number of articles as a result of this collaborative approach (Bates et al., 2012; Clear et al., 2013a, 2013b; Bates et al., 2014). My own thinking has, unavoidably, developed in this context. So it is important to note that the collaboration was actually a result of being able to combine different research goals into the same empirical work. As such, our co-authored articles have been written with the goal of expanding and challenging approaches to the design of digital systems that can support energy reduction in residential settings. There had been a boon in such work within the fields of human-computer interaction and ubiquitous computing, based on an assumption concerning the simple persuasive power of 'feedback' and visualisation. Our aim was to illustrate to these communities, through the studies, the embedded nature of energy consumption and the need to gain a better understanding of everyday life, if new digital technologies are to play a role in enhancing sustainability. The work in this thesis takes a different tack. It aims to develop that understanding per se, in much more detail, and it does this through exploring variations in consumption and practice. I have worked independently on this analysis and the content of this thesis.

Limitations

The insights this work generates into the dynamics of demand are based on a limited set of practices and products. As already explained, it was necessary to limit the sources of variation in the practices studied, such that energy consumption could be connected to patterns of activity, and such that it would be possible to identify aspects of 'doing' through which energy demand is comprised. This methodological strategy has its advantages. But one

downside is that there are likely to be many more dynamics involved than these methods can ever reveal alone.

However, I would argue that this does not compromise or undermine the insights and conclusions that are reached. It is clearly inappropriate to generalise too widely or to claim to have represented the 'life' of cooking, heating or ICE-related practices as a whole. My approach nonetheless allows me to identify a number of generic features and processes in which variations, and change, are reflected in energy use patterns. This does not mean to say that in every circumstance and every comparison the same features will be of value when accounting for observed differences in energy consumption.

The detail I have been able to pursue in each domain, both in my empirical and secondary research, has also been limited by the goal of comparing across these different areas of daily life. In particular, it was evident when analysing the qualitative data, that there were so many more questions to ask, and so much more to understand about how day-to-day integrations are patterned and organised. In other words, there is much more to be said about the 'logic' of each area of practice as it emerges in daily life and across the systems on which it depends.

There was also more that could have been gained from the quantitative monitoring side of my research. In particular, I had hoped that the home sensor data would help to characterise the patterning of activity in daily life over time. With the exception of the case of cooking, for which I generated the data myself from a photographic record, I have not used the energy or home sensor data in detail in this way, using it instead in summarised forms. This mostly reflects the direction in which my analysis took me. For example, in the case of comfort, I focused on the differences in clothing and in detailing their relationship to the indoor climates that were observed, not on an hour by hour basis. Since I did not have monitoring information for clothing, I relied on comparing the accounts participants provided in interviews and diaries. There is a further wealth of sensor data to explore from the comfort study: although the number of participants was small it is by far the richest set of data overall. The entire thesis could have been built around a highly detailed, fine-grained qualitative and quantified analysis of this one domain. However, this was not my approach. Instead, I aimed to capture and explore the diversity *between* different domains of practice and energy demand.

3. VARIATIONS IN COOKING: CHEFS, MEALS AND MODES

Cooking is often referred to as an exemplar social practice (e.g. Schatzki, 1996; Reckwitz, 2002; Warde, 2005; Shove et al., 2012, Warde, 2013). It is therefore a good place to begin my investigation of the relationship between, and the variations within, social practices and energy demand. There is a rich literature relating to food: both as an important aspect of social organisation and as an environmental concern. To date, however, this has included very little consideration of the ways in which home cooking represents a source of domestic energy demand. In this chapter, I describe the part of my research that does just this. I begin by sketching out the broad connection between the practice of cooking and energy consumption over the last 40 years and why a more detailed understanding of this relationship is important for an energy demand agenda. I then describe my methods and analysis and outline my findings which show that, as might be expected, different chefs use different amounts of energy when cooking. To understand these differences, I focus on the meals that were cooked, the associated methods and on the differentiated understandings of more and less proper modes of cooking. Finally, I return to consider the variation in performance between the participants in terms of ways of (dis)engaging with the practice through the different types of meals and modes of cooking.

3.1 Connecting Cooking and Energy Consumption

Cooking and food, more generally, has been problematised and researched in many ways. Within the social sciences, food-related research is diverse and fragmented, motivated over many decades by differing theoretical perspectives and substantive concerns such as nutrition and obesity (Warde, 2012). In particular, home cooking and meals have been discussed in relation to gender and power relationships, the symbolic roles of food in differentiating time, social occasions and class identity and how the preparation and eating of food have embodied broader social changes such as the fragmentation of collective, family modes of organisation (e.g. Douglas, 1972; Bourdieu, 1984; Charles and Kerr, 1988; de Certeau et al., 1998). It is evident that the organisation of domestic food has changed dramatically over the last 40 years. More recently, some explorations of these changes have been framed explicitly

in terms of social practices (e.g. Warde et al., 2007; Cheng et al., 2007; Halkier and Jensen, 2011). The general picture that emerges is one of a decline and disintegration of home cooking and meals, amid the growth of pre-prepared convenience foods, the changing roles of women, and increasingly individualised schedules. Whilst much of this research is concerned with meals, as social occasions, some specifically focuses on home cooking and uses interviews with home 'cooks' to explore contemporary practice, meanings and responses to wider social anxieties about health, cooking skills and sustainability (Short, 2006; Kaufmann, 2010; Halkier, 2010).

However, qualitative investigations into who cooks, how and when have not so far connected to the topic of domestic energy consumption. It is more surprising that neither energy research nor the substantial field of research into the environmental impacts of food seem to have paid much attention to cooking-related energy use. With respect to the latter, this may be because the energy consumed in the home is a small fraction of the environmental impacts related to production, distribution, manufacturing and retail of food (Garnett, 2008; Clear et al., 2013a). It is more mystifying as to why domestic cooking has received little interest in energy research beyond the health and financial problems posed by access to safe and affordable cooking fuels and technologies in developing countries (e.g. Pohekar et al., 2005; Anozie et al., 2007).

One reason why energy-related interest in cooking is sparse may be that such energy use has declined dramatically since 1970, at least in the UK (DECC, 2012). Based on modelled data (Energy Consumption in the UK (ECUK)) released annually by the Department of Energy and Climate Change, the total consumption associated with gas and electric cookers halved between 1970 and 2011 (DECC, 2012). This decline is even more dramatic given that population, the number of households and the unit number of ovens and hobs have grown steadily in that time. The average consumption of a domestic electric oven appears to have declined from 847 kWh/year in 1970 to 181 kWh/year in 2011 (calculated from DECC, 2012). At the same time, as shown in Figure 3.1, consumption by kettles and microwaves has increased, meaning that the absolute electricity consumption connected with *all* cooking devices has remained much the same (even as the number of households has grown).

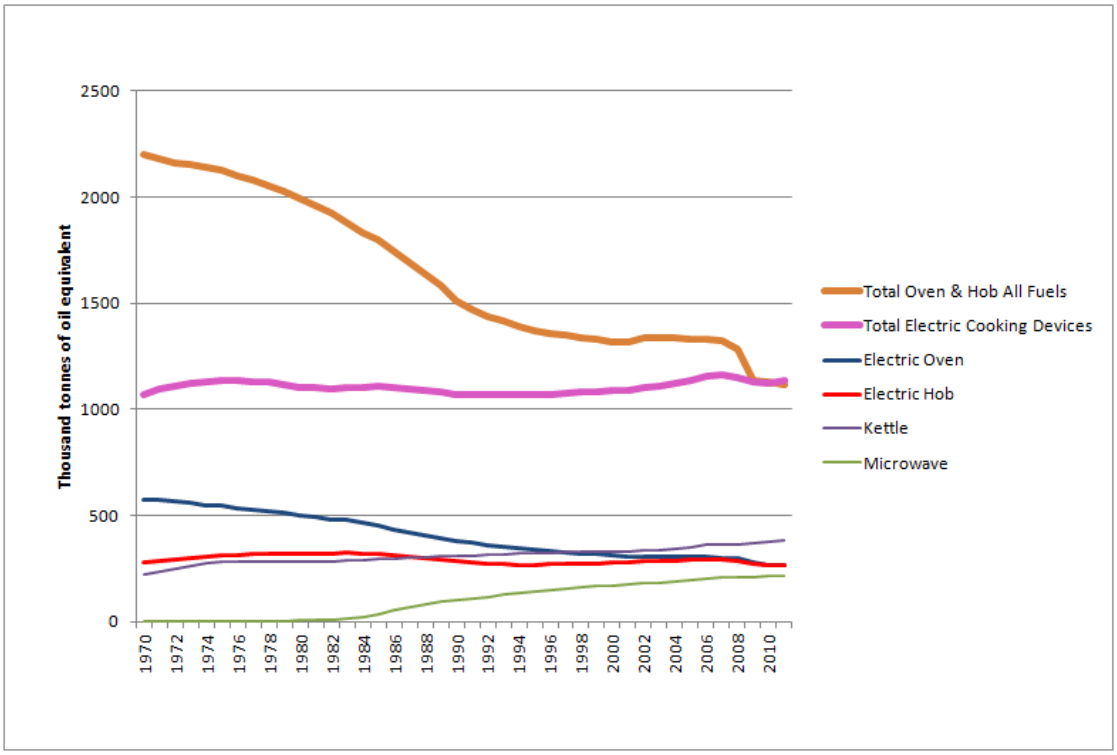


Figure 3.1 Total energy consumption of household cooking appliances. (Data from DECC, 2012).

These figures suggest that a radical change in how cookers are used has taken place, in a way that matches popular and academic narratives of decline in home cooking. For example, the duration of oven use cycles are thought to have fallen because of the "large increase in cooking of pre-cooked meals with cooking times typically ranging from 15 to 30 minutes" which is shorter than that required for "roasting meats which are believed to be less common than previously" (European Commission (DG ENER) 2011a: 44). However, as this quote indicates, there is very little in the way of empirical research that links the changes in cooking to the changes in energy consumption.

For energy research and policy-making, this lack of a more detailed understanding of cooking in practice could be problematic. Firstly, cooking appliances as a group are now roughly as significant by proportion of total household *electricity* consumption (16%) as wet appliances (18%), cold appliances (17%) and lighting (16%) (DECC, 2012). Moreover, monitoring studies suggest that cookers (and ovens in particular) may be a more substantial component of household consumption than the ECUK model indicates: accounting for 9.2% of total electricity use in the Home Electricity Survey (HES) of 251 homes (Zimmermann et al., 2012) compared to 7.5% in ECUK data (DECC, 2012). Secondly, with the exception of

heating, cookers cause the largest peaks in electricity demand for a household (Wood and Newborough, 2003) and this occurs during the hours of national peak electricity load, accounting for 30% of household power demand (the largest category) between 17:00 and 20:00 on winter evenings (Zimmermann et al., 2012). Thus, for most households without electric heating but with an electric cooker, this single appliance is highly significant both for load profiles and levels of total energy consumption.

In addition, without understanding how cooking is undertaken in practice and how it relates to energy consumption it is difficult to interpret past and contemporary consumption trends, to understand the impact of policy initiatives (e.g. peak pricing) and even to design efficient devices. For instance, when designing ovens it is "essential to use realistic cooking times" in the standard efficiency tests (European Commission (DG ENER), 2011a: 60). This is because for longer durations of use, better insulation increases efficiency but adds thermal mass which absorbs more energy into the oven lining than is efficient for shorter cooking times. If variations in oven-use are extreme, within and between different countries, this suggests that a variety of oven designs, rather than a single standard, are required to maximise technological efficiency.

In fact, research suggests that cooker use varies markedly between countries: a mixture of surveys and estimates indicated that households in Finland, France, Sweden and the UK use ovens more frequently (at 185, 150, 146 and 127 times per year respectively) than Italy (23) and the Netherlands (47) (Kasanen, 2000). Within the UK, cooking-related energy consumption also varies substantially between households. The HES monitoring study found that per household consumption across all cooking appliances, including microwaves and kettles, varied between roughly 50 kWh to 1,400 kWh per year (average 460 kWh) (Zimmermann et al., 2012); specifically, energy consumption of electric cookers (or ranges) varied between 20 and 1,300 kWh per year (average 317 kWh) and electric ovens between 30 and 850kWh per year (average 290 kWh). Such variation is usually attributed to "consumer behaviour" (European Commission (DG ENER), 2011b) but the nature of such differences is little understood beyond the apparently self-evident fact that some households cook *more* than others. To what extent this means cooking more frequently or cooking in a more energy-intensive way is unclear.

Although there have been a handful of studies of cooking-related energy consumption and some research into efficient cooking techniques, these do not provide much insight into how variations come about. For instance, the "substantial differences in rates of energy use" which Wood and Newborough (2003: 823) observed in a year-long monitoring deployment with 44 UK households were not of interest in this research, which instead was designed to evaluate ways of reducing energy use through energy feedback and information. In a similar way, Oliveira et al. (2012: 2123) report that consumption varied between 102 Wh and 282 Wh when UK students cook a packet of noodles in a "regular kitchen in their hall" under controlled and observed conditions. Yet the researchers did not explore why and how techniques varied but, rather, why all the participants "used more energy and time than needed" when compared to the most efficient technique for cooking a packet of noodles which the researchers had themselves experimentally developed (Oliveira et al., 2012: 2125). Other studies have taken a similar interest in lab-based experiments to define the most efficient techniques for cooking particular foods such as coffee, boiled eggs and boiled potatoes (Oberascher et al., 2011). Whilst such research illustrates the importance of how people cook for the resulting levels of energy consumption, it defines this relationship as a problem of efficiency. As the variations in cooker use frequency between European countries demonstrate, there is evidently much more to variation in cooking-related energy consumption than technique.

In summary, despite the decline in cooking-related energy consumption over the last four decades there are still very good reasons to learn more about this form of demand: it is a substantial component of household electricity use, it tends to occur at times of peak network load, and it appears to have changed dramatically in ways that have not been empirically evidenced. Not only is this interesting as a form of domestic energy use that has reduced without policy intervention, but the extent to which this reduction trend will continue, or otherwise, is very unclear. My research aims to explore the question of how contemporary cooking-related energy consumption varies in line with how people cook, not so much their techniques for cooking equivalent meals, but what they cook and how often. These differences allow me to develop some insight into wider patterns of consumption and change, which I explore in the next chapter. In the rest of this chapter I describe the methods and findings from this part of the research.

3.2 Investigating Cooking: Methods and Analysis

In Chapter 2, I introduced my methodological approach. In this section, I describe the methods specific to cooking in more detail. In this research, I adopt a procedural definition of cooking as the preparation of warm food and I limit my focus to the cooker. The exclusion of other cooking devices is in part pragmatic: it allows for a detailed investigation of the relationship between consumption and performances of cooking, mediated by a single device. But this device, the cooker, is of particular interest: it is especially important in the recent history of home cooking and is linked to a stark decline in energy consumption.

Methods

The research took place in the kitchens of four 8-person student flats within a hall of residence. Each kitchen had a very similar design with a single cooker, a microwave, two fridges, two freezers, a sink and a table in the centre of the kitchen with plastic chairs. The cookers themselves are electric and combine three components: an oven, the hobs (or burners) and a grill, located in a separate compartment under the hobs and above the oven. In total, there are six 'elements' or separate parts to each cooker, including the four hob-rings (two small, and two large). Three of the cookers were of an identical model, probably at least 15 years old; the fourth was the same make but of a slightly different, perhaps more recent, design.

There were 31 participants in total: 8 in three of the flats and 7 in a fourth (Table 3.1). Of these, 12 were interviewed. I also include in my analysis 2 interviews with residents in other flats from the preliminary stage of research (Duncan and Kate). All participants were undergraduate students, of mixed year of study and aged between 18 and 25. There were roughly equal numbers of male and female participants. I use pseudonyms to refer to the interviewees, I use colours to refer to the flats and codes to distinguish those participants whom I did not interview (consisting of three parts: the initial of the flat, whether they are male (M) or female (F), and a number indicating the order in which I identified them). I refer to the participants as 'chefs', in preference to 'cooks' (as used by Kaufmann (2010) and Short (2006)).

Table 3.1 Summary of participant numbers in the cooking-related research, by flat of residence, year of study and gender.

	Flat				Total
	Red (R)	**Yellow (Y)**	**Green (G)**	**Blue (B)**	
Total	7	8	8	8	31
Year 1	7	8	3	0	18
Year 2-3	0	0	5	8	13
F	3	5	3	4	15
M	4	3	5	4	16
Interviewees: F	Donna, Polly	Jess, Wendy	Leah	Miranda, Ellie	7
M	Aaron		Callum, Henry	Matt, Ian	5

The research took place over a number of weeks in March 2011. This was towards the end of the second term by which point the first year students would have been catering for themselves for several months. Cooking-related energy consumption is known to vary seasonally, being higher in winter than in summer (Zimmermann et al., 2012; Wood and Newborough, 2003). On this count, March in the UK falls at spring-time and thus should be a relatively 'neutral' period in which performances of cooking are neither heavily winter-like nor summer-like.

The doings, sayings and energy consumption associated with cooking were researched using a combination of methods. Interviews were used to collect and record participants' accounts of what, how and when they cook. They lasted from 35 to 75 minutes and took place mostly in the participants' kitchens. The interviews were semi-structured and were designed to explore different aspects of daily life; a section of questions on cooking featured as one part of this. Only participants who had opted in to the full study (including monitoring in study-bedrooms) were invited to participate in the interviews. Interviews were recorded and transcribed in full and analysed thematically using NVivo.

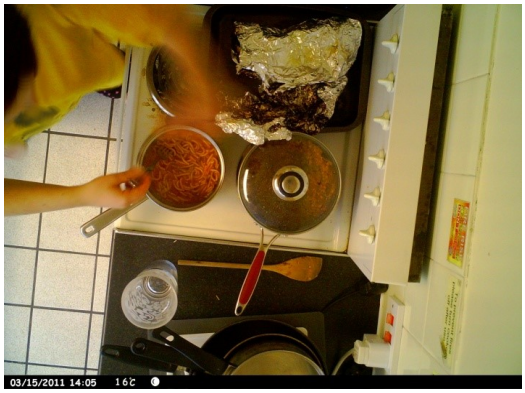
Cooker use within each flat was 'observed' using a motion-triggered, wildlife trail camera (or 'hobcam') fixed to the ceiling above the cooker looking down at the hobs (see Figure 3.2 for example images). The field of view included the control dials (located on a panel above the hobs) and a small margin of space in front of the cooker by which it could be determined if the oven door was open or if the grill was in use. For ethical reasons (consent), the field of

vision was intentionally constrained to limit any images connected to non-residents who happened to be in the kitchen. Images were only taken of people using or standing right next to the cooker and faces were not captured. The top of the head was photographed only *if* a person leaned over the cooker. On detecting motion, the camera took a still image and ignored any further motion for 30 seconds. Images were recorded on an internal memory card and automatically time-stamped. In low light conditions, the cameras took an infrared, greyscale image. This technique quite literally captures a series of snapshots of what participants are doing when they use the cooker.

3.2a) Red

3.2b) Yellow

3.2c) Green



3.2d) Blue

Figure 3.2 Example photographs taken by the hobcams in each flat. Picture 3.2c shows the infrared exposure mode.

A combination of techniques was used to derive energy use. The total electricity consumed in each flat was monitored (wirelessly) by recording the data from in-home OWL electricity meters and display systems that had previously been fitted. As the cookers were directly wired into the electricity supply, and fitted within the kitchen units, their electricity consumption was not directly monitored at source. Instead, the electricity consumption of

the cookers was estimated based on observed cooker use, according to durations of use and estimated power factors for the relevant elements. The power factors were derived from a previous analysis of the same data conducted by Adrian Clear (as part of a collaborative publication, Clear et al., 2013a) which matched cooker use intervals derived from the photographic record to the total electricity consumption of the flat, subtracting a baseline consumption (30 minutes prior to and after cooking) to approximate the additional load during periods when the cooker was known to be in use. For my own analysis, I selected a sample of these calculations for specific instances in which a single element was in use and in which the interval times closely matched those derived from my own annotation of the hobcam record. Thus, based on recorded consumption figures, I derived an estimate of the average power of the oven, grill and hobs in use. For the hobs, I differentiate between the large and small hob-rings and between three observed methods of cooking (boiling, frying and warming-up). As Table 3.2 suggests, these average power factors may produce under-estimates for some uses (oven and maximum hob settings) and over-estimates for others (gentle warming), but overall they are not too dissimilar to cooker consumption figures presented elsewhere.

Table 3.2 Average estimated power for each element of the cooker. Compared with actual power measured by Oliveira et al. (2012) and with figures compiled by Wood and Newborough (2003), both for cookers in the UK. (In France, an average in-use oven power of 1.2 kW has been reported (Sidler, 1999, cited in European Commission (DG ENER) 2011c).)

Element	Estimated Average Power (kW)	Oliveira et al., 2012 (kW)	Wood and Newborough, 2003 (kW)
Oven	1.422	-	1.75 - 2.5
Grill	1.728	-	1.4 -2.9
Big Hob, Boiling	1.236	1.3 - 2.1 (setting 5/6)	-
Big Hob, Frying	1.182	0.9 (setting 4)	-
Big Hob, Heating	0.78	< 0.3 (settings 1-3)	-
Big Hob	-	-	1.6 - 3
Small Hob, Boiling	1.14	0.7 - 1.4 (setting 5/6)	-
Small Hob, Frying	0.96	0.5 (setting 4)	-
Small Hob, Heating	0.78	< 0.3 (settings 1-3)	-
Small Hob	-	-	1 – 1.5

Analysis

Over a period of 21 days in which hobcams were installed in all the kitchens a total of 11,577 photographs were generated. Within this, I selected a one-week period for detailed annotation (4,362 photos, 12-18 March). This involved three main stages: to identify the chefs, to identify the meals being cooked, and to detail the timing of each elements' usage to estimate the energy consumed. This was logged in a spreadsheet whilst the photographs were manipulated and labelled using the photo management software, Adobe Lightroom.

Learning to identify the individual chefs (something not undertaken in the analysis for Clear et al., 2013a) was difficult. The hobcams very effectively removed any easy or normal means of identifying people: faces were simply not visible. But by paying close attention to features on hands and arms, clothes, hair and other objects that chefs had with them, I was able to build hypotheses as to the set of features which distinguished one chef from the other 2 to 5 males or females in each flat, which I continued to revise as I began annotating the meals. Only after analysing the photographic record in detail and annotating all the meals for the week, was I able to decide which of the chefs I had interviewed. Their own accounts of the types of meals and ways they cooked were used, as was my knowledge of their basic physical characteristics such as hair colour. For 10% of the meals it was not possible to identify a particular chef: most of these (7%) occurred in the flat with the highest tally of meals (Yellow).

The meal annotations included a description of the meal, the chef(s) involved and brief notes on the cooking process. As I define it, a single meal may include a number of servings shared between people at the time or eaten later. In total, 216 meals were observed in the four kitchens, including 11 unidentifiable oven-cooked meals (which I refer to as Something Baked) and 1 unidentifiable grilled meal (Something Grilled). Most of these 12 meals were cooked by unidentifiable chefs. In addition, 3 further meals included something unidentifiable, cooked in the oven, as well as other identifiable foods cooked on the hobs. In the final stage of annotation, I conducted a more detailed analysis of cooker use, noting precisely which elements are used and the times they are turned on and off. This allows me to estimate the energy used.

Limitations

Although considerable time and care was taken in the analysis of the interviews and the photographic records, there are limitations to both sets of data. Cooking was only covered as part of the interviews; yet it could very easily have been the topic of a series of interviews. This was because the research was also designed to cover the use of ICE-devices, routines and other aspects of daily life. Also, the hobcam record and data generated from it are not an entirely accurate or full record of the cooking that took place: a) the energy estimates are indifferent to the precise settings used since these could not be seen from the hobcam images (not too much of a concern since I am interested in comparing the different meals cooked rather than the technique used for the same meals); b) a small number of deductions were necessary as to when cooker elements were turned on and off, due to the intervals between the photographs; c) meals may have included other items added away from the cooker, possibly cooked with other devices; d) I am not 100% confident of chef identity in one flat (Blue) where there were more female chefs than there were residents (I have assumed that the residents are those who cooked by themselves at least once); and e) not all the meals could be identified and not all could be attributed to particular chefs.

To compare the chefs I have worked with a sub-set of the meals that could be attributed (set J). From the total set of 216 meals (set T), this excludes 21 unattributed meals. Of these, three meals were unique, joint undertakings between two or more participants, and I have further excluded these from the between-chef comparisons to avoid unrealistically 'splitting' the energy consumption. This arrives a sub-set (set A) of 192 meals (89% of the total) which can be fully attributed to individual chefs. This still includes groups who jointly cook more frequently: several apparent couples (of resident and non-resident) where I denote the resident as 'head chef' and a group of three residents who cooked together but in which one did most of the cooking, GF2, to whom I attribute the meals. On this count GM3, who did not cook independently but did take part in joint cooking with GF2 is not included in set A. Because of these exclusions and cross-overs, the comparisons that I conduct between the chefs are not completely accurate. In particular, the precise ranking of chefs from high- to low- consumption and the frequency of cooking might be different in a perfectly observed dataset, especially since many of the excluded meals are oven-cooked meals from one flat (Yellow) which may have been cooked by just one or two chefs (most likely YM3, YM2,

YM1 or YF3). However, since I use comparisons between the chefs in order to understand more about the relationships between cooking performances and energy consumption, and because I do this in conjunction with an analysis of the whole set (set T), it is not of too much concern if a small number of the chefs are misrepresented in the relative ranking.

3.3 Comparing Energy Consumption Between Chefs

To present the findings, I begin by summarising the cooking performances and variations in energy use between the chefs, (this section) and between different types of meal (section 3.4) as observed in the photographic records. Drawing in data from the interviews, I then explore variations in the ways that cooking is understood and approached generally (section 3.5) and between the chefs (section 3.6). First of all, I briefly summarise the overall nature of cooking and energy consumption.

On average, each cooker was used **54 times** during the week (range 38-78) and consumed **28.7 kWh** (range 25.4 – 34.7 kWh). This accounted for **14.9% of the total electricity** consumed in the flats in that period (ranging from 9.5% in the highest overall consuming flat (Blue) and 21.3% in the lowest (Red)). Compared to the 158 cookers monitored in the HES research for which the average consumption was an equivalent of 8.7 kWh/week (Zimmermann et al., 2012), estimates in the current research are notably higher. From socket monitoring of the other appliances in the kitchen, we can see toaster electricity consumption was also higher, whilst microwave and kettle consumption were roughly equivalent to the HES averages (see Table 3.3). As with the HES results, the cooker consumption was higher than for other cooking appliances, but in this research, the proportional difference is greater. The comparatively high consumption of the cooker is related to the fact that they are shared by 7-8 adults (much larger than the average household size in the HES study). On a per head basis, for an average of **7 meals per chef** the weekly consumption estimate is **3.7 kWh per person per week** and this actually compares well to the HES study, falling between the average for two-person (2.9 kWhpp approx.) and single-person households (6.2 kWhpp approx.). In other words, the average per head cooker electricity consumption, as estimated in this study, is not extremely unusual.

*Table 3.3 Average electricity consumption of cooking and cold appliances in the current research compared to HES (Zimmermann et al., 2012). The proportion of total household electricity consumption is also shown. *upright freezers; †there are no wet or heating/cooling electrical appliances in the flats; ‡ HES figures include wet appliances and water heating but exclude heating.*

Device	No.	Average Consumption (kWh/week)	% of Total†	HES: Average Consumption (kWh/week)	HES: % of Total‡
Cooker	4	28.7	14.9	6.1	8.7
Microwave	4	1.4	0.7	1.1	1.5
Kettle	2	3.1	1.6	3.2	4.6
Stand-alone grill	1	1.5	0.8	0.2	0.4
Toaster	4	1.3	0.7	0.4	0.6
All Cooking Appliances	-	34.5	18	9.7	13.8
Fridge	8	1.9 (3.8/flat)	2.0	3.1	4.5
Freezer	8	5.0 (10/flat)	5.2	6.3*	9.0
All Cold Appliances	-	13.8	7.2	11.3	16.2

However, considerable variation underpins these average figures (Table 3.4). There is a large variation in energy consumption to the effect that the most consuming 25% of chefs consume just over half (52%) of the total electricity, which is 10 times as much as the least consuming 25%. The number of meals cooked by each chef during the week ranges from 1 to 13, which is not quite as variable as energy used. The modal number of meals (6) resembles the mean (6.6, Set J). Yet we should not assume that these meals are distributed evenly on a one per day basis: only 30% of the chefs cooked on 6 days of the week including only two (RF1 and GM2) who cooked something every day. On average, chefs cooked on 4.2 days of the week (mode=4, range=1-7, SD=1.6, Set J) and on these days the average number of meals prepared was 1.5. In other words, the number of meals cooked by a chef reflects multiple meals during a day as well as across different days: this suggests it is not just 'main' meals that are being cooked.

Table 3.4 Average number of meals and energy consumption per chef during the week.

	Total (Set T) (n=216)	Identified & Joint (Set J) (n=195)	Attributable Set (Set A) (n=192)		
Per Chef	**Average**	**Average**	**Average**	**Range**	**SD**
No. Meals	7	6.6	6.4	1-13	3.5
kWh	3.7	3.36	3.34	0.1-10.9	2.7

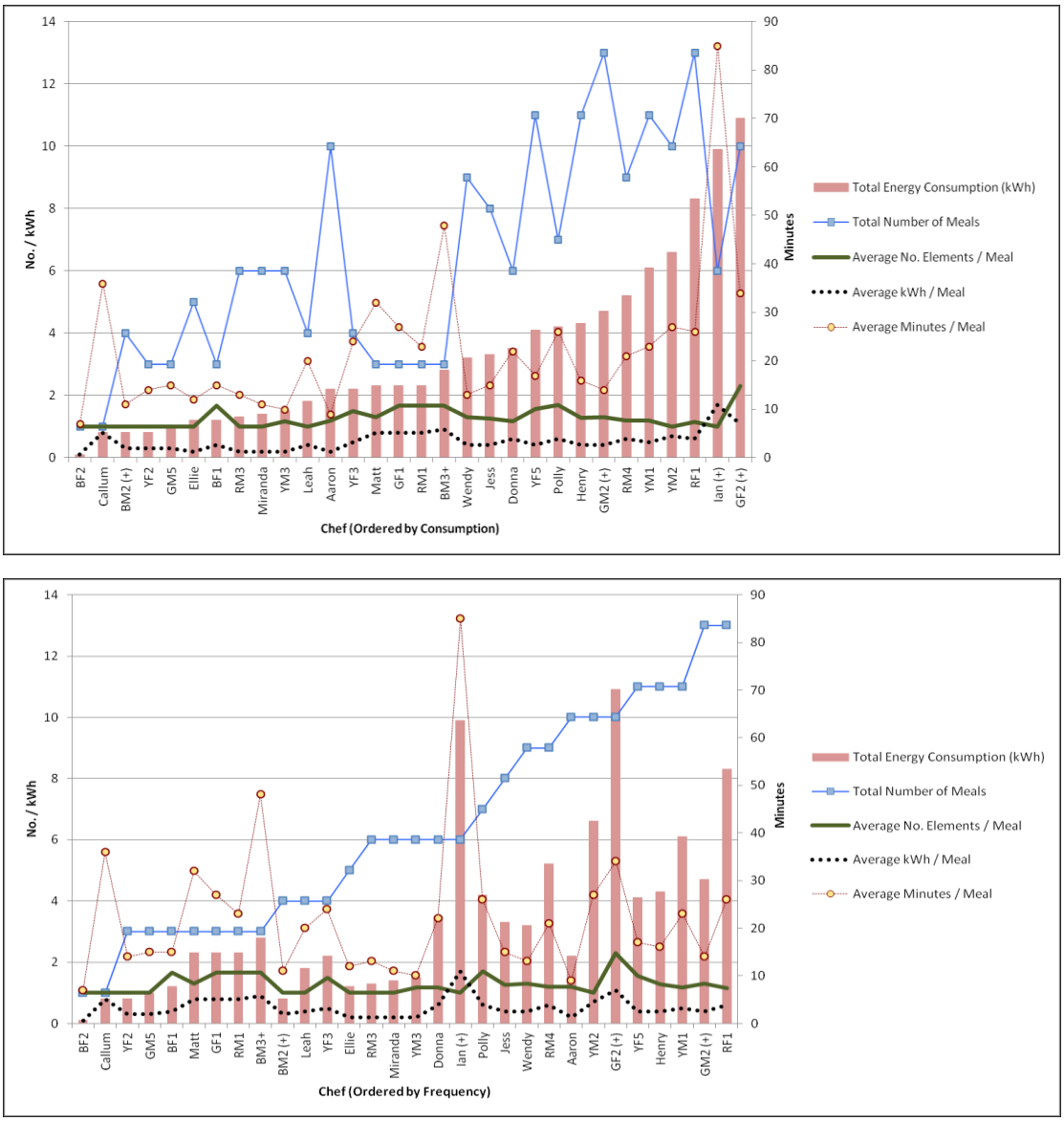
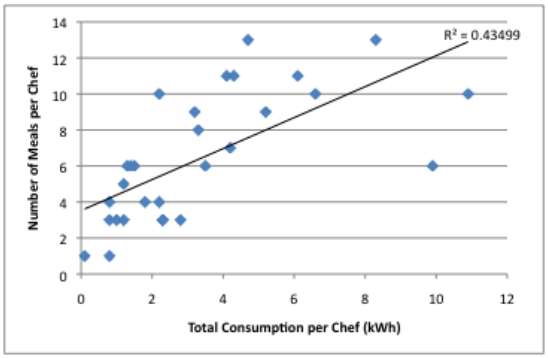


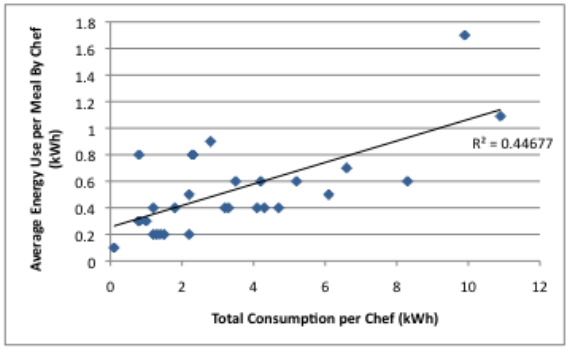
Figure 3.3 Total energy consumption, number of meals and per meal averages for consumption, duration and elements used by each chef. Ordered by energy consumption (top) and cooking frequency (bottom) (Set A).

The frequency of cooking is clearly implicated in the differences in energy consumption between the chefs. As can be appreciated in Figure 3.3 and 3.4a, those chefs who cook more frequently tend to use more electricity during the week. But frequency does not entirely determine consumption. Rather, the frequency of cooking best appears to sort the lowest consuming half of chefs from the higher consuming half. Some chefs in particular buck the trend: Aaron cooks a relatively high number of meals (10) resulting in relatively low electricity consumption (2.2 kWh) whilst Ian cooks a more average number of meals (6) but uses much more electricity than most (8.8 kWh). GF2, similarly, uses notably more electricity during the week than a number of chefs who cook more frequently. Beyond frequency, it also appears

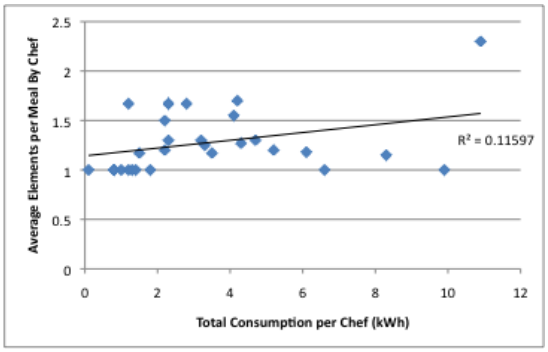
that those chefs who use more electricity, tend to cook meals that are more energy-intensive (Figure 3.4b). In particular, this appears to be associated with longer periods of cooker use rather than with using a higher number of cooker elements (Figure 3.4c and 3.4d). Indeed, the average duration of cooker use per meal roughly moderates the relationship between frequency of cooking and consumption: that is, where frequent chefs, like Aaron consume relatively less electricity in their cooking than might be expected, this is because they cook relatively shorter meals on average, and vice versa, where less frequent chefs, like Ian, consume more than might be expected, this is because they use the cooker for longer when they do cook. But since the average frequency and duration of cooking per chef are themselves not correlated (r^2=0.007) both are independently important in the differences in total energy use between the chefs.



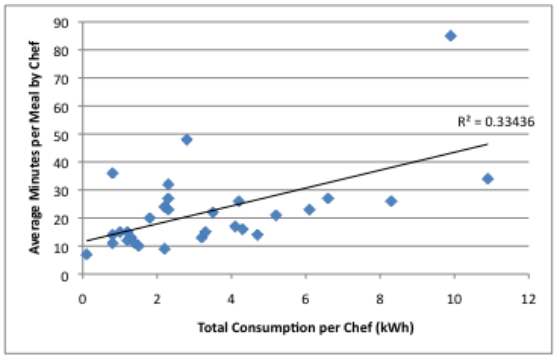
3.4a) Frequency



3.4b) Per Meal Consumption



3.4c) Elements Used



3.4d) Cooking Duration

Figure 3.4 Relation between total energy consumption and frequency, per meal cooking duration, elements used and energy consumption per chef (Set A)

3.4 Comparing Meals: Cooking Duration and 'Complexity'

I consider the frequency of cooking later (section 3.6). In this section, I focus on the features of per meal energy-intensity, in particular how and why durations of cooker use vary. To do this, it is necessary to shift focus to the meals themselves.

Cooking produces meals, both in the sense of the physical food that is to be eaten and the event of eating; I refer here predominantly to the former. If cooking is defined as a social practice, performances can be understood as integrations of many, various elements: foods and the methods, materials and skills required for cooking them as well as understandings about what meals can and should be produced in particular contexts. In this sense, meals and their production are the basic 'units' of cooking performance. Between performances these elements and their inter-relationships may vary, both over time and between practitioners. To start to explore how these variations are implicated in the overall patterns of energy use between the chefs, I now consider the relationships between energy use and cooking methods, types of meals and time of day across the whole set of meals (set T).

Hob- and oven-based cooking

Different foods, and the meals they make, are cooked using different methods such as baking, grilling, boiling, frying and warming up. These methods use different components of the cooker (the hobs, oven and grill) and have differential consequences for energy use. Across the four cookers, the hobs are used twice as often as the ovens, yet consume 12% less electricity (Table 3.5). This is not because the oven has a higher power per use than the hobs (since, as a component, more than one hob-ring is often used at a time), but because each oven use is longer, in fact, over twice as long on average (36 compared to 14 minutes for the hobs). Indeed, only a quarter of oven uses took less than 23 minutes, the average duration for cooker use as a whole, whereas only 11% of hob and 6% of grill uses took longer than this. Thus, oven baking is particularly significant for energy consumption patterns because of the longer duration compared to typical grilling or hob-based methods.

Table 3.5 Energy consumption, number of uses and power for the cooker components (set T)

	Total kWh	Total uses	Average minutes / use [SD]	Min duration (mins)	Max duration (mins)	Wh / use	Power / element (W)	Power / component (W)
Hobs	44.45	130	14 [16.6]	1	187	342	780-1236	1466
Oven	50.47	59	36 [26.1]	4	181	855	1422	1422
Grill	19.66	52	13 [7.0]	3	43	378	1728	1728

Whilst the number of elements used in cooking does not strongly differentiate the higher and lower-consuming chefs, it is nevertheless important when comparing the energy consumption meal by meal. The combination of multiple elements to cook more 'complex' meals results in higher energy consumption (an average of 897 Wh for multi-element meals compared to 507 Wh for single-element meals). Even though such multi-element meals are relatively infrequent, accounting for only 24% of meals, they represent 33% of the total energy used in the week. One combination of components, in particular, was infrequent but energy-intensive: the 5% of meals prepared using the oven and hobs (one or more hob-ring) accounted for 12.8% of the total electricity consumption (Figure 3.5). But since multi-element combinations including the oven are relatively infrequent overall, most oven-consumption occurs when the oven is used by itself. Indeed, this is the single most energy-consuming method of cooking. But what are these meals?

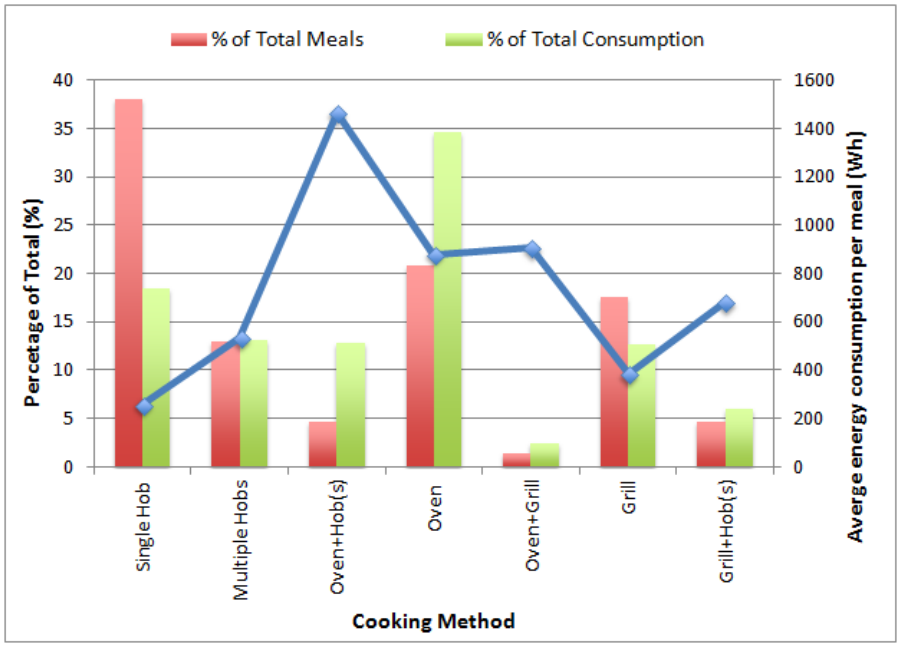


Figure 3.5 Combinations of cooker components used to prepare meals, as a percentage of total meals and energy consumption (set T).

Types of meals and energy intensity

To describe the meals cooked during the week, I have categorised them largely according to the meat or animal product 'centre-piece' (following Douglas, 1972), with an exception for self-contained meals such as pizza and soup and for pasta which appeared so frequently as to warrant a category of its own. In Figure 3.6, which shows the frequency of each general category, I have also grouped together the 'sandwiches' (mostly sausages or bacon cooked by themselves (when visible, these were often seen to be made into sandwiches) and cheese on toast). Considered together, these 'sandwich' meals were the most frequently cooked category (22%), closely followed by pasta (17%) and chicken meals[2] (15%). Together these three categories account for roughly half of all meals. Soup, pizza, potatoes / chips (served without meat), and other unidentified baked foods are also fairly frequent, each accounting for roughly 5% of the meals. Thus, there appear to be some widely shared and significant meal ideas (sandwiches) and foods (bread, pasta and chicken) in the observed cooking performances.

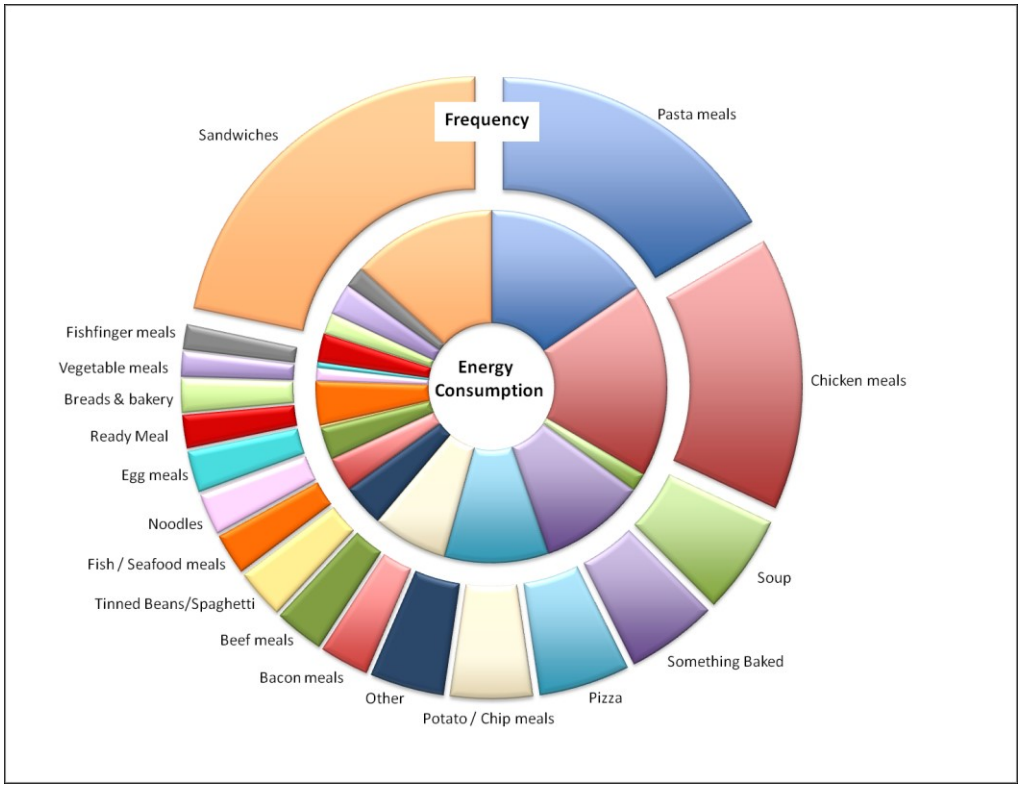


Figure 3.6 The proportion of meals and energy consumption as categorised into meal types (set T).

[2] Turkey is also included in the chicken category.

Energy use overall is also dominated by the same 7 most frequent types of meal, but the proportions change. Sandwiches and soup account for a lesser proportion of energy consumption than they do the number of meals, whereas pizza and unidentifiable baked foods account for more (Figure 3.6). As can be seen in Figure 3.7, pizza and the unidentified baked meals, are amongst the most energy-intensive types of meal (1,000 Wh per meal on average), compared to soups (159 Wh), sandwiches (325 Wh), and even pasta (494 Wh) and chicken meals (616 Wh). The three most energy-intensive meal categories are, not surprisingly, those that tend to be oven-baked or are skewed by a minority of meals that are baked for long periods (e.g. a single tray of roast vegetables). In contrast, those meal types with lower average energy consumption per meal tend to be cooked on the hobs (tinned spaghetti and baked beans, eggs and soup).

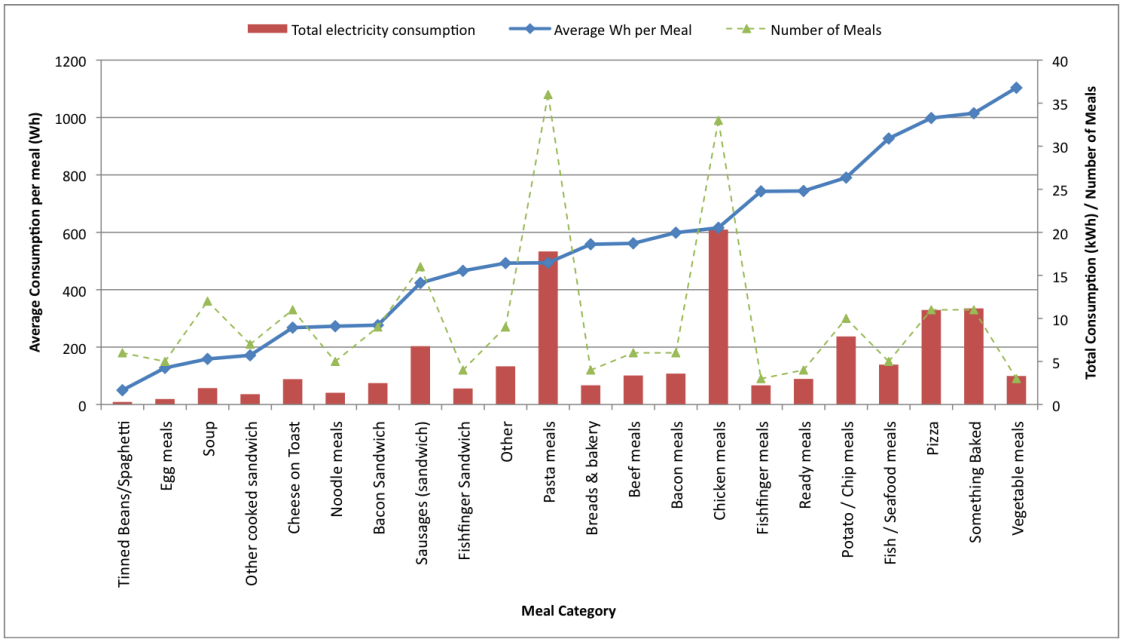


Figure 3.7 Energy-intensity and overall portion of electricity consumption by type of meal (set T).

Although these meal categories are useful for comparing types of meals and methods, there are important variations within many of these categories. Soup, in particular, is a diverse category which includes dumpling soups, rice soups, noodle soups, seafood soup, some kind of milk-based soup as well as tinned and carton soups; consumption ranged between 52 Wh for the tinned soup and 279 Wh for a dumpling soup. Some of these appear to be Chinese and Polish forms of soup. Pizza meals can take between 17 minutes and an hour and a half for a home-made pizza (a range between 400 Wh and about 2,000 Wh). Pasta meals, on the

whole, consist of boiled pasta often with some kind of sauce, cooked using one or two hobs (average 345 Wh and 16 minutes, n=31) but one takes just over three hours (2,431 Wh). In addition, some meals within the categories are cooked using a combination of methods that others do not require (Figure 3.8). For instance, some pasta meals are also prepared using the oven, most likely for a garlic / flat-bread accompaniment (average, 1,335 Wh, n=3). Chicken meals also vary: some are cooked on a single hob (fresh chicken or turkey, fried with seasoning (and onions), average 222 Wh, n=7), some are cooked in the oven (kievs or nuggets with chips or potato waffles, average 818 Wh, n=8) and some use both hobs and oven (curry, rice and naan, average 893 Wh, n=2; baked chicken fillet with boiled potatoes and peas, 2,136 Wh). Thus, the patterns of differential consumption between oven and hobs and between more 'complex', multi-component meals and single-component meals are played out within as well as between the broad meal categories.

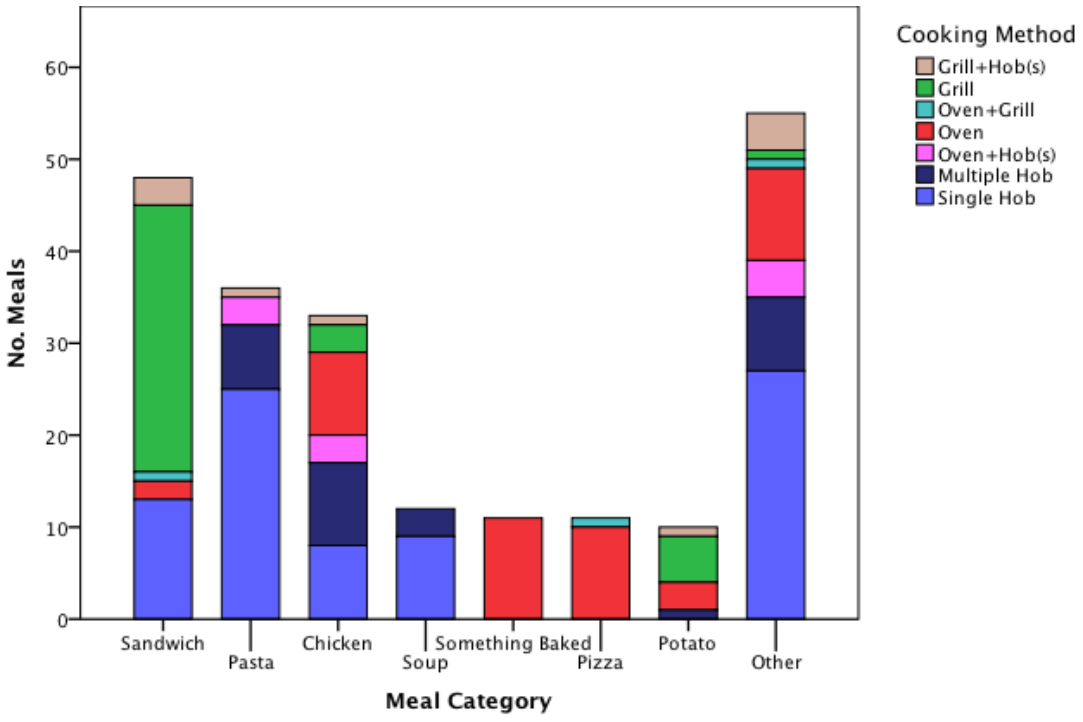


Figure 3.8 Cooking method combinations used for the meals in the most frequent categories (set T).

The variation in energy intensity between meal categories, and within them, indicates that the type of meal is clearly significant to patterns of energy consumption. In particular, some meals require foods to be baked whilst other meals can be achieved quickly with one or two hobs. Most of the visible baked foods were pre-prepared and potentially frozen products that were eaten on their own or combined with other oven-cooked foods. A greater variety of foods

were cooked on the hobs but many are also pre-prepared. Thus, the difference between oven and hob cooked foods is not simply the case that one depends on pre-prepared, convenience foods whilst the other does not. However, those foods cooked in the oven do appear to be more self-contained and require less input from the chef.

Oven-cooking tends towards longer cooking times because that's how foods are baked or roasted, but it also seems more open to co-ordination difficulties that can further extend cooking duration and hence the energy consumption associated with oven-cooking. There is only one example of a meal in which a hob was left on for a prolonged period when the chef was seemingly absent (Ian boils dry pasta, adds a jar of pasta bake sauce, then serves and eats some, leaving the rest on the hob for the next three hours before returning to eat some more[3]). But there are several more examples of long oven uses without the presence of the chef and even the food. In at least 2 of the 6 meals which use over 2 kWh, a lengthy oven 'pre-heating' period was observed, that is, the oven was turned on a long time before the food was introduced. Ovens can also be left on after use. When meals are more complex in cooking or preparation, when they require ovens to be preheated and when cooking is a less-involving process, as it is with many oven-only meals, longer uses may result than specified by the type of meal alone. As indicated, this appears to especially affect oven cooking.

Evening Cooking Takes Longer And Is More 'Complex'

Cooking performances vary over the course of the day. On average, meals cooked in the evening are more energy-intensive because they take longer and use more cooker elements (Table 3.6). The greater duration appears to be related to an increase in the relatively small number of meals that take over an hour to cook rather than an increase in the proportion of meals that require the oven. In fact, the combination of oven and hobs, the most energy-intensive combination of multiple cooking components, is only observed in the evening.

Most of the 10 meals prepared with this combination of oven and hobs are essentially hob-cooked meals with the addition of an oven-baked component like a flatbread or chips. Only on two occasions are (what I identify as) the main components cooked in the oven: chicken

[3] This outlier of 2,431 Wh may be a substantial overestimate if the hob was on a low setting and if the power is less than 0.3 W as Oliveira et al. (2012) indicate.

fillets and a pie, both with boiled vegetables. Thus, even though these meals are more complex in the sense of combining more ingredients, they are mostly meals that might be prepared on other occasions with just two hobs.

Table 3.6 Number of meals, energy consumption and cooker component use by time of day (set T)

	Time period	n	Average Wh / meal	Average minutes / meal	Average elements / meal	% of meals involving		
						Oven	Grill	Hobs
Breakfast	03:30-11:29	25	401	18	1.16	8	32	64
Lunch	11:30-14:29	49	361	16	1.18	14	26	65
Late Lunch	14:30-17:29	34	472	19	1.24	26	15	59
Evening Meal	17:30-20:30	62	622	25	1.48	37	8	66
Late Evening Meal	20:30-03:30	46	697	28	1.26	30	30	46

The type of meal cooked varies throughout the day, more generally. As Figure 3.9 illustrates, 'sandwiches' were most popular during 'lunch-time' and account for about 40% of the meals prepared between 12:00 and 14:00 but were less frequent in the evening, when more chicken and pasta meals were prepared. Soups, like sandwiches, were mostly prepared earlier in the day (83% were served before 14:00). On the other hand, baked foods, including pizzas were cooked for later lunches and throughout the afternoon and evening. In other words, the temporal patterning of the type of cooking does, to some extent, follow cultural expectations that lighter, less structured meals such as sausage sandwiches or soup characterise 'lunch'-times whereas more substantial or more structured meals, such as pasta or chicken meals characterise the evening meal, suggesting this is most often the 'main' meal.

Overall, Figure 3.9 shows that although cooking can take place at almost any hour of the day it most frequently happens in the early evening (with a serving time between 18:00 and 20:00) and in the middle of the day (12:00-14:00). However, in electricity consumption there is no secondary lunch-time peak. The type of meals cooked helps to explain this, in particular the high frequency of low intensity meals such as sandwiches and soup at lunchtime.

Considering the apparent flexibility of the student schedule, which may shift from day to day, the peak in cooking performances in the early evening between 17:30 and 20:30 is perhaps

surprising. It may reflect the fact that, cooking in the evening was valued by the interviewees as a way of spending time with flatmates and friends. Many explicitly aim to cook when others are cooking in the evening, for example Leah reports that "we'll all cook together, I mean if we know that someone's gonna like be eating something soon we'll all cook about six o'clock-ish… seven, something like that yeah". Wendy agrees: "most of us always eat dinner around five, six and we'll eat in the kitchen. Even if we don't plan it we'll find that we're all in the kitchen at the same time eating". This does not mean that they share meals or share the cooking, however, as Duncan describes "we all cook individually, yeah, but we share the time". For these participants, early evenings are a time for eating and coming together, even if the cooking process and the content of the meals is individualised, and even if this confluence of chefs makes access to the cooker more difficult.

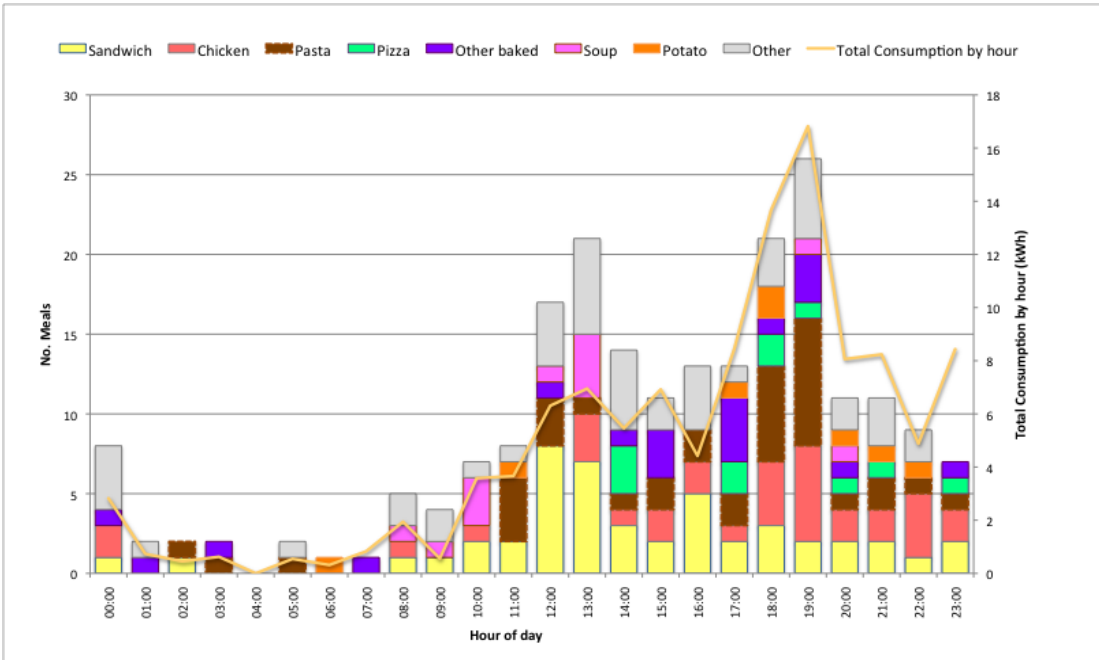


Figure 3.9 Number of meals in each of the most frequent categories and total electricity consumed by serving hour for the whole week. Note: 'Other Baked' includes identifiable and unidentifiable baked meals (set T).

In summary, having identified that chefs who cook longer and more 'complex' meals consume more energy when cooking, we can now better appreciate how and why. Longer meals are associated with oven use, which in turn is associated with particular types of meals, such as pizza and meals involving ready-made products such as chicken kievs, fish-fingers, chips and breads (many of which are potentially frozen). These foods are also cooked as part of some of the more intensive combinations of cooker elements, involving the oven and

hobs, which featured in evening cooking. We also saw that, more generally, the oven is used more frequently in the evenings than other times of day. Meals such as soups, sandwiches, pasta and stir-fries that can be cooked quickly using a single hob (or even the grill) tend to be the least consuming, and some of these also appear to be 'main', evening meals. Thus, for understanding cooker-related energy consumption, it is important to understand *what* is being cooked.

3.5 Modes of Cooking

I now turn to consider an important differentiation in cooking performances, and the meals, that emerged in the interview data. This is the distinction between more and less 'proper' forms of cooking. As I found out, to talk about cooking can be difficult because the term has different meanings. Short (2006), in her study of domestic cooking in the UK, identifies how the term is used in different ways often within the same sentence. Cooking can simply mean the process of applying heat to food, the task of preparing something to eat or it can connote the gendered, provisional role of preparing meals for others. But the distinction of which her informants were most aware was between everyday cooking ("things that are easy and straightforward during the week") and "proper cooking" ("at the weekend we try and *cook*") (Short, 2006: 28). This distinction was also clear in Kaufmann's qualitative research with cooks in French households. Everyday meals were cooked as quickly as possible, representing a way of cooking that belongs to a different world than cooking for pleasure or out of a passion. As Kaufmann puts it "there is cooking and there is cooking" (2010: 159). Again, it was often the weekly cycle of work and weekend over which this distinction played out. In the current research, the distinction between weekend and weekday cooking was not so clear: both in participants' accounts, since many of the participants spent more time away from the flat at weekends, and in the photographic record, since I have only analysed one week. However, different understandings and ways of cooking that reflect the distinction between easy and more proper forms were nevertheless evident.

To the extent that 'proper' cooking is defined by 'proper' meals, in the sense of traditional British cuisine, there is very little sign of such cooking in this research. In describing how

working class families eat in the 1970s Douglas and Nicod (1974) define a meal as a structured, social event at which food is consumed following rules concerning the timing, place and the combinations and sequences of foods served. In particular, they identified a tripartite structure that defined a 'meal': a staple carbohydrate (potato), a centre-piece (meat with one or two additional vegetables) and dressing (gravy) (Douglas and Nicod, 1974; Douglas, 1972). Murcott (1982) also found this 'cooked dinner' format of meat, potatoes and vegetables to be a regular and important feature of working class evening meals. In the current research, only one meal during the week combined meat (a pre-prepared, frozen chicken breast in sauce) with potatoes (boiled) and vegetables (peas) and a handful of others consist of meat and vegetable combinations (gammon and cauliflower, chicken breast and mixed boiled vegetables, steak and chips). For the most part, the meals, even in the evening, are relatively simple, produced from combining a few ready-to-cook ingredients: pasta and a jar of sauce, frozen foods such as chicken nuggets or fish-fingers with chips, fresh chicken fried with a packet of seasoning or a jar of sauce. Other meals, like pizzas and soups, are entirely self-contained and require no combinations. Yet it could be argued that many of these apparently simple meals, which depend on relatively new food products, still conform to the "essential structure of the British meal" with meat, carbohydrate and vegetable components (Wood, 1995: 99). The essential difference is that the process of combining these components now mostly takes place elsewhere. The overall result is what many interviewees themselves identified as 'simple' forms of cooking ("just like really simple stuff" (Ellie) or "all simple things" (Ian) or "simple stuff like cauliflower cheese and pasta bakes, all those really easy things" (Donna)).

In describing their cooking as simple, participants imply an understanding that other more complex and perhaps 'proper' forms of cooking are possible. For some, this also implied that the simple forms of cooking they did undertake did not qualify as 'real' cooking. Miranda and Ellie both claim not to cook for themselves: "I don't usually cook for myself" (Ellie); "I don't like to cook for myself because it's just a lot of effort" (Miranda). But both were observed to use the cooker by themselves 5 to 6 times during the week. For Ellie this included some fried sandwiches and pasta meals whilst Miranda's cooker-use included a lunchtime pizza, two evening pasta meals and some tinned spaghetti. But since she does not prepare these meals and since they are not "big meals for the evening", she similarly did not consider this activity

to be cooking. Microwaved meals may also be considered as "cheat food" (Donna). This captures the sense that 'real' cooking involves some kind of effort and preparation on behalf of the chef, which is absent when simply warming pre-prepared foods. In contrast, 'real' cooking might take place on special occasions and involve cookbooks and recipes: Ellie was the only chef observed to use a recipe during the week when making pancakes with another resident, and Miranda refers to "work[ing] through the student's cooking guide" when she cooks with her friends, at their flat, once or twice a week. Similarly, Polly thinks she is a "good cook at home", that is, at her family home where life is less frantic than on campus and where she has the opportunity to cook. Since Polly also uses the cooker for several meals during the week, the implication is that she has more opportunity to engage in what she sees as more proper forms of cooking at home.

These accounts indicate multiple understandings of cooking, in which a distinction is made between procedural, simple forms and more effortful and proper forms, echoing the findings of Short (2006) and Kaufmann (2010). These multiple understandings at times made it difficult to talk about cooking. For example, after Ian describes how he cooks something every day for lunch and dinner, I ask him if he *likes* cooking, to which he responds that he doesn't bother very often:

> I: Ok, and do you like to cook?
>
> Ian: Erm yeah, it's just a bit annoying when there's just such a mess, so just, we don't bother very often, um yeah
>
> I: What, to come into the kitchen, and ..?
>
> Ian: Well, I do cook everyday, something, but nothing special or… you know, it might be pizzas, or we make our own fresh pizzas
>
> I: You don't make a special occasion out of it?
>
> P: Oh, occasionally, like, the girlfriend will either cook or we'll cook together and make something nice but it's no-, let's say once every two weeks we'll do so-, you know, proper cook but other than that we always cook you know, fajitas or something easy like that.

Here, routine, everyday cooking is distinguished by not being "special" or "nice", just "easy". "Proper" cooking is less frequent, more complex and undertaken with others, such as a

girlfriend. It also seems to be something that might be *enjoy*-able in itself, as evoked by my question about liking to cook. This may well be the understanding of cooking that is being enacted when Ian is observed to cook a home-made pizza (when an unfamiliar female foot, possibly belonging to his girlfriend, also appears in shot).

That cooking can be, but is not always, a domain for enjoyment, relaxation and personal validation has been linked to the growth in gastro-entertainment and celebrity chefs who promote particular ideals and images of cooking, setting it apart from routine forms of cooking that use pre-prepared products (Short, 2006)[4]. Those who recognise this distinction include chefs who routinely avoid proper, enjoyable forms of cooking, as Miranda and Ellie do. Likewise, Jess cooks something for herself almost everyday, by her own account and by the hobcam record (6 days), but she doesn't particularly enjoy cooking, it's just preferable to eating ready meals. Thus, to cook meals for oneself on a day-to-day basis, one does not have to enjoy it. In contrast, one can be "into" and enthusiastic about cooking, even if one doesn't do it very often. For example, one of Donna's flatmates "likes to cook but he's never got the time to". It is this enjoyable type of cooking that Ian feels he would do more of if only the shared kitchen environment was more amenable to it. Aaron, similarly, is looking forward to spending more time cooking next year when he moves to a house with less people and modern kitchen appliances. In other words, because "there is cooking and there is cooking" enthusiasm for (proper) cooking may not actually be met with frequent performances. Instead, frequent commitment of time may relate to (and perform) more instrumental, routine understandings of cooking as a way to eat hot meals (and provide them for others).

Baking is worth mentioning as a particularly discretionary form of leisure cooking for which some of the chefs report an enthusiasm. Distinguishable from cooking as the process of making cakes, biscuits and breads, rather than meals per se, baking has become an acceptable, student pursuit as indicated by the foundation of Lancaster University Baking Society in 2011. Both Kate and Aaron brought baking tins with them to university; Kate even brought a mixer. And both describe recent occasions when they made shortbread (Kate) or cakes (Aaron). Indeed, when Aaron is asked if he enjoys cooking, he refers to baking: "yeah yeah I

really do. I mean every so often I'll make, I'll try and bake a cake to the best of my abilities".

The distinction between more or less enjoyable and more or less proper forms of cooking represents a basic contention about what counts as cooking. Thus, although many of the participants make or imply some kind of distinction, they might not agree on the boundaries. Even the process of combining pre-prepared ingredients in a meal such as a curry can be 'engaging' and distinguished from even easier forms of oven-based cooking, as Henry remarks:

> "yeah, I like it because it's not erm… I don't just put it in the oven and then come back to it 25 minutes later and it's done, I have to actually do something with it. I have to, I have to cook the rice myself, I have to cook the curry myself, I have to cook everything else, and I quite like that."

Indeed, many of the apparently simple, but hob-cooked, meals did involve some integration of different ingredients: "I usually have like a can of tuna, smart price tuna or basics or whatever, you know the cheapest one and then probably I'm making pasta and then really cheap tomato, chopped tomato things, and I'll add salt and pepper to it" (Duncan). In fact, such meat (mostly tuna) and tomato based 'sauces' (bolognese / chilli) were relatively common. Donna similarly describes cooking stir-fries as "fun if you do them from scratch, like cook all the chicken and all the vegetables and stuff separately… they're so easy". Thus, when there are no cleanly separate categories of foods that are "fresh" or "raw", but only degrees of processing and presentation to which we are more or less accustomed (Short, 2006), there may similarly be no cleanly separate category of proper meals. What might be easy and routine for some, may be enjoyable and more complex for others.

Yet there is no question that some meals are more complex and that, at least some of the time, some of the chefs consciously engage in what they consider to be more enjoyable and more proper forms of cooking (or baking). For many of those chefs, this appears to be occasions when they cook with others. Regardless of whether these occasions are infrequent and 'special' or whether they are more routine, the type of meals prepared when cooking is

[4] Anecdotally, in a recent BBC TV programme (Nigel and Adam's Farm Kitchen, December 2013) a 'member of the public' is asked if she cooks often. She replies that she cooks curries and things like that with jars of sauce, "if that counts". To this, celebrity chef Nigel Slater responds "No that does NOT count as cooking".

shared tend to be more complex and take longer. Those (mostly female) interviewees who cook infrequently with others (Ellie, Miranda, Donna, Leah) seem to reserve 'proper' cooking (and baking) for these occasions. Ellie, who "doesn't usually cook" for herself, mentions a "baking party" in which she made cookies. She is also observed to make pancakes during the week with one of the other female residents (Miranda also joins in at one point). When she gets together with friends in other flats to cook, once or twice a week, Miranda makes meals like risotto, pasta and shepherd's pie. Three female residents, including Leah, who don't usually cook together, get together on Thursday evening to cook steak and chips (with what looks like a black-pepper sauce). Similarly, Donna who cooks birthday cakes with her friends, enjoys cooking *if* it's for other people:

> "I like cooking for people so if there's anyone around like, like if Polly is around then we'll, like we keep saying we're going to cook together but something always gets in the way kind of thing."

Yet even when sharing is more routine, the meals also appear to be more complex. In two flats (Green and Blue) cooking was shared regularly with other residents (1 group) or between the male residents and non-resident female friends or girlfriends (4 pairs). Amongst these meals, there is an absence of simple, one pot pasta and sauce meals or sandwich-based meals. Some are classic, recognisable meals: "spag bol", chicken curry and "cooked dinner" of chicken, potatoes and vegetables. They are also the most complex meals in terms of the number of discrete foods and cooker components used: using an average of 2.5 elements per meal compared to 1.2 used by other evening meals. Including the one-off shared meals, the subset of 13 shared evening meals observed during the week also took longer (43 minutes compared to 26 minutes on average for the 81 non-shared evening cooking events). As a result, shared evening meals are considerably more energy consuming: 1, 292 Wh compared to 604 Wh for a non-shared meal. It is tempting to think that sharing meals should be a more efficient than cooking for oneself (Clear et al., 2013a), but because of the types of meals that are cooked jointly, they work out overall as roughly equivalent per head in energy terms compared to cooking for oneself (469 Wh per head[5] per meal compared to 472 Wh for non-shared meals).

[5] Assuming an average of 2.4 sharers for each jointly cooked meal.

In summary, this section argues that as well as the different categories of meal, different varieties of cooking can be identified, with differential consequences for energy consumption. Since many participants may engage in proper or simple cooking at different times, I refer to this differentiation as modes of cooking.

3.6 Cooking Strategies: Repertoires and Engagement

In section 3.3, above, I described the differences in energy consumption between the chefs and highlighted the general (not determining) relationships between relatively higher consumption per head and a) frequency of cooking b) longer durations of cooking and c) the use of more cooker elements. In section 3.4, I switched focus to the meals in order to explore how and why some meals take longer and involve more cooker elements. This highlighted a key difference between hob and oven-based cooking, the latter of which generally takes longer, and is associated with (mostly frozen) pre-prepared foods, such as pizza and some types of chicken meals. The much more frequent hob-based cooking is generally shorter and associated with meals such as pasta, soups and fried meats (sausages, bacon) for sandwiches, foods which are more varied but also include pre-prepared products. I then explored some cross-cutting distinctions in the type of cooking that takes place (section 3.4 and 3.5): over the course of the day and between simple and more 'proper' forms of cooking (which tend to be shared, enjoyed, longer, more complex and take place in the evening). It is now time to relate these types of meals and modes of cooking back to the variations between the chefs and to return to the question of how and why the frequency of cooking varies.

Different Repertoires

There are clear differences in the types of meals participants cook. Some chefs appear to 'specialise' in particular meals which they cook again and again, such as fried chicken meals (GM2), sausage sandwiches (RM1), soup (YF5), grilled potato slices (RF1), boiled pasta (Aaron) or bacon and egg sandwiches (Henry). Thus, even though what chefs cook varies from one chef to another, there can be a high degree of repetition within the types of meal that individuals cook. As such, some of the general categories of meals (chicken and soup, in

particular) are amongst the most frequent because of the cooking performances of only a few chefs (Figure 3.10).

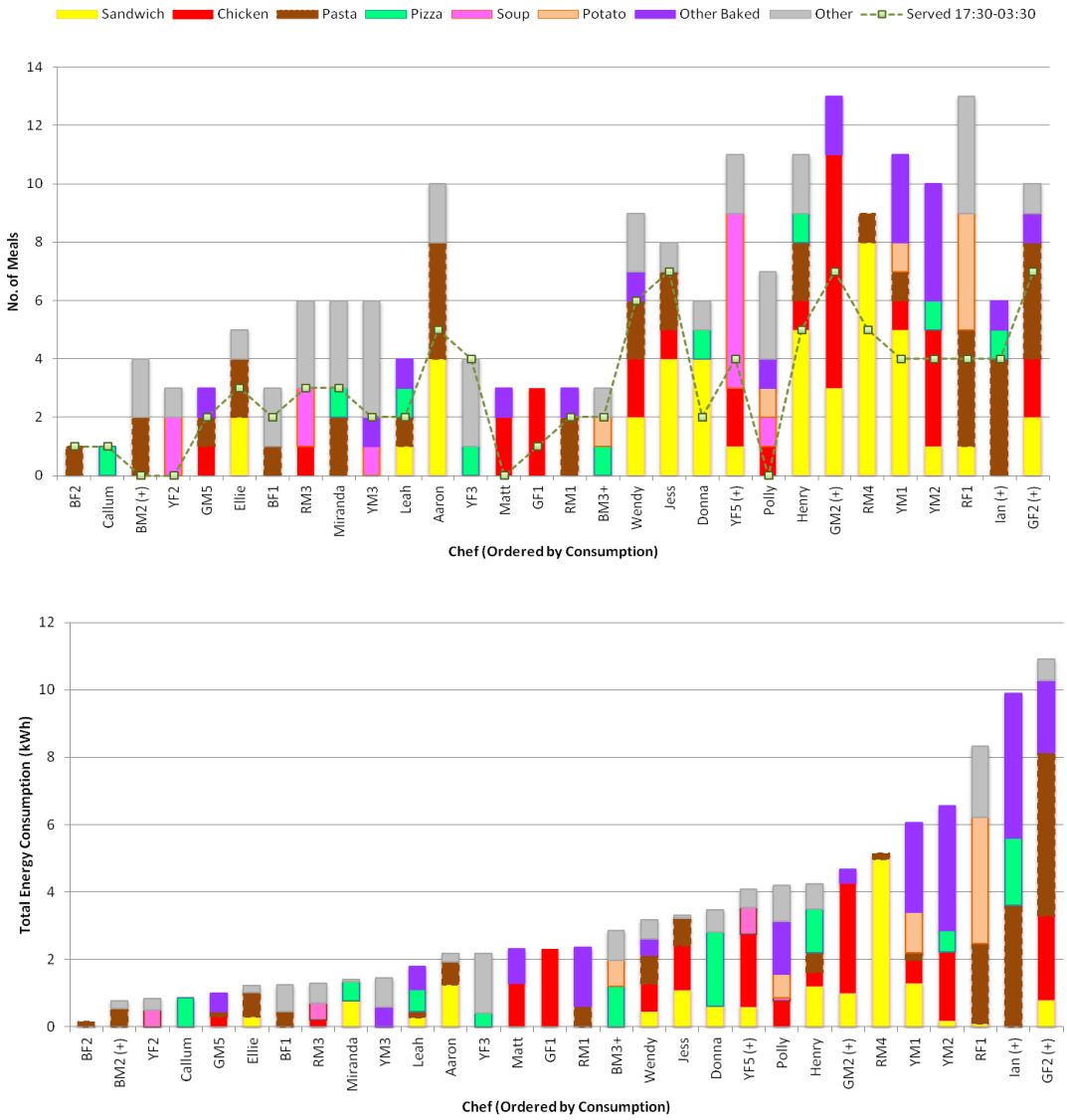


Figure 3.10 Number of meals in each category cooked by each chef (top) and the total associated energy consumption (bottom)(set A)

Yet the connections between the frequency and types of meals cooked and the resulting energy consumption per head are complex to follow. On the whole, the higher consuming chefs appear to cook a greater variety of different types of meal. Within the space of a week, this is not surprising since these chefs also tend to cook more often. However, when the lower consuming chefs do cook, it tends to be pasta, soup and 'other' meals (which are mostly hob-cooked meals including baked beans, tinned spaghetti, dumplings, tofu with sauce, noodles, and bacon and eggs). In contrast, the higher consuming half of chefs cook

proportionately less 'other' non-baked meals and more potato, chicken, sandwich and 'other baked' meals.

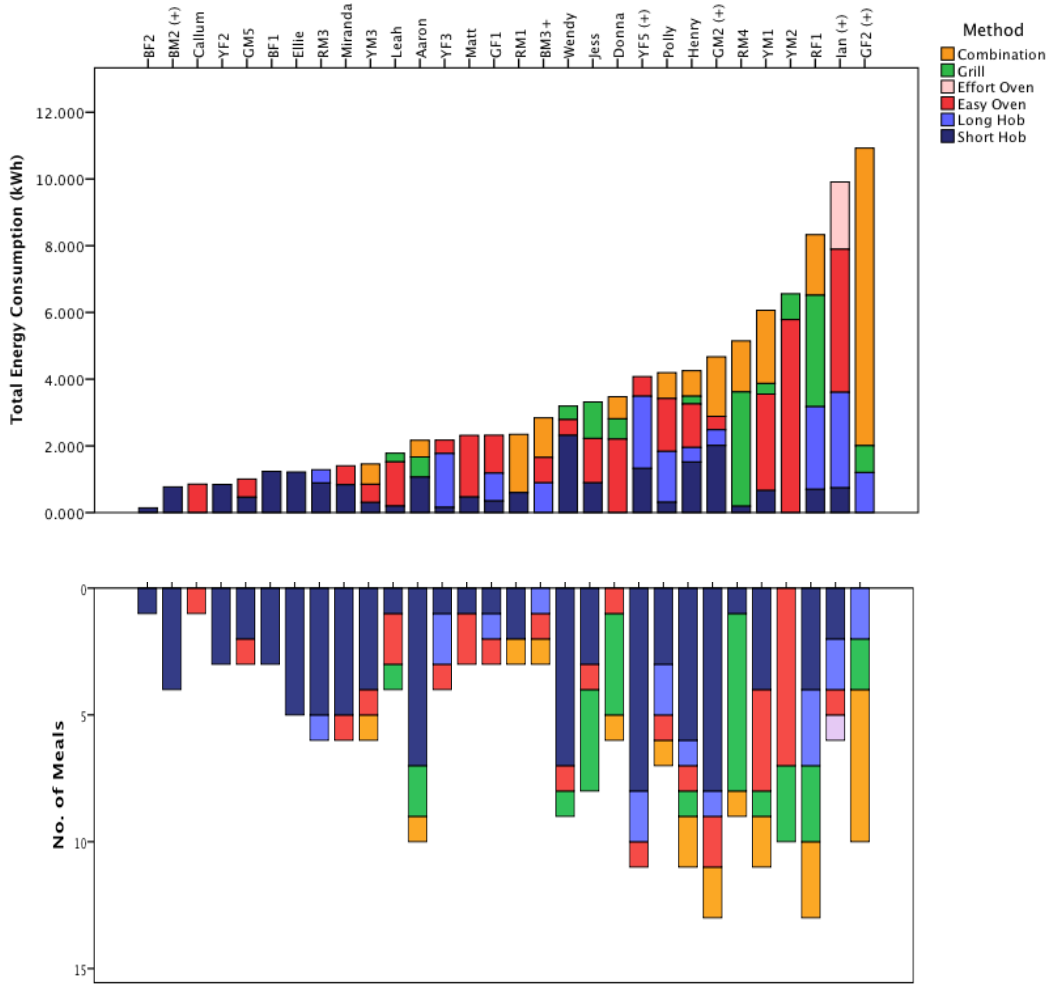


Figure 3.11 The number of meals and total consumption per head related to different cooking methods (short hob = less than 20 minutes; long hob = over 20 minutes; effort oven = where food was 'prepared'; easy oven = pre-prepared food).

Indeed, if we compare the cooking methods used, as shown in Figure 3.11, we see that the highest-consuming chefs do use the oven more, either on its own (YM2, YM1 for baked chicken products) or in combination with the hobs (GF2 for baked chicken, pasta or tuna meals that include some kind of bread or chips). Thus, just as we have seen that oven-cooked meals are more energy-intensive, we can also trace this difference to the variations in energy use between the chefs. Relatively long cooking sessions also seem to set the highest consuming chefs apart, although the component used varies (the hobs for Ian, RF1 and GF2, the grill for RF1 and RM4, the oven for Ian). For the lower consuming chefs, oven, grill and longer-hob methods are much less frequent (even as a proportion). In sum, those who cook less frequently also tend to cook quicker hob-based meals, whilst there are several ways to be

amongst the highest consuming chefs (frequency, complexity and duration across different types of meal)

Differentiated 'Engagement'

This suggests that the different styles of cooking in which chefs may engage, differentially and at different times, have consequences for overall variations in energy consumption. Firstly, the cooking of 'secondary' meals, generally indicated by the category of 'sandwich', increases the frequency of cooking and thus the overall consumption even though such meals are not very energy intensive. Secondly, a convenient mode of cooking using the hob for short periods (under 20 minutes) characterises more of the meals cooked by lower consuming (and less frequent) chefs, and a lesser proportion of the cooking undertaken by the higher consuming chefs. Thirdly, however, some chefs actually cook frequently in this way and are amongst the most 'efficient' chefs: cooking more meals, such as pasta, soups and stir-fries, than suggested by their comparative energy use (Aaron, Wendy, YF5, GM2). Fourthly, those chefs who, at times, cook longer meals (e.g. home-made pizza) and more 'complex' main meals (e.g. roast meats and vegetables and pasta with warm bread) tend to use more energy in their cooking. In so far as this includes occasions, primarily when cooking with other people, when chefs consciously engage in more 'proper' forms of cooking the extent of such engagement is significant for understanding the differences in cooking-related energy consumption (for Ian and GF2, as indicated in Figure 3.12). At the same time, however, an apparent commitment to a different mode of cooking, simple routine meals for oneself, is also important in terms of energy consumption since it sustains the frequency of cooking (as for RF1 ,YM2, YM1).

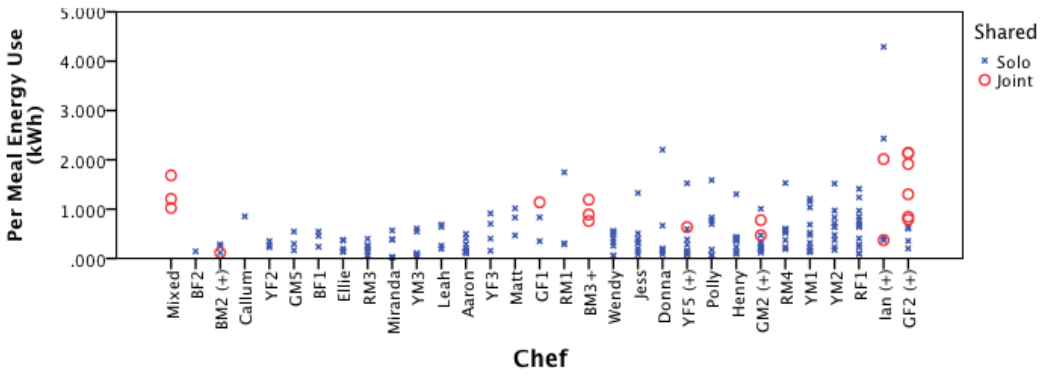


Figure 3.12 Energy consumption per meal comparing joint and solo cooking, ordered by chef.

So how can we understand variations in commitment to routine, frequent cooking? This is not just a question of additional 'sandwiches' as secondary meals. Most of those who cook most frequently do cook more 'sandwiches' but they also cook more of other types of meals. In general, it seems an affinity for cooking plays a role: the most frequent chefs amongst the interviewees (Henry and Aaron) spoke positively about cooking whilst the least frequent (Callum and Matt) did not. In particular, both Henry (11 meals) and Aaron (12 meals), find something to enjoy in cooking tasks: for Henry it is the process of hob-based cooking (e.g. when assembling a curry) and Aaron "really like[s] cooking pasta" because he has "started to like experiment a bit more with it so I've started to enjoy it a lot more" (on one occasion he is seen to cook pasta with baked beans). In contrast, Callum (1 meal) "wouldn't do it for pleasure" and Matt (3 meals) is also a little indifferent: he doesn't mind cooking. But other chefs who cook more frequently, like Jess (8 meals) and Miranda (6 meals), also express a similar indifference and Ellie positively does not like having to cook for herself (5 meals). On the other hand, other chefs who cook a similar number of meals like Ian, Donna (6 meals each) and Polly (7 meals) are more positive about cooking: they claim to enjoy it, at least at times. Thus, an enthusiasm, or lack of it, for doing cooking, does not necessarily translate directly into frequency of cooking. But it helps.

Differences in enthusiasm also seem to translate, at least partially, into differences in energy consumption. Those interviewees who expressed an indifference to cooking were observed to 'minimise' their involvement in the practice in various ways. Some of these 'strategies' result in lower frequency of cooking. For example, Matt cooks meals like chilli in bulk and then freezes portions of it, defrosting them in the microwave as needed for further meals. In a different approach, Callum tends to eat sandwiches and cold meats from the fridge and when he does want a warm meal, like soup, he tends to use the microwave, perhaps only using the cooker for pizza (which was observed). In a similar way, Miranda claims to 'graze' (on biscuits) and small meals throughout the day. This means that although she does cook it is generally only lighter meals, like tinned spaghetti, pasta and pizza, mostly cooked on the hob, in a few minutes. Like Jess and Ellie, she appears to minimise cooking by cooking simply, rather than necessarily cooking less often. Based on the overall meals that were observed during the week, this way of easy cooking and the associated understanding of it as avoiding more 'proper' forms of cooking, appears to extend to many of the chefs, most of

the time.

In contrast, the highest consuming interviewees (Ian, Henry, Polly) expressed enthusiasm for and enjoyment of some aspects of cooking. But a cooking strategy limited to pre-prepared oven-baked foods offering limited opportunity for 'doing' and enjoying cooking also proved to be intensive (YM2). Thus, *both* an engaged approach to cooking, when time is spent taking part in the practice, and a disengaged approach, when time doing cooking is minimised or avoided, *can* be energy-intensive forms of cooking (*if* particular products are available and used).

Cooking, of course, takes place amid a host of other practices that compete for time. None of the interviewees who were indifferent or disinclined to cook, specifically claimed that they did not have the time. However, some of those who talked about cooking more positively did give 'excuses' for not doing it more regularly. This included a lack of time, and problems of co-ordinating with others. Polly in particular had a busy lifestyle in which she was frequently out of the flat (sports, employment, work and relationship) and so she did not cook as frequently as she would like, nor as much as she does when 'at home' with her parents. Here, the relationship between cooking and sports and fitness practices in particular are interesting. Much of the content and timing of Polly's cooking is informed by a need for energy (lots of pasta, potatoes) and to have food with her when doing her sports (e.g. a very large box of salad that takes 40 minutes and 3 hobs to cook). In addition, it is possible that much of the fresh meat cooked by GM2 (for lunch and evening meals) is related to the fact that he is also muscular, so perhaps involved in body-building or other sport. Cooking is also related much more closely to other food-related practices: it has to be co-ordinated with washing up, including and perhaps especially that of other residents, the lack of which Ian gave as a reason not to 'properly' cook more often. Shopping, financial constraint and a lack of choice on campus also featured in participants' accounts of what they cooked.

In summary, cooking performances vary between chefs in relation to varied enthusiasm for cooking, varied understandings of whether one should bother to cook properly for oneself, and varied ways of minimising and simplifying (eating cold food, simple cooking with the hobs or oven, bulk cooking) and engaging in cooking (cooking from scratch, baking,

experimenting, combining multiple pre-prepared foods into a meal, cooking in support of other (physical) activities). As a result, the different types of meal, the different modes of cooking and the frequency with which chefs cook combine and interact in complex ways. There is clearly a lot more to understanding how and why than I am able to cover here, but this research does allow me to flesh out some of the distinctions and subtleties that exist within cooking, and their implications for energy consumption.

To bring this chapter to a conclusion, this research shows that the level of energy consumption associated with cooking emerges in relation to a number of interacting features of cooking performances: their frequency, the types of meals that are cooked and the methods that are used. These vary over time and between chefs in cross-cutting ways associated with whether the meal is a main or secondary meal, whether it is a simple meal cooked with the hobs or in the oven, or whether it is an occasion to cook a more complex meal, with more components and methods. Such occasions are mostly when cooking is undertaken with and for other people. These findings echo previous studies showing that cooking is not one thing: it is a practice with many internal differentiations. In the next chapter, I consider how this insight can help to interpret the decline in domestic energy use associated with cookers over the last 40 years.

4. COOKING AS A PRACTICE: DECLINE AND DIVERSIFICATION

The study of cooking in student residences, outlined in the previous chapter, revealed that the energy consumption of cooking varies from person to person depending on how they cook. This apparently obvious and mundane fact depends on a very particular relationship between a social practice and energy consumption that should not be taken for granted. In this chapter, I discuss this relationship with reference to my detailed analysis of variations in cooking performances and energy consumption. In particular, I am concerned with what the relationship means for the evolution of cooking demand. First, I consider the conceptual framing of cooking as a practice in relation to energy demand. Then, I turn to consider what this means for how cooking-related demand varies. Finally, I relate these insights to changes in energy demand in the past, and the possibilities of change in the future.

4.1 Cooking and the Constitution of Energy Demand

Cooking as a Single Practice

I have begun my investigation of energy demand in everyday life with cooking precisely because it provides a strong exemplar of a social practice (e.g. Schatzki, 1996). In my own analysis, I did indeed find that the activities I observed at the cooker were recognisable to me as cooking, even if I did not always recognise the meal being prepared.[6] Whilst there were variations the most basic constituents of the practice were sufficiently common and necessary as to define cooking as a particular patterning of activities, understandings of appropriate meals, the valuing of warm food, conventions of timing and material arrangements including cookers, kitchens, food products, storage facilities, pots and pans. Moreover, the interviewees themselves recognised cooking as an activity they undertake to a greater or lesser extent: they can talk about whether, how and when they do it. This indicates that cooking is indeed a recognisable practice-as-entity which organises what people do and how they think and talk about their activities. Although not detached from other practices of

[6] There were two exceptions that I hesitated to define as cooking: a couple of hob-roasted marshmallows, which do not feature in the findings because I literally did not 'count' them when labelling and coding the meals, and some warmed milk which I did count, but am inclined to think of as preparing a 'drink' rather than cooking a 'meal'.

daily life, which are more or less interdependent, cooking can usefully be treated as a single, well-bounded practice and a unit of social organisation.

When conceptualising practices, researchers and theorists have found it useful to distinguish between dispersed and integrative practices (Schatzki, 1996, 2002; Warde, 2005). Dispersed practices are procedures like explaining, questioning, or imagining which may be incorporated in any number of other practices. Cooking can be considered to be an integrative practice, which is to say that it integrates and is organised by shared understandings and activities that have their own purpose. Accordingly, integrative practices can "always be subjected to judgements of correctness and acceptability" (Warde, 2013: 23). They also depend upon dedicated human activity: each performance and the ongoing reproduction of cooking requires some people to spend at least some time 'engaged' in it. This connection has inspired researchers to investigate the evolution of practices, including cooking and eating, by looking to time-use research (e.g. Warde et al., 2007; Cheng et al. 2007, Southerton et al., 2011).

Distinctions between different types of time are made within time-use research and this is useful when thinking about practices too. In particular, researchers have sought to differentiate between what is necessary to do for oneself, like leisure and sleeping and what is, in principle, possible to 'delegate' to other people or machines such as child care or washing up (Gronau, 1977, as described in Hamill, 2001). Importantly, those activities which others could do on your behalf are mostly forms of work, regardless of whether they are paid or unpaid. Cooking could be classed amongst other types of domestic work, like laundry, in the sense that it can be, and routinely is, undertaken by others and its results still enjoyed.

In this sense, cooking is a work-like but discretionary practice: one does not have to cook in order to eat. Indeed, only two participants were observed to cook in their own kitchen every day, although it might be assumed that all did eat something on a daily basis. Thus cooking is not necessarily synonymous with the unavoidable and non-delegatable activity of eating, despite a close connection. Even for hot meals, which are a persistent and prevalent expectation, one might go to a restaurant or cafe, order a take-away, or find a (hopefully willing) friend like GF2 to cook for you. In other words, the provision of warm meals is a

kind of service of which the outcome, being 'well' fed, might be conceptualised as a composite and heterogeneous achievement (a service in the sense that Shove (2003) develops; I discuss this distinction more fully in Chapter 7). Despite the fact that there are diverse ways of organising and achieving such outcomes, the options in any given circumstance may nevertheless be constrained. If one does want to eat a hot meal, cooking for oneself is only avoidable to the extent that other means are available, appropriate and affordable. That all the participants were observed to do some cooking (with the cooker) during the week suggests that it is not *entirely* discretionary in the context studied; everyone in this self-catering accommodation is 'recruited' to the practice of cooking to some extent.

In addition, we have seen that cooking and baking can also be a form of leisure, the enjoyment of which consists in the doing, an outcome that cannot be achieved if someone else does it. Yet this leisure or hobby-like form of cooking does appear to be more discretionary: not everybody engaged in it. Thus the different forms of cooking evident in participants' understandings and activity appear to be radically different (work on the one hand, leisure on the other). As such, we might question whether cooking should be treated as a single practice at all. At the very least, this discussion suggests that cooking has a split-identity, to which understandings of how it varies and changes need to be sensitive. I explore this idea further in section 4.2 and 4.3. In this section, I consider how this understanding of cooking as a time-consuming activity, of different forms, is reflected in the ways that energy is consumed.

Embedded Energy Use

The findings presented in the previous chapter point to a close connection between what people do and how much energy is consumed by the cooker. Cooking can be described as a process in which human inputs (requiring time) co-ordinate and combine with forms of heat energy to produce meals from food items. Energy consumption is embedded in this process, and could even be considered as a tool in itself. That is, the cooker is used in order to apply heat to food, and the control of this heat through stirring, settings and testing is very much part of the practice of cooking. This means that the time and energy used in cooking are closely related. This might be highly synchronous, as in the case of much hob-based cooking, where chefs are engaged in cooking (in stirring and adding ingredients) when the foods are

being cooked. Or it may be more staggered and disproportionate as in the case of much oven-only, convenience meals. But either way, cooker energy use only ever takes place in direct temporal relation to the (prior and subsequent) activity of the chef. No matter how minimal, cooking requires a degree of co-ordination from the chef to integrate, at that particular time, ideas of what is appropriate, desirable and possible to eat, the foods and method required and to negotiate this alongside other practices of daily life.

This largely contemporaneous and largely direct connection between the practice of cooking and energy consumption has consequences: it means that cooking-related electricity load directly follows the temporal patterning of everyday life. This may be equally true for many other practices, such as watching TV, showering and laundry, but the connection is especially important for cooking. It requires quick, on-demand heat which is power-intensive. In addition, the practice remains highly time coded: even for students with irregular schedules and ready access to the kitchen throughout the day, the bulk of cooking performances and consumption occur during the hours of peak network electricity load (18:00-20:00). This clearly has implications for understanding patterns of peak load and for the prospects and impact of peak management strategies. For example, would peak pricing tariffs disrupt socially-valued family eating patterns, affecting how cooking is organised, and further complicating the routines of those (mostly women) who do the cooking (Carlsson-Kanyama and Linden, 2007)? Is such a policy fair if it selectively disadvantages those with electric cookers, who may already be amongst the most economically disadvantaged in society (e.g. tenants who are more likely to have an electric cooker and not be able to do anything about it)?

Distributed Demand

Cooking does not just demand energy and time; it is at the intersection of several other 'flows' or cycles of consumption. The pots, the plates, and even the cooker are used and cleaned on an ongoing basis, and infrequently purchased and disposed of. The rapid cycles of purchase, use and disposal of the food itself are most striking. It is the ultimate 'consumable' (Warde, 2013). Cooking integrates and depends on these elements, but they are also shared by (and pass through) various other practices that take place at different times and places, some of which are domestic, many of which are not. First and most obviously, cooking is

inter-dependently connected to the other food-related practices carried out by the same practitioners or other members of the household, friends and relations: it is connected to the eating of meals, to doing the washing-up, and the shopping, storing and managing of foods and food-waste. We might identify such a group of practices as a complex (Shove et al., 2012: 81) or part of the compound over-arching practice of eating (Warde, 2013). As the research indicated, the type of cooking that takes place depends on the types of foods that are available to buy, how much they cost, and on whether the kitchen is full of dirty crockery. Secondly, if we consider foods to be an element in the re-production of cooking practice, it follows that these items are also elements in the practices of agriculture, manufacturing, retail, shopping, dining and waste management. By virtue of such shared elements, these practices are connected and the food supply 'chain' can be seen as a highly distributed bundle of practices.

It has been well argued that consumption should not be understood in isolation from the systems of production and infrastructure through which demand is 'created', enabled and thus co-constituted (Harvey et al., 2001; Shove and Chappells, 2001; Southerton et al., 2004). Understood in this way, the demand for energy (as for water) is 'distributed' (Browne et al., 2013). But such accounts have tended to emphasise the role of the infrastructures and systems that supply resources such as water or energy. In the case of cooking, my findings show how patterns of energy consumption depend on the types of meals that are cooked, and thus the type of foods and the methods that are used. In this light, it is not so much the energy industry but the food industry that is clearly and significantly implicated in the constitution of this portion of domestic energy demand. In other words, just as practice theoretical approaches propose that elements are integrated in and thereby comprise performances, the demand for energy that is actualised in any given cooking performance is constituted through the journeys those elements have taken.

The demand associated with cooking is distributed in two further senses: firstly, the direct energy used in the production of foods that are cooked at home, and secondly, the more general demand for the other commodities, namely food, that are used in cooking and eating. On the first point, it is plausible that the reduction in home cooking energy consumption over the last 40 years has come at the cost of an increase in energy consumption upstream, in

food manufacturing. This follows from the (re)distribution of work that is possible in a work-like practice like cooking. The process of preparing meals from 'raw' foods can be distributed or delegated to others, so long as appropriate systems for storage, retail and final cooking of such products exist. In other words, the work of cooking has been re-distributed, binding the level of energy used at home to that used elsewhere, in potentially complex ways. On the second point, the energy used in cooking, where ever it takes place, is just one part of the overall energy used to produce, distribute and retail food. Considered together there is a possibility that a more sustainable system of food practices overall may be predicated on higher energy consumption in the home. The opposite may also be true, that more collective forms of eating outside of the home, and a further reduction in home cooking offers the most energy-efficient social organisation of cooking and eating (Spurling et al., 2013). This is a much bigger question than I am able to address here. The point I am able to make, is simply that cooking, as a practice, and as a form of domestic energy demand, is inextricably tied up these distributed systems of production and consumption of food. These macro, institutional dynamics define and redefine the daily, and private organisation and understandings of cooking (Halkier and Jensen, 2011).

4.2 Conceptualising Variation Within a Practice

Since cooking can be conceptualised as a single practice, this research provides an interesting opportunity to reflect upon the nature of the variations that were observed. Yet given how cooking unfolds at the intersections of other practices in everyday life and amidst the larger societal dynamics, mentioned above, it is not an easy job to make sense of the "many dimensions" on which social practices may be differentiated (Warde, 2005: 138).

At the most micro-scale, it seems unlikely that any one performance of cooking during the week was precisely identical to another in every detail. Practices consist of active integrations of elements, at different times, contexts and places, and as such they are inherently variable and "inherently dynamic" (Shove et al., 2012: 126). In other words, cooking consists of many elements, which themselves vary, and it is performed by different practitioners in different contexts in which the relationship to other practices, past and present, proximate and distant,

also varies. Given this complexity, lack of a systematic (and systemic) analysis of the kinds of variation that emerge within social practices may not be surprising. Here, I attempt to organise and describe the types of variations in the cooking performances that emerged in the study.

Integrative Approaches Across Individuals and Groups

I begin at the individual level with the idea that variations in performances arise in "the day-to-day dynamics of integration" (Shove, 2003: 155) and "daily manoeuvring" between a multiplicity of practices (Halkier and Jensen, 2011: 105). This steps beyond singular performances, to the idea that performances are patterned at the level of practitioners as they respond to, interpret and resist shared conventions and anxieties, and actively stitch together routines. As Shove (2003: 163) notes "there are different ways of reproducing none the less shared conventions… individual habits vary despite being held in place by what are experienced as collective injunctions".

This is evident in my finding that no two chefs appeared to share the same pattern of cooking: either in terms of frequency and timing or in the type of meals that were prepared. We might also see signs of how "people in myriad situations adapt, improvise and experiment" (Warde, 2005: 141) in some of the more singular performances: in Polly's huge box of cooked salad to support her sports activities, in Ian's hob-cooked pasta 'bake' and in GF2's integration of take-away chips into an otherwise home cooked meal. Variations within the elements of cooking (in the understandings, procedures, foods and so on) and in the relations between cooking and other practices (sports, socialising and relaxing) both enable and limit the ways that cooking is done by individuals. Moreover, in this way, variations in performances emerge along with individuality, that is, at the "unique crossing point of practices" (Reckwitz, 2002: 256; Schatzki, 2002).

Theoretically, this process of integration at the individual level is fundamental to understanding reproduction, change and variation within practices. However, the types of change and variation that are analytically important are usually those which occur, or are otherwise identifiable, across groups of practitioners. Groups might be defined by pre-existing social identities or in relation to the practice itself. For example, the findings

tenuously suggest a gender-based differentiation in the understanding of cooking. More of the female participants expressed a view that (proper) cooking was something to do with and for other people, rather than for oneself. This may relate to the traditional gender roles and although I don't see any substantive difference in the performances (types of meal, frequency of cooking or even shared cooking), a gender-differentiated understanding may have consequences for the future careers of these chefs, and for cooking as a whole.

It also appears to be possible to identify groups of practitioners by the way that variations in configurations of elements and styles of integrations coalesce (Pullinger et al., 2013; Browne et al., 2014). Indeed, it is possible to group chefs according to a general approach to cooking. In particular, there were marked differences in the extent of oven-only forms of cooking, which dominated some approaches (YM3) and were completely absent from others (Aaron, Ellie, BF1, YF2). In addition, low-frequency of cooking and quick hob-based methods both seem common to the lower consuming chefs. In this way, as Warde (2005) notes, "differentiation within a practice is partly a matter of commitment to it: the analytic distinction between insiders, regulars, tourists and strangers with different levels of investment in any particular world has proved valuable" (2005: 138).

Group-based variations may not be limited to differentiations within particular elements or to the routines and approaches associated with varying degrees of commitment, but they may also emerge in more contingent relationships to other practices and contexts. Firstly, since cooking exists as part of a complex or compound of eating-related practices (Warde, 2013), it seems patent that patterns of variations will exist across these interconnections. For instance, Ian mentions buying frozen meat in bulk, which implies a particular form of defrosting and cooking likely to be shared with others who shop in this way. Other cross-complex differences (of which there were some hints) might include access to cars for food shopping, being in a close relationship, and being vegetarian. Secondly, relationships to other, non-food practices in daily life might also account for patterns of variation across groups of practitioners. In the broadest terms, negotiating multiple practices that take place away from home may be associated with less frequent patterns of cooking. In more particular terms, those who participate in sports activities may share certain ways of cooking and eating, differentiated by sets of ideas about what different foods like carbohydrates can do for

energy (Polly talks about eating lots of pasta) or what lean white meat can do for physique (muscular GF1 cooks a lot of it). Thirdly, there are other connections between practitioners that may lead to similarities and differences. They may share access to a cooker (and distrust of the oven, as in one flat). They may also share ideas about meals and foods, by cooking in the same kitchen. There certainly appear to be resemblances in the types of meals cooked by a few chefs in at least two of the flats (a lot of fresh meat in one, and a lot of frozen meat products in another).

The point is that a single practice like cooking can be differentiated across individuals and between groups in a number of ways, ranging from variations within particular elements like understanding, general approaches or routines, to relationships with other practices and connections with other people. Whilst I find these dimensions useful for thinking about the variations I have observed, I also find that they are heavily inter-related through the recursive nature of the very integrations in which practitioners are implicated: for example, differentiated understandings are arrived at in relation to particular practices and are also associated with different ways of integrating other elements.

Variants and Modes of Practice

Yet practices do not just vary in performances at the level of the practitioner. The forms that practices take can vary in more systematic and cross-cutting ways. For instance, Halkier and Jensen (2011) identify 'ideal types' of nutritional responses within food practices that differ across seven dimensions: activities, understandings, procedures, engagements, relations to other practices, connections to other people and moments of consumption. These dimensions also characterise and distinguish one social practice from another. The ideal types or forms of practicing nutrition identified in this way are, in themselves, coherent and distinct patterns of doings and sayings.

Distinct and alternative forms of a practice may also be called variants (Pullinger et al., 2013; Spurling et al., 2013). In my analysis of cooking, I have found it helpful to distinguish between modes of cooking, selecting the term specifically to indicate a distinct form that can be switched into or out of at different times. In this way, I would view more or less proper forms of cooking as potentially cross-cutting. Moreover, in the sense that this mode offers a

set of resources, in the form of rules, know-how and materials, as to what is appropriate in proper cooking, it is possible to view it as a kind of entity in its own right. The differentiation of 'quick and easy' versus 'proper' cooking allows for, and is simultaneously based upon, an elaboration of the distinctive qualities of each. An analogy to Shove's (2003) analysis of showering and bathing can be made: the repositioning of one (quick and easy meals), has redefined the other (proper meals). Whilst individuals may experience this as their personal responses to managing the variety of contemporary anxieties that surround eating and time, it is also worth noting that these modes of cooking do not simply emerge from individual-level integrations. Instead, they have to a large extent been configured by producers of convenience foods, microwaves and cookery programmes and books, amidst the wide-scale re-distribution of female work. In other words, these variations in cooking are organised at the level of the intersection of these different systems (Shove, 2003).

The existence of such variants or modes within a practice provides a different departure point in the analysis of variation. In particular, it complicates the analysis of participation and commitment to cooking. This is because the forms of cooking in which people engage are so different that cooking can be experienced both as a chore and as a form of leisure. As Kaufmann (2006) suggests this ambiguity may be managed by a clear differentiation in the occasions when easy cooking or proper cooking are called for. In relation to the differences between chefs, it means that a person who enjoys cooking might act for most of the time like someone who does not. They may even do less cooking. On the other hand, as in an example provided by Short (2006) someone who has to do the cooking for others may turn it into a leisure-type of practice, rather than cope with the notion of taking on a chore. In short, modes of cooking have implications for patterns of recruitment and commitment. Some chefs may cook every day and spend as much time in so doing as an enthusiast who cooks infrequently but spends hours embroiled in complicated recipes when they do. To judge differences in terms of time commitment would therefore miss important shifts in the balance of the relative commitment of chefs to these different forms, and hence their contribution to more generic trends. In the section 4.3, below, I explore this connection and consider trends in different modes of cooking.

Shared Concepts of Service

In addition to differences in integrative approaches from practitioner to practitioner, and the cross-cutting variants or alternative forms of the practice, it is also helpful to identify alternative means of achieving similar outcomes within or in relation to the practice. Here, it is useful to draw on the notion of service. For instance, I have described the two broad means by which much of the simple, convenient mode of cooking was performed: either quick, hob-based meals that use and/or combine (relatively) pre-prepared ingredients, or pre-prepared products that could be popped in the oven and left. In this case, the mode of easy cooking is defined by concepts of convenience, ease and simplicity which participants share but achieve in different ways. Other concepts of service such as affordability, nutrition and being well fed might provide other cross-cutting dimensions over which to analyse variations in cooking. As above, cooking for oneself in general is one of several means of being "well" fed; in so far as these are understood to be alternatives united by a concept of service (or outcome), changes within each may redefine and configure others (of which more in the next section).

These ways of exploring variation, by type of practitioner, by variant or mode, and by shared service with differentiated means, are not necessarily mutually exclusive perspectives. They may include reference to the same differences in performance but they are able to parse and explore variations in different ways. In my analysis of the variation within cooking as a practice, these were the primary distinctions that I made. Thus, in comparing the chefs, I identified that those who tend to cook less often cook meals that use hob-based methods, whereas those who cook more frequently tend to cook more sandwich meals, which also means they tend to use the grill more often. These are general approaches that can typify groups of practitioners. Other 'styles' of cooking are feasible (and perhaps easier to identify in a larger sample). But I also compared performances over time to show how they vary depending upon time of day (more sandwich meals cooked at lunch-time) and in terms of engagement with more or less 'proper' modes of cooking. This distinction contrasts proper cooking with easy cooking across all the elements and dimensions by which a practice is comprised (thus they are complete forms or variants). I also recognise that there are different ways to achieve concepts of service that are common to and define each mode of cooking.

In summary, let me re-iterate the subtle but important difference between two ways of conceptualising variation within cooking: firstly, as different ways of performing the practice of cooking, and secondly as performances of different ways to practice cooking. The former presupposes a relatively uniform practice entity, which may be "internally differentiated on many dimensions" but is essentially understood as the "same activity", done differently (Warde, 2005: 138). The latter position emphasises regularities and the systematic organisation of difference: there are different forms which themselves may still be done differently. Whilst the existence of such variants clearly indicates variation within practices-as-entities, this is also true for variations in integrative approaches. Differences in performance actually presuppose, to some extent, variations in pre-existing ideas, arrangements and relations. In this view, the practice-as-entity is less a tightly specified pattern against which individuals have little choice but to differ, and more a loose set of resources, guidelines and scenarios, from which individuals construct action depending on how they understand and interpret their circumstances. Looked at this way, variations are not so much introduced by individuals as enabled by practices.

4.3 Diversification and Decline in Energy Demand

In this final section, I discuss the decline in cooking-related energy consumption over the last few decades in the light of variations within the practice. If the conceptualisation of such energy demand as presented in this chapter is accurate, that is, if it is closely tied into how people cook, then the dramatic decline in per household energy consumption for cooking since 1970 (DECC, 2012; as outlined in Chapter 3) suggests that the practice of cooking has changed dramatically. I argue that this needs to be understood as more than a general decline in 'proper' cooking amidst a general decline in levels of commitment to the practice. Rather, focusing on the differentiation between proper and easy modes of cooking, I suggest that cooking has diversified, and that this has happened hand-in-hand with other changes including a reduction in the time spent cooking and the energy consumed.

A Decline in Proper Cooking?

The decline in energy consumption associated with cookers across Europe has not been linked so much to an increased technical efficiency of cookers as to the ways that cooking as a practice has changed. Possible explanations include an increase in eating out, increased use of microwaves and pre-cooked meals, and a decline in roasting meats (European Commission (DG ENER), 2011b). As in the case of laundry and bathing (Shove, 2003), radical changes in practice appear to have occurred despite the fact that the basic hardware has remained the same. In the UK, all of these trends are highly plausible, as are the implications for reduced consumption. As shown in my research, microwaves consumed considerably less than cookers (though I cannot say much about how they were used); meat was hardly ever roasted and on the few occasions it was (or I suspect that it was) the meals were very energy-intensive. Instead, most of the cooking involved pre-prepared and processed products of some kind, either on their own or in relatively simple combinations. In so far as this reflects trends in cooking more widely within the UK (and I suggest it may[7]), this indicates that a decline in the traditional 'cooked dinner' meal format (of meat and vegetables) can be linked to a decline in cooker-related domestic energy demand.

However, whilst this may be the general gist of the story, my analysis suggests that this decline, and therefore the ongoing changes within cooking, are more nuanced. In particular, the 'cooked dinner' format is now just one idea amongst others of what constitutes a proper meal and proper cooking. If reports indicating "a resurgence of interest in cooking at home in recent years" are accurate (European Commission (DG ENER), 2011c: 13), then it is possible that 'proper' cooking has not declined at all, but rather become more popular as the overall energy used in cooking has declined. That is, 'proper' cooking has emerged as a distinct mode, defined in contrast to routine cooking. To explain, let us return to the evidence from time-use research.

[7] This sample of cooking performances are unlikely to be representative, numerically, of cooking performances in the UK. Interviewees would often refer to their cooking as being typically "student". But, with the exception of such a heavily shared kitchen, the constraints they appealed to (affordability, lack of time) do not appear to be uniquely "student". What characterises this as student cuisine, if at all, is the frequency by which "simple" meals dominate. Such forms of cooking may be less prevalent, more generally, but may still be widespread, just as the products are upon which they depend. The distinctions between different modes of cooking and their implications for energy consumption are therefore likely to be of relevance more generally.

Declining and Differentiated Commitment?

Since cooking is an integrative and time-consuming practice (section 4.1), time-use surveys provide another source of data about changes in cooking. On average, the time spent cooking and washing-up in the UK is less now than it was in the 1970s. In 1975, an average of 57 minutes a day was spent on these two activities; in 2000 that was down to 51 minutes (figures from the Multinational Time Use Survey as quoted in Warde et al., 2007). It is unfortunate that cooking and dishwashing have been recorded together, since the increase in dishwasher ownership (from 18% of households in 1994 to 40% in 2000 (DECC, 2012)) may account for a sizeable reduction in time spent. Yet, an increased participation rate suggests that decline in time spent per person is more dramatic than the overall average indicates. In 1975, 72% of respondents spent some time cooking and/or washing-up during a day; in 2000 that figure was 88%. This means the decline in average time spent in these activities by any single participant during the course of a day has changed from 79 minutes in 1975 to 58 minutes in 2000.

The overall decline in time spent cooking and washing-up may be partly associated with an increase in eating out: there was indeed an increase in the average time spent and in the participation levels in eating out. However, the trends in eating out and cooking/washing-up are not necessarily operating in mutually exclusive ways. The figures suggest some people (30%) must have cooked or washed-up *and* eaten out in the same day, whilst the proportion of people who did not eat at home at all only declined slightly from 99% to 97%. Thus, the increasing incidence of eating out appears to be linked to, but is partial as an explanation for, the changes in cooking/washing-up time-use.

It is clear that patterns of commitment have changed: more people are cooking and washing-up, between them they are spending slightly less time in these activities, and much less time is being spent by any single participant. Yet, the (re)distribution of these activities appears to be the biggest change, most likely associated with slow reformations of traditional gender roles, a rise in solo living and otherwise individualised schedules. As men have got more involved in domestic work, as women have got more involved in paid work and as more people have found themselves in living arrangements where there is no-one to cook for them, the distribution of cooking "work" appears to have changed significantly. It is less clear whether

participation levels also reflect higher recruitment to explicitly discretionary and leisurely forms of cooking. It may be that more people have taken up cooking and baking, not just because they have to but also for pleasure.

Thus, caution is needed in interpreting time-use data of this kind. The type of cooking in which people participate and the frequency with which they do it are highly relevant to understanding patterns of commitment. As Southerton et al. (2012: 241) recognise in their analysis of commitment and recruitment to reading: "the structure of participation… may affect the status and reproduction of the practice" wherein the balance of time-use between enthusiasts and between different forms of practice is important to understanding trends.

Diversification

In my analysis, the differentiation of cooking into distinct modes of more or less proper, and more or less pleasurable forms of cooking, was an important variation reflected in understanding, performances and energy consumption. Yet this differentiation has not always existed. A full understanding of the emergence and evolution of 'quick and easy' cooking, which has at the same time, defined and created a tension with more 'proper' forms of cooking is beyond the scope of the current work. But since it allows me to explore how variations of one kind (variants) are deeply implicated in transformation in the practice of cooking and the energy it demands, I will sketch out these connections, as I see them.

The first and most important point that I wish to make is that the rise in quick and easy forms of cooking that depend on pre-prepared, convenience products represents not just a simple transformation in cooking but a diversification into at least two distinct modes. This diversification is implicated in the greater participation rates in cooking but also in an overall decline in the time and energy devoted to cooking as a whole and as required to prepare a meal. The key to understanding this lies in the nature and meaning of routine cooking as time-consuming work, something that people might understandably try to minimise during an otherwise busy day. This generalised reduction in time commitment has consequences relating to the meals that are cooked and the foods that are involved: as we have seen, these have diversified.

My second key point is that this diversification in cooking has taken place with respect to the concepts of service that define appropriate meals. These concepts have changed dramatically. I will try to briefly illustrate how, and how this, in turn, relates to a diversification in understandings and performances of cooking into more or less easy and proper forms.

According to Wood (1996), the increased participation in eating out in the UK since the 1960s and 1970s has influenced the types of meals that are cooked at home. Meals that were becoming familiar to the British public through the international cuisine served in restaurants, proved to be ideal opportunities to market something new: the ready meal. Curries were amongst the first meals marketed for microwave cooking and frozen pizzas were not far behind (Wood, 1996). By incorporation into the range of foods that were possible and acceptable to cook at home, these new foods introduced a way to produce meals that was 'quick and easy' compared to the types of meat and vegetable meals ('cooked dinners') that previously dominated the British diet (Douglas and Nicod, 1974; Murcott, 1982). The availability of such pre-prepared products and the very possibility of 'quick and easy' meals that they enabled, transformed understandings of what cooking is. In a self-reinforcing manner, convenience foods define cooking as a chore to which they position themselves as alternatives. As Kaufmann notes this can help explain why even quick and easy meals feel like an effort: "the fact that there is, at least in theory, a quicker alternative means that the slightest delay (such as having to peel the potatoes before we cook them) introduces a feeling of annoyance" (2010: 167). This suggests that for any given service, as for warm meals, alternative means of provision are defined and evolve in relation to each other. And as they do, they refigure and redefine the concepts of service on which they converge.

In this way, the existence of alternative ways to cook a meal creates tension and the potential for higher degrees of variation between chefs. As Kaufmann notes there have always been variations between different chefs, in their enjoyment, skills and success (i.e. in integrative approaches). In the past, if your role happened to be that of the cook "cooking was simply something that had to be done" (Kaufmann, 2010: 163) following relatively prescribed procedures. You might enjoy it, but it was "work" nevertheless. As new pre-prepared products were marketed, it became possible to avoid prescribed procedures; this introduces choice and tensions that were not previously present. Thus, in Kaufmann's view, cooking has

become increasingly individualised as it has diversified: variations in personal commitment to more or less 'proper' forms of cooking have become inescapably a part of what cooking is.

Trajectories of Cooking and Energy Demand

Given the different ways of preparing simple meals and the differentiated modes of engaging with more or less proper forms of cooking, I would suggest that future trends in cooking related energy demand may emerge in a complex fashion. My research indicates that both types of variations are highly relevant to patterns of energy consumption (contemporary and historical). Enthusiast or leisure forms of cooking and baking, and more routine, simple forms of providing meals may evolve in largely uncoupled ways: for example, discretionary forms of cooking may wax and wane, quite unrelated to the steady, day to day reproduction of routine cooking. As patterns of energy demand follow the (relatively) parallel lives of these variants, increased enthusiasm for and participation in cooking and baking may accompany a continued decline in overall energy consumption, if more quick, hob-based meals are cooked from day to day, or if the frequency of cooking declines in other ways. Thus, overall energy demand emerges in the balance of multiple and different patterns of recruitment and commitment between variants.

These trends, themselves, emerge in the flux of the intersecting daily practices and processes of provision. As such, the food industry is heavily implicated in the paths that might be taken: both in the kinds of simple, routine forms of cooking and in the promotion of otherwise enthusiast forms (in which the media industry is also involved). Yet in so far as hot meals remain valued and fixed within daily routines, and those routines are reproduced in stable forms, the pace at which cooking, and associated energy demand, changes may be somewhat slow. This stability (or inevitability) of cooking is presumed in forecasts for the UK over the next ten years (Energy Saving Trust, 2011). However, my research suggests that the same complex intersections that hold cooking routines in place may mean that rapid change could come from unexpected quarters, for example, changing patterns of employment, leisure or food products. This is an unstable field.

In conclusion, based on the variations observed in cooking performances in student accommodation, this chapter has discussed ways of conceptualising variations within the social practice of cooking and the connections to domestic energy demand. It has argued that energy consumption is closely embedded within the practice, such that patterns of demand follow from changes in how people cook, and from the variations in cooking which can be observed today. In organising and describing these variations, I found it necessary to consider not just how cooking is done in general but how particular modes of cooking are organised, and how general outcomes (or concepts service) are achieved in different ways. I then argued for the fundamental importance of the internal differentiation of cooking, reflected in today's variable understandings and ways of cooking, and in the general decline in time and energy invested in cooking since the 1970s. In contrast to previous arguments which link diversification in practices to increased levels of consumption (Røpke, 2004), this account suggests that diversification within a practice can be implicated in declining demand for a particular commodity, energy. However, given the complex flows of other materials, which bind the energy demanded in the home to the production of pre-prepared convenience foods, and the energy consumed therein, the energy used across society in the provision of "home cooked" meals may not have declined so markedly – and may not have declined at all.

In the next chapter, I turn my attention to the energy consumption and practices associated with space heating. In contrast to cooking, this has been a 'hot' topic within energy research for many years, yet the domain is not associated with an archetypal, well-bounded social practice as is the case with cooking-related energy use.

5. VARIATIONS IN COMFORT: CLOTHING AND HEATING IN PRACTICE

This chapter, and the two that follow, address a domain responsible for roughly a quarter of all final energy consumption in the UK: domestic heating (DECC, 2012). This represents two-thirds of the energy used in homes and is the focus of attention for a large portion of energy-oriented research. Although framed in different ways, there is considerable interest in better understanding the demand for heated space, what it represents, how it varies and how it changes. This includes qualitative enquiries into the nature and achievement of thermal comfort as part of everyday life (e.g. Strengers, 2008; Gram-Hanssen, 2010; Hitchings and Day, 2011; Hitchings, 2013), quantitative analyses of monitored indoor temperatures and household data (e.g. Kane et al., 2011, Huebner et al., 2013), some smaller scale combinations of temperature monitoring and interviews (Gram-Hanssen, 2010; Fell and King, 2012; Tweed et al., 2014) and discussion of how theories of thermal comfort may contribute to escalating, sustaining or otherwise reducing levels of heating-related consumption (e.g. Shove, 2003; Chappells and Shove, 2005; Nicol and Humphreys, 2009; Humphreys et al., 2011). In other words, compared to cooking, there is a relatively rich literature at the intersection of everyday practice, comfort and energy consumption. However, few studies have yet explored how variations in room temperature and radiator use are connected to what people do, and specifically to what they wear, in those spaces. This chapter does just that.

This calls for a different approach to explore the connections between comfort and energy use, than for cooking. Firstly, I focus on the demand for heat, that is, the service demand, rather than final energy consumption; this is partly for pragmatic reasons and partly because it is actually service demand and not the efficiency of the building envelope in which I am interested. Secondly, since I could identify no single practice to focus upon, but many potentially interesting aspects, this part of my empirical work was conducted in a more exploratory fashion: in greater depth, with a smaller number of participants and with a scope broad enough to reveal the role of diverse elements of everyday life. However, in analysing my findings, it became clear that clothing played an especially important and interesting role,

but one that has rarely ever been studied in the home. In this chapter, I describe and analyse the relationship between clothing and heating as revealed in my empirical work. In the next chapter, I develop further insights into this relationship through secondary research into the history and material culture of clothing. I begin, in the next section, with a brief history of how domestic indoor spaces in the UK have become increasingly warm. I then outline how clothing has been conceptualised and researched in relation to the indoor climate. I describe the methods I used in my own research, and explain my findings: I compare the ways that participants dress, consider the role of clothing in managing thermal comfort and trace the connections to differences in indoor climate and the operation of radiators. In so doing, I show how clothing and ways of wearing it, co-constitute demand for heated indoor space.

5.1 Home Climates: Warming and Converging

Whilst outside temperatures have been measured in England since 1659, forming the longest-running record in the world (Saner, 2007), there appears to be very little in the way of historical records of indoor temperatures. Evidence from sporadic measurements, though, does indicate that indoor air temperatures during winter were routinely considerably lower in the past. For example, Meyer (2002: 398) notes evidence that in 18th century Philadelphia an indoor winter temperature of 14°C was regarded as "notably warm". Anecdotal evidence of water freezing inside has also been commonly reported.

Thanks to the introduction of central heating, temperatures in homes have increased; they have also become a matter of interest and contention. For example, Meyer (2002) details a comparative history of indoor climate change in the US and the UK for a time in the early 19th century when closed stoves and central heating systems were becoming widespread in the US. The result was a dramatic change in indoor climates, which was much longer arriving in the UK. Written accounts of the experiences of travellers between the countries showed that in the first few decades UK visitors to the US complained of the heat, whilst some of the US visitors appeared to particularly enjoy the cooler winter climates in the UK. But by the end of the 19th century, this had changed and most US visitors to the UK winter found it uncomfortably cold indoors (Meyer, 2002).

Central heating in UK homes is relatively recent, only becoming widespread since the 1970s. During that time record-keeping has also taken off. For example, a large survey of homes in 1978 yielded an average living room temperature of 18.3°C; similar but not identical methods gave figures of 19.1°C in 1996 and 21.1°C in 2007 (Mavrogianni et al., 2011; Shipworth, 2011). In bedrooms, a higher rate of increase was measured from 15.2°C in 1978 to 18.5°C in 1996. Better insulation, longer heating times, and higher levels of heating throughout the house (e.g. hallways and bathrooms) are also likely to have contributed to the growth in temperatures. At the same time indoor temperatures during the winter remain far from uniform. Each of these surveys reported a high degree of variation between homes; but this does appear to be declining, from a standard deviation of 3 in 1978, 2.7 in 1996 and 2 in 2007 for living room temperatures (Mavrogianni et al., 2011; Shipworth, 2011). To some extent, this supports the claim that indoor climates in homes have converged as they have warmed (Shove, 2003).

Moreover, it has been argued that a global trend of converging indoor climates seriously challenges the prospective effectiveness of climate change policies (Chappells and Shove, 2005). If predicated, as most policies are, on universal, standard room temperatures (variably understood to lie somewhere between 19-22°C), the problem of reducing energy consumption is framed as one of increasing the technical efficiency of heating rooms. Not only is this blind to the existing divergence from the narrow range of acceptable temperatures, but assuming a fixed requirement for comfort also assumes a certain level of service demand, thereby limiting the possible degree of reduction in energy use (Shove et al., 2008).

Of course, the energy consumed in heating is not simply a question of average room temperature: insulation, efficiency of the heating system, the volume of space heated, the physical aspect and other thermal properties of the building and the outdoor climate all influence the final energy consumption associated with heating a home. But it is still striking how unevenly spread heating-related consumption is between homes: some households consume 27 times more gas (the most typical fuel used to provide heat) than others (BRE, 2005). From these figures, it can be estimated that the most consuming 30% of homes account for roughly half of the total consumption. Further, because of the many factors

involved, it is conceivable that household energy use for heating could become even more diverse as average indoor temperatures continue to converge.

Amidst this complexity, the project of identifying the most important 'determinants' of variability in domestic heating energy consumption has been the focus of several quantitative analyses. These often show sizeable correlations with income, size of home, the number and age of occupants (Van Raaij and Verhallen, 1983; Sardianou, 2008; Guerra Santin et al., 2009). Thermostat settings and occupancy rates are also important (e.g. de Meester et al., 2013). As far as I am aware, however, differences in the clothing worn by occupants have not been explored in relation to variations in heating energy consumption.

5.2 Clothing: The Skeleton in the Thermal Comfort Closet

Clothing has been of slightly more interest to those exploring and applying the science of thermal comfort in the built environment. The level of thermal insulation offered by clothing has even been quantified, in the form of the clo unit. One clo roughly corresponds to the insulation value of a winter business suit (shirt, trousers, jacket and light underclothes), which is also the level of insulation required to keep a resting person comfortable at 21˚C (Morgan and de Dear, 2003; de Decker, 2011). This calculation is based on Fanger's (1970) heat-balance equation, which was developed experimentally in a climate chamber and specifies an optimum ambient air temperature for 'comfort' (or thermal neutrality) depending on humidity, ventilation, radiant temperature, clothing insulation and activity level. The clo value of particular garments and ensembles are assessed using thermal manikins, are specified in the ASHRAE standards and are used to establish comfortable operating temperatures for commercial buildings (The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Standard 55-2004). Here, I use the term loosely to refer to relative levels of thermal insulation of clothing.

Field experiments into comfort perceptions in different countries find differences in tolerance (or rather, feelings of thermal neutrality) that reflect prevailing climatic conditions. These are to some extent, but not entirely, explained by differences in clothing (de Dear and

Brager, 1998). Physical activity, physiological acclimatization and psychological adaptation (expectation) thus also have varying and important roles to play. This means that any relation that exists between clo and indoor climates is mediated by other influences. In particular, levels of clo, interpretations of comfort and the temperature of immediate surroundings have all been very different in the past. For example, it has been noted that "the inhabitants of Tierra del Fuego, which would seem to be one of the harshest climates in which humans have lived, were usually close to naked, and presumably coped with their need for warmth without clothing" (Ross, 2008: 6). Thus, warmth or thermal comfort can be achieved in different ways: the meanings of these concepts are not universal.

The equation of thermal comfort with air-heating and cooling technologies reflects an historical and systematic neglect in the conceptual articulation of "thermal comfort", which has almost entirely belonged to a specialist literature within building engineering research and framed in terms of the design and operation of building infrastructures, such as air conditioning (Shove, 2003; Nicol and Humphreys, 2009). This is changing somewhat with the growing prominence of an "adaptive model" of thermal comfort which treats building occupants as active beings who adapt their local conditions and clothing to provide comfort for themselves (e.g. de Dear and Brager, 1998, 2001; Nicol and Humphreys, 2009). Even so, clothing's role is still largely reduced to that of a means of adapting either *to* variable thermal conditions or *to* the variable "comfort goals" of those who must share the same conditions. In another genre of research, that which starts from an interest in reducing carbon emissions, a focus on (interactions with) energy-using systems appears logical, and clothing practices[8] tangential. But if energy demand is conceived in terms of everyday practices (Chapter 2), it becomes plausible that clothing might be involved in creating "day to day definitions" and expectations of comfort that are pursued through heating (Chappells and Shove, 2005: 37). Understanding variations in clothing practices, therefore, could help to understand variations in heating demand.

This chapter considers the role of clothing in co-creating demand for heated spaces. Through a study of heating and associated practices I ask: How does clothing vary and why? Does it

8 Note: I use the term 'clothing practices' to refer to ways of dressing and adjusting one's clothes. I do not necessarily imply that clothing is a social practice, as defined in Chapter 2. I discuss the status of this term further in Chapter 7.

work as a thermal "comfort mechanism" (Hitchings, 2009: 93)? And if so, in what way and how is it implicated in heating consumption? To help answer these questions, I pay particular attention to the differences and similarities between four participants. This attention to interpersonal differences also relates to the question of whether divergent demand and/or convergent comfort expectations and conditions are reproduced in the setting of the university halls of residence.

5.3 Investigating Comfort: Methods

This study starts from the premise that thermal comfort is a meta-level concept that is useful to the researcher but may not be reproduced in everyday life in a way that cleanly aligns with an academic definition. Rather, it may intermingle with other ideas and routines organised around various senses of comfort and wellbeing. This is likely to contribute to the different ways in which "comfort" might be understood and done, which adds to the difficulty of talking about and of observing it in practice. As I am especially interested in thermally-relevant practices, as they are performed, observation would be the ideal technique to deploy alongside interviews that could learn more about the meanings being practiced. This is difficult to achieve in someone else's home over any length of time. In addition, my intention is to ultimately link the potentially variable nature of these practices (between practitioners) to differences in energy consumption. To do this, sensors can be deployed in the environment to remotely monitor or "observe" particular, pre-specified events. The opening of doors and windows, the operation of radiators and the thermal conditions in the room can all be monitored. This provides a body of relevant data, however, clothing practices are especially difficult to track in a private, residential setting.

Most studies of clothing as a mechanism of thermal comfort have used observation to reveal the extent of ongoing adjustments made to clothing throughout the day (e.g. Nicol and Humphreys, 1973; Baker and Standeven, 1996). But these studies have taken place in the relatively public environments of offices and schools. Taking observation into homes has lead Gauthier (2011) to work with motion-activated cameras worn on the body. Supplemented with simultaneous temperature logging, this research investigates responses to

thermal *dis*comfort. But it can be difficult and time-consuming to analyse the data collected. In addition, careful consent and deployment is needed to manage privacy concerns. In other studies, self-reports of comfort and clothing adjustments have been used (Morgan and de Dear, 2003). But it appears many questions have not been asked about how people understand these "adaptations"? Of those few studies which appear to qualitatively investigate clothing in relation to thermal comfort, Hitchings and Day (2011) used interviews and diaries to explore older people's practices of staying warm, whilst Brown and Walker (2008) reported an ethnographic study of clothing, amongst other things, as an aspect of vulnerability to heat in nursing homes. Each of these takes a different approach to observing and understanding clothing practices in the everyday context and relation to thermal comfort. In the present study, a self-report diary method is included, with a specific focus on clothing, to encourage participants to engage in self-observation and reflection.

Methods

The study took place between February and June 2012 in four study bedrooms in a student hall of residence on the campus of Lancaster University.

Participants - Four students volunteered to participate: 3 females and 1 male between the ages of 18 and 21. Pseudonyms are used. All were first year undergraduates on different courses and had been living with their parents in the UK prior to moving into the hall in October 2011. Their home towns were in different parts of England: two in the South, and two in the North, and all but Zoe had grown up in these locations. Zoe had moved to the UK three years previously, having grown up in a place with a warm climate.

Recruitment was achieved primarily by email, sent by the officer responsible for day to day management of the accommodation. In addition, posters were put up in the hallways and the researcher engaged students who passed by at the time. A door-to-door recruitment strategy had been planned but proved unsuccessful because there were no shared doorbells for the flats (only exceptionally loud alarms that sounded directly in bedrooms and were not in fitting with a polite invitation to take part). One participant was recruited via another but this snowball technique did not prove as successful as hoped within the relatively short recruitment window.

Location - The study was conducted in a four-storey building with approximately 250 undergraduate residents. It consists of conjoining sections (houses) each containing flats of 3-4 en-suite bedrooms sharing a kitchen. The flats in the corners of the building house follow a slightly different layout than those situated mid-building. Natural gas-fuelled boilers and storage tanks are located on the ground floor of each house and serve the radiators and hot water for the flats in that house. The University's Facilities department is responsible for their maintenance and configuration. As far as could be discerned, the boilers did not have individual metering points. In this light, the study has been designed to investigate heat consumption instead, which can be monitored at the radiator of each participating bedroom.

The site was specifically selected because of the comparable structural design, heating system (its technical specification and configuration) and maintenance regime between each room (and flat). Each bedroom has exactly the same basic features: a radiator with a thermostatic radiator valve (TRV), a window and within an en-suite bathroom, a shower, toilet and sink. All these are provided and serviced through the same institution, meaning that each occupant has similar access to resources and is subject to similar constraints. This helps to isolate the influence of the occupant's practice on any differences in heat consumption and temperature that emerge.

Some caution is needed when comparing room temperatures, however, as the rooms are not located in identical thermal environments: two of the rooms (from 3-person flats) are slightly larger. The rooms are also on different floors. Two are south-facing and hence potentially exposed to the sun; two of the rooms are north facing. There is also a difference in configuration of adjoining rooms which affects the heat the room is potentially exposed to from the broader environment of the building. In particular, Jack's room is located next to a room which houses a boiler and this is something he was aware of. Since all the boilers were located on the ground floor it wasn't necessarily unusual for a ground floor room to be next to the boiler (though his was the only one in the study). But it was unusual in that the boilers were mostly located in kitchens of the flat, and here it was an adjoining storage room. The other rooms are also exposed to different parts of the infrastructure, such as stairwells and kitchens, which could differentially affect their broader thermal environment.

There were three key parts to the study: (i) interviews, (ii) deployment of sensors for logging conditions and activities in the rooms, (iii) a diary task. The precise order and duration of each was agreed with participants at the start of the study, and is summarised in Table 5.1. Following further agreement with 3 participants, the sensor-based data collection continued into the summer term and concluded with an additional short interview.

Table 5.1 Duration of the comfort research for each participant

	Interviews			**Diary**	**Sensors**
	1	**2**	**3**		
Emily	7 Mar	22 Mar	21 Jun	7-22 Mar	7 Mar – 21 Jun
Jack	15 Mar	12 Jun	-	11-12 Mar	10 Mar -12 Jun
Nadia	25 Feb	23 Mar	-	19-22 Mar	28 Feb – 23 Mar
Zoe	25 Feb	24 Mar	28 Jun	12, 20-23 Mar	27 Feb – 28 Jun

Interviews - Two to three semi-structured interviews were conducted with each participant, lasting between 30-80 minutes. In most cases, the first interview preceded the diary task and sensor deployment. It featured general questions on the meaning of comfort, particularly in relation to living on campus. It moved on to discuss the thermal aspects of comfort and the activities and materials that might be involved. It concluded with discussion of clothing and the features in the room about which the sensors would collect data (doors, windows, radiators) (see schedule in Appendix 2). The second interview followed the diary task and a period of sensor-data collection. It was largely framed around the diary, and returned to the topics of clothing, thermal experiences and the use of the features in the room. Data from the sensors was also presented to and discussed with participants. The third interview (Emily and Zoe) had three foci: a) changes in thermal experiences and coping tactics for the warmer time of year, b) reflections on the thermometer that I had left with them, and c) discussion of further patterns in the sensor data.

Sensors - The aim of deploying the sensors in each room was to unobtrusively and remotely capture traces of activities associated with the thermal management and use of the space. This included:

- Contact sensors for windows and doors (bathroom and main)
- Temperature and humidity sensors (main room and bathroom)

- A motion and light sensor (main room)
- Socket-based electricity monitors

The above sensors were deployed in a wireless network and logged using a small computer (a Mac Mini) that was placed as unobtrusively as possible under each participant's desk. In addition, a number of small, stand alone temperature sensors (iButtons) were fixed to:

- The radiator inlet and outlet pipes
- The hot water pipes at the sink and shower
- A surface in the study-bedroom
- Just outside the main door

To monitor outdoor climatic conditions an Oregon Scientific 'weather station' was located on the roof of one of the buildings on campus, connected wirelessly to a logging computer located nearby.

Diary - The primary aim of the diary was to raise participants' awareness of the features in daily life that relate to thermal experience and regulation, in order to promote a fuller and more insightful discussion during the interview. It also aimed to engage the self-observational services of participants for two elements which were otherwise difficult to monitor with sensors: clothing and adjustments to the radiator valves. There were three main parts to the diary and participants were invited to try each over a suggested period of 3 consecutive days not too long before the second interviews were scheduled. These were:

- A photo journal of clothing
- A log of "comfort" activities and experiences
- A quick, open questionnaire to complete at the end of the day

For the log, two options were provided: (a) a paper diary sheet for each day, where coloured stickers could be applied to denote particular "events"; notes could also be added, (b) a smart phone with a specially designed "comfort diary app" which allowed participants to log broadly equivalent events with a few button presses. It was also suggested they could use the camera on the phone for the photo journal. The questionnaire was presented in paper form along with the log sheets and instructions/ information about the task (see Appendix 3 for an extract from the paper diary).

Analysis - Interviews were fully transcribed and thematically coded using Nvivo. Paper logs were transposed into spreadsheets comparable to the records from the phone app. Questionnaire responses were transcribed (from the participant's own hand-writing). The sensor data was loaded into Matlab for graphic presentation and computational analysis. The diary and sensor data were used to elicit richer accounts in the interviews; they have also been used in the analysis, where they support what is a largely qualitative analysis of each participant's "case" based mostly on the interviews. As this analysis came to focus mostly on clothing, the sensor data from the windows in particular does not feature strongly in what follows.

5.4 Comparing Clothing

In order to trace the connections between clothing and energy demand, I start with the relatively simple question of how clothing is "done" by this small sample of student residents. I focus here on the "snapshot" collected through the interviews, diaries and photo journals in the main study period in late February and March. As can be seen in Table 5.2, there are commonalities *and* variations amongst the four participants. For example, jeans and t-shirts were frequently worn by all, but for Jack and Nadia these staple garments featured everyday (though the precise items varied) and would be worn when in their rooms and elsewhere on campus. In contrast, both Emily and Zoe would dress specifically for leaving their rooms. This meant they wore different clothes inside and, for outside, the type of clothes would vary from day to day depending on the weather, though keeping to much the "same style" (Emily). When inside her room for any length of time Zoe would change into cotton pyjamas and Emily would "nip back" into her "loungewear" which was a t-shirt and tracksuit (trousers) usually worn with a dressing gown.

*Table 5.2 Indicative descriptions of how participants 'do' clothing. *The discussion of clothing priorities is framed by a prior discussion of comfort in general, and thus reflects different senses of comfort. In other contexts, it is likely that (some) participants would have mentioned fashion and aesthetical priorities more explicitly.*

	Zoe	**Emily**	**Nadia**	**Jack**
Example outfits *i = during interview* *p = photo journal* *d = described*	i) tights, shorts, ¾-sleeve top p) jeans, vest under jumper p) jeans, polyester top p) jeans, cotton hooded shirt d) tights, shorts, jumper	i) trousers, t-shirt under jumper d) trousers, t-shirt under cardigan	i) jeans, t-shirt p) jeans, t-shirt p) jeans, t-shirt p) jeans, t-shirt	i, d) jeans, long-sleeved shirt under 2 t-shirts
What's typical?	"I'd be wearing jeans with a sweater or something most of the time"	"I just pretty much wear, not the same clothes but the same style of clothes"	"it's all… pretty much the same. I mean my basic is… t-shirt and jeans"	"I always wear one shirt and two t-shirts"
When staying in	"Mostly when I'm in my room I prefer wearing pyjamas all day and night"; if it's cold adds one or two t-shirts underneath	"I usually just nip back to my lounge clothes, my loungewear": t-shirt and tracksuits, dressing gown	Similar to above: "comfy" pair of jeans and a t-shirt but "it's not that much different from when I'm out"; slippers; sometimes pyjamas "if I've had a long day"	Same as above
Wardrobe and range	"A lot of clothes…more than I need" including "enough clothes for winter, yeah, my sweaters and jackets and stuff"	"I brought a lot more this term because I was bored but I don't really wear them"; needed more jumpers, tights and shoes for winter.	"Just a basic wardrobe" "just a few pairs of jeans, t-shirts, I like my plaid shirts… just general clothes like that" but coped well with winter: "I came prepared."	"cartoon character wardrobe" "loads and loads of pairs of identical jeans, loads of pairs of similar t-shirts and loads of pairs of this shirt in varying colours."
Clothing priorities*	That clothes suit the weather - cold or sunny (when leaving the room); to be able to wear cotton clothes; to avoid feeling cold; that clothes don't smell of cooking.	To "feel as if I'm me"; to feel comfortable wearing them; that they match; that clothes don't smell of cooking or are dirty or creasy.	To feel comfortable wearing them; that clothes fit well and don't itch or rub; to be free to wear a t-shirt; to avoid feeling cold.	To not freeze when leaving the room; to conceal arms from view; to avoid change and changing during the day.

There is diversity in what is worn within the bedrooms. These indoor outfits can be graded roughly in terms of the insulation provided: from the lightest, Zoe in her cotton pyjamas, followed by Nadia who claims to be mostly able to wear just the single t-shirt with her jeans,

to the more insulated end, Emily if she is wearing her dressing gown, and Jack, in his undeviating long-sleeved shirt with two t-shirts worn over it. It is possible, that if calculated in terms of clo value, these bedroom outfits could differ more widely than their 'outside' outfits. Even so, some absences can be noted: none of the participants at the time of the first interviews *in late February or March* were regularly wearing jumpers in their bedrooms, nor were any wearing more than three layers on their upper bodies.

As can be appreciated, there are differences in how frequently participants change their clothes, in other words what they dress *for*. But there are also commonalities. Changing into (and out of) specific clothes for sleeping was common to all. Each female participant referred to pyjamas, whilst Jack talked about sleeping without anything on his upper body (under an un-filled duvet cover or "quilt"). For Jack, this was the only change from one outfit to another that featured in his daily clothing routine. Zoe, Emily and Nadia all talked about changing into clothes for going out with friends in the evening and captured this in their respective diaries. On these occasions, they tend to be "pickier" (Emily) and wear less in terms of layers: "even if it is cold we don't really… wear a sweater or anything when going out" (Zoe). But Emily did take a cashmere cardigan with her which "does keep you warm" and "it's not much different" for Nadia (leggings and a long top) for whom feeling comfortable remained important. In addition to these changes for sleeping and "going out", Emily and Zoe changed for "staying in". For Zoe this was primarily because she didn't like the feel of the material from which jeans are made. And neither wanted to wear clothes in public that carried cooking smells on them: "say I cook and then I go to the library, I don't really like staying like that… you know, I don't really like that smell. So I have to change clothes" (Zoe), "I'm constantly changing all the time. It's quite annoying… because I wouldn't want my outside clothes to smell like food" (Emily). Broadly speaking, then, the range of activities the participants engaged in on a day to day basis was similar, but some participants dressed differently *for* certain of these activities whereas one set of clothes was fine for others across nearly all activities. On the whole, the participants appear to get by with between two and four broad clothing styles (sleeping, casual / outside, lounge / inside, going out). Formal clothes, sports or active clothes, ritual or traditional dress, or particular dress for other activities were not evident in this study.

In this descriptive comparison of four ways of clothing, some reference has already been made to the thermal side of life. Indeed, participants did, more or less freely, refer to thermal conditions when talking about how they dress. But this often included ideas of comfort more broadly understood. Participants seemed to share a notion that clothing, at least at times, should be comfortable to wear and/or that one should feel comfortable wearing it (these are not necessarily equivalent). Yet despite these shared ideas, there were differences in what counted as a comfortable property of the clothing or as comfortable state when wearing it. Let me consider this briefly before focusing on how clothing featured as part of thermal management, which I do in the next section.

Nadia was the quickest and most consistent to talk about comfort in clothing. In fact, Nadia was the only participant for whom an open question about the importance of "physical comfort" initially and immediately made her think about clothing. She responded:

> "I'm not one for trends. I just wear things that if… you know I mean feel comfortable rather than trying to dress to impress people… I mean I'm sat here in t-shirt, I'm comfortable in that rather than… you know"

For Nadia, materially comfortable clothes ("not too tight… not too big… nothing that's… gonna rub and gonna itch") are what she is comfortable wearing both around other people and when on her own. Emily specifically mentions various material properties of clothes that prevent her from feeling socially comfortable wearing them outside: they cannot be "dirty or creasy" or "smell of food". This means reserving different clothes for use outside. It's also important to Emily that outside clothes match and are identifiably hers. Conversation with Zoe tended to highlight the material comfort of clothes, either in the guise of a particular dislike for "jeans type of material" or a like of wearing "cotton clothes more". In her diary, she noted down the materials like polyester or cotton that clothes were made out of. And for Zoe, who has a particular relish for the weather, it matters that her outside clothes (though she doesn't use the term, unlike Emily) are suited to it. And when asking Jack if his choice of clothing is comfortable he replies:

> "I suppose it's comfort in the familiar. Err, I don't really buy new clothes, I have kind of an aversion to change. If I get…comfortable with one kind of way of being then I'll stick to that rather than changing it all the time."

In summary, this section describes four different ways of clothing by four participants, highlighting some of the most common elements: the clothes themselves, such as jeans, t-shirts and pyjamas, the activities that require dedicated clothes, such as sleeping, and the idea that clothing should make one feel comfortable. I have also set out some differences. In particular, being comfortable in clothing can mean different things. For some, it means maintaining one's way of clothing from day to day and throughout the day, either because that is the most physically comfortable way to be or because this constancy and familiarity is in itself comforting. For others, being comfortable in one's clothes means changing garments, style and priorities from day to day and throughout the day to suit different situations (the presence of other people, the sun or the cold) and activities (cooking, staying in). Thus, even in this small group of four, these different ways of thinking and organising clothing are reflected in the diverse range of garments worn inside their respective homes. Most remarkable is the distinction between those who divide their clothing strategy for inside/outside and those who do not. This is not a distinction based upon engaging in completely different practices and their inherent 'dress codes'. Rather it is the role and meaning that clothing has within common, generic activities that differs. These different ways of clothing clearly have thermal implications, though we cannot as yet be sure if these are intended, so let us now consider the extent to which the participants explicitly organise their clothing around thermal comfort.

5.5 Clothing as Thermal Adaptation

It seems obvious that clothing insulates the body to varying degrees so that a person can be comfortable at different ambient temperatures by varying their clothing. And indeed, this was evident in the participants' understanding and reported practice of clothing on a cold day. They would add jackets, jumpers, scarves and cardigans when going outside and each had a similar way of assessing the outside conditions: to look out the window and feel the air as the window is opened (supplemented by reports from flatmates (Emily) or a visit outside to smoke, (Jack)). This affected whether they wore an additional outer layer(s) and if so precisely what kind. Although the precise garments varied depending on the conditions and from person to person, and although their assessments were not always successful, each person

responded knowingly and explicitly anticipated the climatic difference posed when venturing outside. In the thermal comfort literature this is referred to as a thermal adaptation (Morgan and de Dear, 2003). The term is specifically associated with the adaptive comfort model and it conveys the idea that people use clothing as a response to thermal conditions in order to maintain and achieve their "comfort goals" (Nicol and Humphreys, 2009). This can also apply to the clothes put on when people get dressed, particularly if that choice of clothes varies with the season, as Morgan and de Dear (2003) have illustrated. But the term, adaptation, is most resonant with the observed modifications that people make to their clothing throughout the course of the day in response to variable thermal conditions *in the same space* (Baker and Standeven, 1996). One of the key questions posed by the present study is whether clothing operates in a similar way in this residential, private setting. First, let me consider the role of climatic factors in the selection of whole outfits.

Dressing for the Weather?

As above, it is not surprising to find that coats and jackets were added when going outside. But conditions outside also affected the combinations of clothes that participants put on for the day to wear *underneath* those jackets. Discovering this of her own practices surprised Emily: "I didn't quite realise that the temperature would affect what I'm wearing. I was just like 'as long as I had a jacket on it'll be fine', well, that's what I thought before but… there's so much more than that". She realises, in keeping the diary, that "if it's quite hot I'll just wear a normal t-shirt, cardigan… jeans and walk out but… if it happened to be cold, put on my jacket, tights, skirt or jeans and yeah… bit more layering". This was repeated with Nadia: "I mean my basic is… t-shirt and jeans, so, and then it'll… whether I wear a cardigan or what cardigan I wear will depend on… what it's like outside". On a very cold winter's day this might be extended further but the same principle applies: "I'd probably wear what I'm wearing now, the t-shirt and the jeans and then maybe just a shirt on top so I've got some long sleeves and then…put my cardigan on, my thick cardigan". In contrast to Nadia's incremental clothing adaptations over a base style, Zoe tends to adapt her whole outfit to suit the weather on a day-to-day basis (and even during the day). If it's sunny, which Zoe also equated to being warm, she likes to wear "cotton clothes" but if it is cold she would want to wear "sweaters and stuff". In more detail, this could mean on a cold day: "jeans, no tights, over that jeans (laughs) and I'll be wearing at least two or three tops… and over that a jacket

of course… Hat and scarf." But "if I feel like 'oh the weather is fairly alright' then I choose something lighter" such as the jeans and polyester top recorded on one day in her diary and jeans and vest on another day. Such is Zoe's responsiveness to the conditions outside that it even contributed to a complete change in her outfit during the day, as it got colder outside in the evening. In contrast, for Jack, it was not temperature but rain that prompted the only variation he acknowledged in his standard outfit. On wet days, he put on a hooded long-sleeved shirt under two t-shirts in place of the more usual non-hooded shirt.

A degree of responsiveness to outdoor conditions was, thus, common to all participants in a way that affected what they wear when *inside*. For most, a response to cold conditions outside added insulation to clothing worn inside. *If* the indoor climate varies in line with external temperature variations this would be a good thermal adaptation. Otherwise, in thermostatically controlled environments, this is an adaptation to a largely dissociated climate. It means that time spent indoors on days that look cold outside would actually be experienced as warmer. The findings suggest that such an experience would principally occur for Zoe and Emily in other indoor climates, since their ways of dressing in their own rooms seem to be routine and unvarying, regardless of the weather. However, such inside dress did still appear to be waived during the day when not staying in the room for a sufficient time to warrant getting changed especially for it.

Adapting to the indoor climate

Although I cannot be certain, the clothing worn by each participant for the majority of time they spend awake in their room appeared to be relatively stable and consistent with the descriptions given above (summarised in Table 5.2). However, some changes to these outfits on days when the indoor climate felt cooler were reported. When asked, Nadia reported that she might wear a long-sleeved shirt over the t-shirt and under a cardigan. Zoe reported wearing a t-shirt or two underneath her pyjamas but this arrangement did not appear to be too frequent. At the time of the first interview, at the end of February, Zoe said she wouldn't need those extra layers since "today is nice and warm I think". She does not wear a dressing gown. In contrast, "it wouldn't matter at all" to Emily if it was cold outside because when staying in she says she "can afford to walk around in my dressing gown, my trousers, my top". She only seems to recognise and respond to the cold indoors when it is very cold. This

happened at times over winter in a way that Emily had not experienced before: she describes how, when alone in her room, she "wore two jumpers, two tights, three socks, two hats and… wrapped myself with my throw-over. Just walking around like a penguin (laughs)". So each of the female participants responded to a feeling of coldness in the indoors climate by wearing a different arrangement of clothes. Jack did not. This is because Jack simply never felt that his room was cold. He did acknowledge at times feeling chilly, but only when he was ill and "my… way of sensing temperature has been askew rather than the temperature itself'. On these occasions "I'll have another jacket or two… but that's a rare occurrence".

Such re-arrangements in what participants change into for days when they feel cold seem limited. These were by most reports rare responses which were not apparent during the study period. Jack is unequivocal about the constancy of his clothing. For Zoe and Emily the study could easily have missed turning up differences in their inside wear from day to day, but they didn't respond as if they had an explicit, ongoing strategy of changing and adapting clothing to variations in the inside climate. Nadia is the exception: it seems likely that she did wear an additional long-sleeved shirt inside during the study period (though not apparent in the diary, it was in the way she talked about dressing at the time) and, significantly, she is the only participant whom I am confident did adapt her clothing *during the course of a day* specifically as a response to *indoor* climatic conditions in her room. This was the addition of cardigan over her t-shirt for some but (as indicated in the diary) not most of the time she spent in her room.

In summary, participants do explicitly use clothing as a thermal "comfort mechanism" but this is mostly about managing outside climates, rather than responding to variable indoor conditions in their rooms. Yet although the style of clothing worn in these spaces was relatively consistent from day to day, there were differences between the participants. These differences may be significant. Firstly, they may reflect differences in the indoor climate between the rooms. For example, it may be that lighter clothes such as pyjamas and t-shirts are worn *because* it is generally warm inside. Secondly, clothing may be implicated in *generating* differences of indoor climate and heating demand in the first place. In a dynamic relationship, it is difficult if not impossible to pick apart these 'contraflows'. But just as I have spent time considering how and whether clothing is deliberately used in adapting *to* indoor

climates, I should consider the other perspective: that indoor climates are an adaptation *to* clothing practices.

Climatic Adaptations To Clothing

This study does indeed help to show that indoor climates are, on occasion, adapted to the clothing that people wear. The clearest example is an explicit strategy of Jack's to keep his clothing constant, whilst regulating and adjusting the climate of his room to suit. Jack's priority is to keep his room cool enough to be able to perform the "way of being" and doing clothing with which he is most comfortable: his set pattern of jeans with a long-sleeved shirt worn under two t-shirts. Because although Jack wears the most layers in his room (comparable in insulation terms perhaps only to Emily in her dressing gown) he is the only participant to find the climate of his room consistently and uncomfortably warm. He "can just about get by in here with the fan and the window" which he has worked into daily routines of frequently opening the window widely whilst cranking up the electric desk fan placed by his bed. Whilst Jack would add layers on top of his basic set of three when going outside, he resisted taking any of those standard three layers off when coming back to spend time in his room. Prior to the study, the option of adapting his clothes to reduce his discomfort might not have occurred to him, since it was clearly the room's climate which was problematic. Taking part in the study, the diary task in particular, invited him to reflect so that by the time of the interview it had occurred to him that his clothing "for the purposes of being in here is, is absurd really". But he remained resistant to changing it, partly because he was able to justify it as a strategy that provided him with a "middle ground" from which, with the help of up to three additional layers, he could negotiate external climates without "freezing". It was also apparent that Jack wanted to conceal his arms from view. In other words, Jack had a way of clothing, with its own logic, around which the climate of the room had to adapt. He differed from the other participants in that he made a very deliberate effort to do this; but similar ideas can traced in the accounts given by the others, too.

Across the other participants, it seems comfortable climates can be defined by and expressed in terms of the ability to wear the clothes in which one feels comfortable. For example, Nadia likes "being able to just sort of sit like I am now in a t-shirt rather than having to put any like jackets on or any you know jumpers or anything". Emily reports feeling particularly

comfortable at a certain time in the afternoon when she is able to open the window, and "wear layers" whilst relaxing on her bed. Zoe's clear and stated preference for wearing pyjamas "all day and night" also requires a certain degree of ambient warmth and does not appear to have been frustrated except on the odd occasion over winter. Thus, the way of clothing in which a person becomes most comfortable (in a general sense) has implications for what indoor climates should be like and how they are managed. That this principle appears to be shared means that the differences in clothing strategies identified are, from one perspective at least, differences in heating demand. In other words, the non-thermal and thermal comfort of wearing pyjamas or a t-shirt engenders a form of demand for climatic conditions that differs to that of dressing gowns and tracksuits or layered shirts. Next, I will trace the lines of interaction onwards from clothing to consider the climates of the rooms, the ways in which they were managed, and finally the implied energy demands.

5.6 Connecting Clothes, Climates and Energy

When considering how clothing practices might both adapt to climate(s) and configure them (those indoors), inevitable questions are raised about the climates themselves. Is the apparent lack of ongoing 'thermal adaptations' to dress within most of the rooms during the course of a day appropriate to the stability in that climate? Do the different clothing practices indicate different temperatures? In this section, I broaden out the focus with a look at how the participants experienced the climate of their rooms and compare this to what was recorded by the sensors.

As summarised in Table 5.3, all the rooms at the time of the study were experienced as being warm. To Zoe, Emily and Nadia this was not "too warm" most of the time. For Jack it was "incredibly warm" and he frequently found it uncomfortable. By the time of the second interview towards the end of March, all participants reported moments when they did feel uncomfortably hot, typically this was during the night or when coming back into the room after being away from it (Emily and Nadia) and even Zoe who claimed to "need it a bit warm", noticed it had become unbearably hot in her room on the morning before the second interview. This followed a couple of warm, sunny days. In general, rooms were heated to a

Table 5.3 Summary of how participants experience the climate in their rooms and elsewhere.

	Zoe	Emily	Nadia	Jack
What's the climate of the room like?	"It does not get really hot". Only been cold at times in December. Mostly fine.	Mostly fine. Wakes up hot or "feeling stuffy" in the morning. At times over winter it was surprisingly cold.	Doesn't struggle to warm up or cool down, "most of the time I'm fine" but compared to home it's "hot all the time"	"incredibly warm"
Preference?	"cos I come from a hot country… I need it to be a bit warm"; but "I don't like it to be really, really hot like on a really hot sunny day. But I wouldn't want it to be too cold either. I'd want it to be… at an average normal temperature"; about 24°C	"that it's not too hot" "warmish" but not hot enough to make her feel ill. 22.7°C	"I like the temperature to be not too hot not too cold", likes being able to "sit in a t-shirt"	About 17°C
Ever felt cold?	"in December when it was really, really cold sometimes the heaters wouldn't work"	"it was considerably cold in here" "more than what I expected"	Sometimes if "had the window open too long and it's been a really cold day outside"	Only when ill
Ever felt hot?	"it was a bit warm so I opened the window"	At night and when coming back to room.	Coming back to room, and at night when in bed.	Most of the time
Compared to home?	Comparable to UK home town, a lot colder than where grew up abroad	Colder region here; the heating is much better at home.	A lot warmer here. Colder at home, especially getting into bed.	By implication, much warmer here
Compared to elsewhere on campus?	Kitchen and corridor get really warm	Friends rooms can be really cold or really hot. Learning zone can be hot, kitchen usually cold.	Kitchens and corridors warm	"very often find myself a bit chilly" in other places on campus, including the kitchen
Most comfortable or enjoyable thermal experiences	Loves gloomy rainy windy weather. But also liked being outside when sunny and warm. Likes to be able to wear cotton clothes.	A nice room temperature is having the window open, and wearing layers, whilst laying on bed relaxing to music	"where I feel cosy but not too cosy" e.g. enjoyed feeling "nice and cosy" in bed, and being outside in warmer weather	When going outside for a smoke; lying on bed with no t-shirt and fan on.
Activities in room	Study, sleep, watch something on laptop	Sleep, work, eating, listening to music. Cleaning, ironing	Sleep, watch something on the computer, do a bit of work	Sleep, read, guitar, pass the time, occasional work
Time in room	Most of the time	Very little. But more than usual during March, because of work	Most of the time	Most of the time other than the evenings

level that allowed for the frequent wearing of pyjamas and t-shirts, whilst being potentially too warm when sleeping under duvets at night, or when returning to the room wearing "outside" clothes. For Emily the latter experience, in fact, resulted in a further thermal clothing adaptation: "whenever I come back from lectures and seminars I take off my cardigan, my shoes, sometimes my trousers, just walk around".

Table 5.4 Temperatures recorded in participants' rooms and outside. NB. There may be some discrepancy when comparing these figures attributable to the sensing: the figures come from slightly different sensors in slightly different locations in each participant's room.

	Lent Term (until 22/3/12) (˚C)				Easter Holiday (23/3/12 – 22/4/12) (˚C)			
	Average	SD	Min	Max	**Average**	SD	Min	Max
Outside	**9.6**	3.10	2.1	17.2	**11.3**	5.10	-0.1	24.8
Zoe	**25.8**	0.97	22.6	28.1	**27.1**	1.23	23.6	31.7
Emily	**22.5**	0.86	19.0	24.6	**23.0**	0.64	21.6	24.6
Nadia	**23.6**	0.67	21.4	25.4	**-**	-	-	-
Jack	**21.2**	0.64	17.1	23.1	**22.5**	1.01	19.6	26.6

As reflected in these experiences, the temperatures recorded in the rooms in March (Table 5.4) ranged between an average of 21.2˚C in Jack's room, at the lowest end, and 25.8˚C in Zoe's room, at the highest end. The average temperature in Emily's (22.5˚C) and Nadia's (23.6˚C) rooms were in between but they were still undeniably warm in comparison to the average outdoor temperature during this time, which was 9.6˚C. From my earlier account of clothing and the demand it engenders much of this is as expected: that Jack's room is the coolest is in fitting with his three layers, but is nevertheless still warm enough to pose a problem for him. That Zoe's room is the warmest is in keeping with her mostly unchallenged desire to be comfortable wearing light pyjamas at any time of the day. In simpler terms, divergent expectations for coolth and warmth are played out in divergent indoor climates. But to follow the logic from expectation through to climatic difference I need to demonstrate there are appropriate differences in climatic adaptations, that is, in the control participants exerted over the conditions in their rooms.

Sure enough, temperature differences between the rooms can be readily associated with the participants' accounts of their approach to heating (Table 5.5): Zoe left her radiator on, turned up to the maximum setting on the TRV, whilst Emily, Nadia and Jack did not have theirs on at all during the study period, apart from the odd occasion when Emily used it to

dry her clothes after doing the laundry. That Jack's room is cooler than either Nadia's or Emily's despite this similarity may well be associated with his evidently more active and intentional strategy of using the window and fan to cool the room.

Table 5.5 Indicative participant accounts of climatic adaptations

	Zoe	Emily	Nadia	Jack
Windows	To cool and because it gets stuffy "have to keep open for at least some time during the day". Leaves open when goes out.	Used to cool the room, without "it would be really hot in here". Shut at night (for noise), but open just before sleep and when wake up. Open a lot.	"usually have it open a few hours each day" " to let a bit of air in" – to avoid "sitting in… stale air". Open at night.	"usually on the latch all the time to try and draw air through" – about drawing in cooler air. Shut at night (for fear of disturbance).
Radiator	"I don't really bother with that much" "I just leave it on cos I don't know when it goes off and on so". On during the most of the study: highest setting in March, off for a couple of weeks in April, then back on in a less regular pattern (max setting on last interview). Used for drying clothes.	"It's off now because it's not that cold but if it gets colder in the near future I will have to turn it on again." Mostly off during March, came back on in April. Didn't appear to work consistently over winter: "it's only been about three or four times it broke down and I caught a cold". Also used to dry laundry.	Puts on heating "the odd time when I'm feeling a bit cooler", but "haven't needed it on that much". Has TRV set to 2 on first interview to "keep the temperature of the room right" but it's not on at the time. Afterwards it's set to 0.	Never been used
Fan	No	No	Has one, used in October a couple of times "to blow some cool air in the room", not used recently	"on pretty much all the time"; sometimes puts extractor fan on and leaves bathroom door open

Thus, the comparative differences in temperature between the rooms can be associated with controls that the participants have exerted: their climatic adaptations. But on the whole, the warmth compared to outside temperatures is striking, even in rooms that were not being heated. The similar temperatures in Emily and Nadia's room appear to represent a baseline (for the building) that may well be similar in all the rooms, and not due to the influence of the residents. To shift a room temperature in either direction seems to require an input of energy, either to drive the fan to draw cooler air around the room when the window is open or as heat through the radiator. In doing so, neither Jack nor Zoe were necessarily explicitly acting to create the ideal climate for their way of clothing but their respective tolerance for heat was no doubt informed by their clothing practices, which in turn affected how actively they sought to cool or heat their rooms.

5.7 Comfort Strategies

By focusing on clothing, the above account does not consider the full extent of the thermal comfort experiences and the related materials, actions, routines and expectations. For each participant, we might call this a thermal comfort portfolio, strategy or integrative approach. If compared across the participants, on these terms, clothing would appear to assume a differing function and importance in each portfolio. For example, Nadia readily associates being cold with putting on a cardigan *and* closing the window. For Emily and Zoe, coldness didn't seem to be part of everyday life in their rooms. Instead, it was a rare and crisis-like event that happened over winter and reconfigured everything else in daily life. In fact, both retreated to bed. Emily's portfolio for coping with this crisis-like cold also involved extra throw-overs, the radiator and "a nice cup of hot chocolate", whereas Zoe's included blankets, teddies, hot-water bottles, hot towels and cups of tea. Neither emphasised clothing and it required some prompting to find out if they used clothing *at all*. Emily did report trying multiple layers, but it seemed that wrapping oneself in a duvet and throw-overs was a preferred way to add insulation (again disrupting daily life). Zoe, it appeared, didn't do more than put on a couple of t-shirts under her pyjamas, preferring to rely on explicit sources of heat, such as the radiator, a hot water bottle and "steaming hot towels".

It was also intriguing to note the pride (or pleasure) with which the participants reported their routines for managing conditions in their room. Nadia smiled as she compared her routine of opening the window first thing, to how others might get a hot drink or go for a shower. Similarly, Emily developed a routine of opening the window before and after sleeping. Jack refers to his "rituals" for cooling himself and cooling the room, that seemingly integrate smoking, the fan, opening the window wide and drinking tea. It appears that thermal comfort is performed in the shape of these repeated integrations of different things and activities into routines. The more complex of these routines (Jack's) are reminiscent of how residents in low-impact passive houses talk about managing the house, on a daily basis, as if it were a ship (Woodruff et al., 2008).

It is also interesting to speculate on how habitual ways of dressing in particular might have developed and proved effective in one setting, but 'fail' in another. Such pre-established

habits, or long-term modes of thermal adaptation become routinised. As such they are not noticed; and when they are they appear difficult to change. This is most apparent in Jack's case. Zoe was also not sure if she drank tea because it helped warm her up, or because she was in the habit of drinking tea. Something appeared to be comforting in itself about these habitual arrangements and routines. But they are not as fixed as they might appear. For Zoe the tea-drinking declined as the weather got warmer. Even Jack had eventually "lost a t-shirt" by June.

Relatedly, practical know-how and ability to regulate one's own temperature is clearly important in each participants approach, but this did not seem to be on the basis of shared common knowledge: Emily and Zoe's accounts implied they simply did not know (from experience or cultural knowledge) what to do when the heater didn't deliver the warmth they were expecting, so they innovated in different ways. Such skills and related 'folk' theories (Kempton, 1986) of "heat", "cold" and "getting warm" appeared to be important in the way that difference or commonality emerges and how it affects the demand for heat. For example, Nadia, who didn't recall it being particularly cold this winter, and who readily used clothing as an ongoing thermal adaptation, reported that she found it "easy to regulate my temperature if I need to", which reveals not only a sense of competence but also an explicit idea of what she is doing: regulating her own temperature. At times Jack seemed to share this notion, but he seemed more prepared to think of feeling cold as his own, internal state whereas the condition of being 'too hot' was definitely attributed to the room.

Social conventions, including those of gender, were also relevant. Participants appeared to be navigating a number of clothing injunctions in different ways: some of which they downplayed altogether, some they carried into their rooms and some they left at the door. The relative lack of social injunction when in private, appears to work in different directions: some choose pyjamas, others tracksuits and dressing gowns. This space is further 'freed-up' by the relative dissociation of indoor and external climates. In a more variable and uncontrollable form, the former could serve to 'regulate' ways of dressing in a more cross-cutting manner. If clothing and climate practices continue to evolve and diverge in largely controllable and largely private spaces, how diverse could they become?

To conclude, in order to explore the energy demand for heating I have, in this chapter, presented an account of differential demand that is as much to do with clothing practices, as with climatic adaptations and the recorded temperatures in the room. I argue clothing's role in this divergent pattern is more than circumstantial and more than a post-hoc adaptation to enacted climatic preferences. It is intertwined in an ongoing interaction where clothing is adapted to climate, and climate is adapted to clothing. This is a dynamic dance played out across multiple time-spaces: from hour to hour, from day to day, from inside to outside, from one home to another. And from person to person this dance can follow distinctly different patterns. By iterative repetition, in a context that is sufficiently free from social injunctions, it is easy to imagine how differences become self-reinforcing and climates and heating demand become genuinely divergent. Some authors argue that greater climatic control for building occupants is important in lowering energy demand (e.g. Cole et al., 2008). But in this setting, because of the way the demand for heat was distributed, it seems that a higher degree of occupant control over the climate would not result in lower energy consumption: the majority of the total heat "consumed" was in Zoe's room and she was comfortable with the result.

In the next chapter, I extend my exploration of clothing in relation to thermal comfort. Picking up the dynamic relationship with indoor climates at quite a different scale I explore the history and material culture of clothing, focusing on how it has changed, how it 'works', and how it may yet continue to change in relation to indoor climates.

6. CLOTHING: TRENDS, T-SHIRTS AND EXTRA JUMPERS

In the previous chapter, I argued that clothing co-constitutes the demand for indoor heat. This research shows that, for any individual, it is at least possible for clothing to "lead" in the dynamic relationship with indoor climate and that clothing is not simply an adaptation to it. This suggests that a growing and widespread preference for warmer clothing combinations, even if not intentionally adopted for warmth, could lead to a widespread reduction in indoor heating demand and thus energy consumption. It is relevant then to expand from the micro-dynamics of clothing and indoor climate control to a broader consideration of the dynamics of clothing and the insulation they offer over time and how this has interacted with changes in indoor climates. At the most coarse level, it appears incontrovertible that compared to one or two centuries ago, the clo value of indoor winter clothing in the UK is today less whilst the temperatures of homes and other buildings are higher. But how has this happened? And are the two related in any way? This is the topic of the first section that follows. I then consider the role of particular types of garments within this broader history. Finally, I return to consider the role of material properties and relations between garments, and the kinds of systems in which the thermal insulation qualities of clothing evolve.

6.1 Going Casual: A Brief History of Clothing

The transformation of the indoor climate of UK homes between 1950-1985 does not appear to have unleashed new, lower-clo styles of clothing. Rather, such a transformation in clothing was already well underway. A shift towards lighter, more casual and more revealing styles of clothing began in the late nineteenth century, amid a raft of other social changes. This is not to say that clo levels worn specifically during the winter periods were not affected by the broad arrival of central heating, but that commonly worn styles have not changed so dramatically since the 1950s and 60s as they did during the preceding hundred years.

One of the changes that appears to have influenced general styles of dress, was the rise in the late 19th century of (upper and middle class) leisure and sports activities, such as golf, tennis,

bicycling, boating and more latterly motor-driving. Whilst the many social occasions of the upper classes had previously demanded dedicated and appropriate costumes, this growing diversity of social activities also had new physical demands. Previously established forms of dress (for that classes) restricted movement and most likely became very warm and uncomfortable when active. New sports costumes were often made out of cotton, and were more casual (looser) and lighter in style. Moreover, they demanded modifications in underwear to fit under the now-shorter garments. Cycling in particular provided the first occasion for women to wear bifurcated garments. For men's styles, the more casual garments such as blazers that originated for use in sport (in this case rowing), later became fashionable in their own right.

Up until about the 1950s, men's clothing gradually continued to relax in style. For example, the lounge suit, a three-piece outfit we would recognize today as the business suit (though now usually without the waistcoat) became popular from about the 1880s. It increasingly replaced the formal morning suit in more and more situations, so that by the 1910s the latter was confined to particular professions and particularly formal occasions. By the 1930s even lounge suits were only being worn at work. Out of work hours, more casual alternatives such as cardigans, tank-tops, blazers and open collared shirts became worn with "slacks" instead of suit trousers. By the 1950s the waistcoat was no longer a required item. For example, two-piece demob suits were issued at the end of WWII (when fabric was in short supply). Tank tops and pullovers served as acceptable additional layers during the winter months. Then, in the later 1950s and 1960s, there was a dramatic change in what men wore out of work: t-shirts and jeans arrived, becoming popular at first with the new 'teenagers'.

Thus, during the hundred years from the mid-1800s up until the 1960s, minimum standards in terms of the number of garments and their coverage of the body, for upper and middle class men, reduced significantly from (mostly) long underwear, shirt and three-piece suit, to jeans, t-shirt and "smalls" by the 1960s. Precise combinations might still vary seasonally but the point is that by the 1960s a t-shirt worn with jeans was possible, acceptable and even common in public, whereas a hundred years previously any ensemble approaching this in terms of clo value would not have been acceptable. Furthermore, this lower (minimum

acceptable) clo of men's clothing remains similar today. Yet in the 1960s it had arrived in many homes before central heating.

Women's dress on the other hand appears to have dramatically reduced clo value in the early 20th century, by an intentional and explicit move to lighter clothing. In part, this was achieved through dress reform initiatives that aimed to liberate women from the sheer weight and constriction of their garments, and in particular undergarments such as corsets and bustles. But in the 1920s a dramatic shift took place in what some young women wore: these were the "flappers" who wore skirts that ended near their knees rather than ankles. Whilst it appears that it had long been acceptable in the evening wear of the upper classes to reveal arms and shoulders, skirts had always been long (though rising slightly in the 1910s). And most daywear appears to have had long sleeves. Despite emerging as a minority fashion, the ostensibly modern-looking styles of the 1920s stuck and skirts have not been the same since. Which, of course, means that underwear also has not. The 1960s mini skirt is an extreme example of this trend.

Just as the indoor temperatures are likely to have been enormously varied at any one point in history, the same is likely of clothing. Indeed, this crude portrait is largely based on the most fashionable and generally upper or middle class attire. Everyday dress for working men and women and for children might have involved a lesser degree of clo, certainly where dress was specific to work (e.g. miners, dockworkers). And of course, these styles are not necessarily worn in the home. But to place this very crude portrait of changes in dress against an equally crude portrait of change in indoor climates (Chapter 5), it is possible to conjecture that by the early 20th century clothing styles had begun to shift away from standards that involved higher clo value to include lighter and lower clo styles. At first, these may have been confined to particular activities or seasons but through incorporation in everyday and more casual styles, the minimum expectations (and resulting clo) were already declining by the time central heating started to warm indoor domestic climates in the latter half of the century.

One possible implication is that the default for clothing had shifted to a lighter style such that by the 1950s adaptations to clothing had to be made to cope with winter, whereas in the 19th century, it was the reverse: that special garments (like the "sun dress") were required for

summer. For example, "putting on a extra jumper" might not have had any meaning nor been practically possible until the early 20th century. For most men, "separates" only really emerged in the 1930s, until which time the three piece suit would have made jumper-wearing somewhat of a non-sense, both practically and in terms of necessity. Any extra warmth (or 'coolth') for that matter would have had to be made through changes to the undergarments. Equally until women stopped wearing complete "dress" outfits (the suit - comprising of a jacket and skirt was not a recognised term until the 1920s-1930s), extra overgarments would have been cloaks or shawls but not jumpers.

As separates came into use by men and women by the 1950s then, I suggest that a more 'layer-able' clothing system developed. Previously it might have been possible to add layers such as housecoats or shawls, but the 'new' system made it possible to reduce the layers of a winter set of clothes. Short sleeves had become socially acceptable and practically possible throughout the year, if worn under something else. Thus before central heating arrived, I conjecture that clothing styles were readily adaptable to year-round warmer indoor climates. Year-round and winter clo may have even reduced already by that time. Thus, I do not think the rise of central heating and of indoor temperatures exclusively accounts for the reduction in clo between the present and early Victorian period. Rather, it may be that by the 1950s people were becoming accustomed to much lighter clothing throughout the year, and that this in some (no doubt complicated) ways contributed to desirability of central heating.

Since the 1950s, it is difficult to chart the decline in clo that was evident in the general styles of the previous half-century. Generally speaking clothes appear largely 'modern'. Men might still have worn suits more regularly, and with them, they might have worn waistcoats or tank tops which might appear out of place today. Also, there has no doubt been a rise in the time spent dressed in informal clothing. But otherwise, it is mostly the fashion of the clothes rather than the types of clothing or possible combinations that has changed. Yet one notable item, the t-shirt, has spread to almost every home in that time. And what has happened underneath? We have been shedding clo in the underwear department since the 1950s. In my research, all the participants wore t-shirts, in combinations with other upper body layers and on their own. None wore substantial undergarments. If there has been a reduction in clo to match the increase in indoor winter temperatures assumed over the last 60 years, this has

plausibly been achieved through an increase in t-shirt wearing and a reduction of under-layers, rather than change in the range and types of clothes that are available and socially acceptable. I consider the connected histories of t-shirts and other underwear in more detail in the next section.

In summary, on a day to day basis, as evident in the study, the relation between clothing levels and climates appears closely tied, following a fairly predictable dynamic (putting a cardigan on, dressing for the weather, feeling too hot in several layers and so on). At a broader scale, developments in clothing and heating infrastructures have followed dramatic trajectories of their own, under the complex influence of many social and technical developments. The links between them are not obvious. When an understanding of clothing is framed around thermal comfort and concerns of energy, it appears obvious that we just need to wear warmer clothes to save energy. But, under a host of complex influences, our clothing styles have been in the process, over the last century and a half, of becoming lighter and more casual. This has dramatically changed what it means to "dress warmly" when indoors.

6.2 Changing Layers: T-Shirts, Under-layers and Loungewear

In this section, I follow some specific 'threads' of enquiry concentrating on particular garments, or types of garment, that have been important in the general evolution of clothing styles and were also relevant to the clothing worn by participants in my research.

The T-Shirt

The t-shirt is essentially underwear that has gone public: it evolved from undershirts and, today, frequently performs much the same role as a comfortable base garment worn next to the skin, over which other garments can be worn. As such, it has effectively "replaced" the undershirt. But it is not just a base garment: it can and is often designed to be displayed. This has arguably dramatically increased opportunities for socially acceptable reductions in clo. Alongside jeans, and often worn together, it is perhaps the most globally ubiquitous item of clothing today.

The undershirt has a long history and by the 1900s, several variants were available for men, one of which was a cotton garment slipped over the head, with short sleeves and maybe a few buttons at the collar. Such items were increasingly used as undergarments in military costume, when they may have been worn on their own for heavy or sweaty work (which may have also been the case elsewhere, amongst stevedores and miners, for example). Beside the shape of the garment, an alternative origin of the name t-shirt may reflect its use in military training (Wells, 2007).

During the Second World War, many US troops posted to hotter climates also dispensed their outer shirts. The t-shirt emerged and was soon publicised: by 1942, a tanned, muscled soldier carrying a heavy gun, was featured on the cover of Life magazine wearing a white t-shirt printed with "Air Corps Gunnery School" and logo. As demonstrated here, the garment provided a new space for print and image and by the end of 1950s, t-shirts bore messages of presidential support, images of Mickey Mouse and mementos of Florida. The invention of the printed t-shirt posed an incredible commercial opportunity to add value to a cheap item in endless ways, and production boomed: nowhere more so than amongst the growing number of pop fans (Wells, 2007). Elvis' likeness was one of the first to be worn. In the 1960s, a growing teenage counter-culture fuelled the growth of the printed t-shirt when "there was plenty to proclaim and protest about" (Wells, 2007: 56).

However, the rise of the t-shirt is not purely a tale of a new surface in a visual and commercial society: another line of development follows the t-shirt as part of the costume of jeans and (leather) jacket adopted by teenagers of the 1950s in emulation of the new teen rebels screened in such films as The Wild One, Rebel Without a Cause, and A Streetcar Named Desire. This, I suggest, is an adoption (and subversion) of the military and manual labour origins of the garment, and perhaps its association with powerful and heavy machinery (guns, motorbikes). In this, the t-shirt travels and spreads in tandem with denim jeans, which perform an equivalent step into the fashion limelight from a lowly, working garment of American labourers.

Another part of the t-shirt's story has to do with its material nature: in its design and fabrication, it embodies the qualities that we tend to now find comfortable. It follows a

simple form that can be worn unobtrusively under other clothes (due to its original design as an undergarment). And it is traditionally and still largely made from cotton: which can be made into light and flexible fabric. In fact, in the 18th and 19th centuries, undergarments were amongst the first clothes to be widely transformed by the availability of cheaper, mass-produced cotton. This material rapidly became the preferred choice for underwear in the summer months. The t-shirt can also be easily laundered and worn without ironing, perhaps contributing to its ongoing popularity. Its look and feel contrast markedly with the starched shirts of the 1950s. It is almost the ideal embodiment of the casual styles that had been seeping into men's clothing for the previous 50 years.

Under-layers

As the t-shirt has grown in popularity, it appears that other underwear has 'shrunk' in terms of the size of the garments, the frequency with which they are worn and the numbers who wear anything other than underpants and for women, bras. Common practice is harder to trace (at least, in this brief enquiry), but it appears that, in the 1950s, it would have included a vest for men and a slip or chemise for women. That is to say, many adults would have worn more items of underwear, especially in winter, offering a higher clo value than is common today. Under-vests for men and camisoles for women are still sold in high-street shops. However, personal experience and anecdotal evidence suggests that there is no norm or expectation for either sex to wear them, at any time of the year, especially amongst younger generations. Today, even the question of whether and for how long to dress infants in vests is confusing and contentious (Netmums, 2008).

It seems possible that the apparent decline in vest-type underwear may be associated with the rise of the t-shirt. What is to be worn underneath a t-shirt? Previous forms of upper body underwear existed in relation to those items under which they sat. Whilst it is possible to wear a vest underneath a t-shirt, say, there is not a history of association as there is between formal shirt and vest, or dress and slip. Yet, at times, layering with t-shirts and vests can be fashionable and desirable. Jack's style of clothing for example, is based upon layers: the longer t-shirt (reminiscent of long-sleeved underwear) serves as undergarment to the t-shirt. This illustrates well the prominence of the t-shirt and also the reversal of its fate, from under

to outer garment. With this and other contemporary styles, the idea is that layers worn underneath show.

In women's clothing, this idea might be linked to the current popularity of the camisole or cami. Whilst discussions on web forums indicate some confusion about how to wear these layers, for example why anyone would wear a camisole under a t-shirt, it also provides some clues that layering with the camisole is a clo-raising fashion that has brought the 'undershirt' back into everyday use. One respondent on *Yahoo! Answers* (2011) writes: "once you wear them under your clothes for about a week you can't go without it again" (Becca). The reasons are varied but at least for some, a 're-discovery' of the benefits of undergarments has taken place which simultaneously means that wearers are warmer: "It's weird at first, and it can get a little hot during the summer depending on how thick of a material the cami is" (Becca).

Another subtle rise in the clo-value of women's clothing may also be taking place with the growing popularity (re-emergence) of body-shaping undergarments or 'shapewear'. This includes "girdle knickers right through to corselets and full body shapers" (*Very.co.uk*, n.d., a shopping website). It is reported that such undergarments have helped fuel a recent growth in the market value of underwear: whilst the outerwear market declined in value between 2005 and 2009 (owing to price deflation) the underwear segment proved profitable with a growth of 14.3% (Key Note, 2010). Though often a light material such undergarments cover more of the body than a bra and pants and so will enhance the overall clo value of an outfit.

If in the 1950s, vests and chemises were in common use, 70 years earlier longer underwear appeared more common for both men and women. Today, these types of undershirts and long johns (or long janes!) are referred to as "thermal" underwear. And they are still available in shops. At least in part, these garments are marketed for outdoor activities. For example, in December 2012 a set of long underwear for men featured on *Amazon.co.uk* as the second most frequently purchased item in the category of "fishing clothing and accessories". The same website features feedback comments from purchasers of similar items, from which it appears that many buyers' first encounter with thermal underwear is for a winter holiday to cold locations, often Scandinavia. In outdoor shops, and for activities such as skiing, similar

garments but perhaps with more emphasis on 'technical performance' are sold as 'base layers'.

Amongst the feedback on the *Amazon.co.uk* website (n.d.a, n.d.b), however, there is evidence that some buyers are discovering thermal undergarments for the first time in order to keep warm at home over winter. One customer purchased a thermal short sleeve vest "to help me keep warm instead of putting the heating on" (TWINKLE, Nov 2011). Most feedback on similar items of thermal underwear were positive: first-time buyers "never knew how warm they can keep you" (T. Carpenter, Nov 2012). But others are more familiar with them and "would not be without one for the winter" (A. Hayes, Oct 2010). Thus, it appears that some people do wear vests (long and short sleeved) as everyday thermal underwear during the winter. Similar comments can be read for men's garments. On this evidence, thermal underwear is still in circulation and, perhaps in combination with the fashion for layering, it may become more widespread. Indeed, there now appear to be thermal garments available that look more like currently acceptable outerwear. One purchaser reported that she bought one such item as a gift for a younger female relative who had always thought that thermal underwear was "too frumpy". It may be that the exceptionally cold winters in 2010/11 and 2012/13, which followed a 20-year period of relatively milder winters (Palmer and Cooper, 2012) prompted some to look for extra comfort from what they wear. The signs of increased interest in thermals is also an indication that, despite the general progression to date, the path towards lower and lower clo is far from inevitable.

Loungewear

Zoe's preference for wearing pyjamas when spending time in her room is not so much an idiosyncrasy, or a sign of student laziness, as a reflection of a contemporary trend with a long history. The clue is in what Emily also refers to as her "loungewear", though she prefers tracksuits and t-shirts. Just as undergarments have made a transition to outer-garments (in the form of the t-shirt), so sleepwear has exchanged styles and status with daywear over the centuries.

Nightgowns, for example, which were worn over nightclothes and taken off when getting into bed became acceptable in public areas in the 17th century, and even evolved into a

formal style of court mantua (Worsley, 2011). Clothing designed for the specific purpose of "lounging" at home and in informal settings, perhaps first appeared in the form of the smoking jacket that accompanied the growing popularity of smoking around the 1850s. This was a casual garment, worn over the day clothes to protect them from ash. Two-piece smoking suits for men in a light pyjama style were popular around the turn of the 20th century. And in the 1920s, following the influence of Hollywood, the glamorous satin pyjama first became popular for women as "appropriate leisurewear for the fashionable" before becoming, as they are largely known today, nightwear (Worsley, 2011: 87). Longer robe-like varieties of the smoking jacket may have been called housecoats, but the term is more synonymous with women's robes: lighter ones of which were worn in the home over dayclothes for cleaning or as informal evening wear, perhaps in a warmer, quilted material. Chances are that any pyjamas worn (out of bed) during a UK winter in the 1920s or 30s would have "disappeared" under such a robe (Worsley, 2011: 86).

Conventional overgarments for the home, like the housecoat and smoking jacket, have declined in popularity since the 1950s, but both dressing gowns and pyjamas are still common today. However, their meaning and status have largely changed: from connotations of elegance and style to those of sloth and privacy. Yet these associations and the apparent status as night or morning wear is far from fixed. In particular, an article in the fashion pages of *The Telegraph* (Alleyne, 2010) describes how a new "lounge culture" has contributed to an increased popularity of traditional nightwear "not just for bed but for lounging around the home." This is, apparently, especially popular with young women, both teenagers and young professionals and is thought to be behind a steady growth in the nightwear market. Several influences are suggested: "a mix of fashion and de-stressing", "escapism" from the world outside, more working at home, the popularity of evenings in, surfing the Internet, and colder winters. An analyst from Mintel expects that "colder winters and hotter summers, could force people to buy more types of nightwear to suit the seasons" (quoted in Alleyne, 2010). The article suggests a whole new category of clothes has emerged: "home or lounge wear". Indeed, this now appears to be a label applied by retailers to casual and loose fitting clothes, resembling pyjamas, tracksuits and oversized knitwear. Some companies even

specialise in them[9]. And in the US there is some concern that teenagers are taking the "just rolled out of bed style" on to the streets and into schools. An article in *The Wall Street Journal* (Holmes, 2012) describes the layered camisoles and vests (girls), t-shirts and shirts (boys), worn with sweatshirts, "lounge pants" (pyjamas) or "sweatpants" (tracksuit bottoms). In the winter, UGG-style slipper-boots complete the look for the girls. The style could also been seen on Lancaster University campus during the winter of 2012.

Elsewhere in the UK, the wearing of pyjamas in supermarkets has caused a stir in recent years (e.g. BBC News, 2010). But other parts of the style - the layered camisoles and UGG boots - are perhaps most popular. Pyjamas still appear to be largely private rather than public dress. Zoe was certainly uncomfortable in her pyjamas when her flatmates brought their friends into the shared kitchen. Loungewear, as a distinct set of clothes, embodies the distinction between outside and inside, between public and intimate settings. The character of this distinction matters for the types of clothes and clo that are acceptable in each sphere, and thus it has implications for heat demand. For example, ethnographic research in Madrid has highlighted the habits of residents to dress in conventional, smart designer clothes in public but on returning home, they change into something "extremely shabby, often old, even worn or torn" (Miller, 2010: 32, referring to the research of Marjorie Murray). Equally, in the UK, I suspect that many people distinguish between those clothes for wearing in the house and those for public even without recognising them as distinctly as 'loungewear'. What does appear to be distinctive about the loungewear trend is the use of pyjamas as daytime wear, and the idea that such clothes might even be newly purchased and stylish. One might even be able to invest in a whole new 'wardrobe'. Clearly, if this wardrobe can allow for higher-clo garments and combinations, this is a significant and relevant diversification.

Indeed, loungewear appears to be a distinctly seasonal phenomenon, marketed for snug times at home over the winter. The genre might also include 'onesies' (fleecy all-in-one suits) and snuggle blankets that cover the body like a large gown. Some of what is marketed as loungewear, then, is clearly designed to be warm. On the other hand, a pyjama suit might be much lighter and of lower clo value than more public, day-clothes. After all, most pyjamas

[9] For example, see Hush https://www.hush-uk.com/ [Last accessed 29 April 2014]

are designed to be comfortable when worn under duvets. In as much as it recruits wearers (mostly younger women), a putative loungewear trend appears to contain both clo-enhancing and clo-reducing elements.

6.3 The Logic of Clothing

In the previous section, I briefly charted the history of some specific garments. This aims to show that the nature and clo value of contemporary, conventional clothing worn at home during the winter have evolved over a punctuated history in which particular garments and styles have had a significant impact. As a multivalent garment which can now be worn on its own or as underwear, the t-shirt has been at the cutting edge of clo reduction, and has probably had a knock-on, clo-reducing effect on the levels of underwear worn more generally. When considering clothing worn, specifically in the home, the approach of adding an overgarment to day clothes appeared more common in the past. Today, it appears that if one does change clothes to get more comfortable at home, one might rather swap day-clothes for less restrictive garments, which may also be lighter. Describing these changes is difficult enough; understanding how and why they have taken place is much more challenging still.

To some extent, theories of fashion have attempted to explain the ever-changing or "self dynamic" (Gronow, 1997) nature of clothing styles. To most accounts, clothing is primarily a form of communication, whereby change takes place through the distinctions sought by individuals (e.g. Simmel, 1957) or classes (e.g. Bourdieu, 1984). Indeed, contemporary distinctions between classes can be observed (e.g. Fox, 2006) and research reveals the often subtle distinctions young people make between and within a style in order to look similar to, but not the same as, peers (Woodward, 2009). But the larger history sketched above is not purely of a contained, self-changing system but one subject to all manner of social influences: the advent of a global film industry, the diversification in leisure practices, the changing nature of formal occasions, dress reform movements, the increasing affordability of textiles such as cotton and the changing status of women in society. In addition, there are the clothes themselves to consider: which, even though they are "ostensibly the subject matter of such

accounts – remains a ghostly presence, coming to appear immaterial by the very lack of engagement which the physicality of clothing" (Woodward, 2005: 21). Recently, the materiality of clothing, and its role in constituting social relations has received more interest, particularly from anthropologists. Although this rarely touches upon the thermal aspects of clothing, there is clear interest in the embodied experience of clothes-wearing which could readily be extended in this direction, as for example in the account of sari-wearing provided by Miller (2010). Importantly, an approach rooted in the materiality of clothing also opens up questions about how the evolution of clothing styles are linked to the material properties of particular garments. If we are seeking to understand, and possibly influence, the contemporary 'dynamics of clo', such a perspective is especially relevant.

One way of attending to the materiality of clothing is through studying it as part of everyday practices, possibly of what people are wearing when in public, when people are getting dressed or by exploring what is in their wardrobes. Klepp and Bjerck (2012) outline their methods for wardrobe studies that can foreground the ways individual garments relate to other clothes, larger collections, to the body and to practices. The "wardrobe" for example, of which one might have several, for various situations, is here thought to be a related set of clothes, which may be mutually exclusive. That is, items may be reserved for some situations or occasions and not mixed with items that are typically worn at other times. Thus, loungewear may remain for many of those who identify such garments a largely independent wardrobe. Woodward (2005) explains this principle using the example of a British woman whose limited set of clothing for special occasions were unmixed with and remained unaffected by the other clothes she owned. She also found that larger wardrobes tended to be categorised by some sense of what fits together and what does not: "The colours (black and red), and the styles (a loose shirt and a skirt) articulate with each other in such a way that she feels she cannot intervene. What she feels to be the logic of the clothing means that she will only combine these items together" (Woodward, 2005: 30). As I have suggested above, this extends to the types of garment and their fit, in a way that might constrain higher-clo combinations.

Another aspect of how women, in this case, organise their clothing was revealed by Woodward: "almost without exception every woman I interviewed divided her wardrobe

primarily into winter and summer clothing – many having a biannual switch of wardrobes in around May and September" (2005: 28). The shift is one of colours and materials that make sense on practical grounds - darker clothing that absorbs heat is impractical in summer but useful for concealing splashes of rain. But the seasonality of colours is also about social appropriateness. Woodward remarks that the switch between wardrobes effectively creates the seasons, rather than the weather, which usually shows no such binary demarcation. Thus, although Woodward highlights the importance of a "semiotic fit" to the weather, the expectation of a binary switch between wardrobes of lower and higher-clo combinations has clear implications for the "thermal fit" during the most unpredictable seasons of spring and autumn. Perhaps the most important point, evident with Zoe but less so with the other participants, is that many women expect to vary their dress by season. This is supported by observational studies of clothing that report changes in dress, appropriate to the weather, even by office workers who actually spend much of their time in static, climate controlled conditions (Morgan and de Dear, 2003).

Another outcome of emphasising clothes as material rather than necessarily-changing symbols of fashion, is the opportunity to recognise and explore stability (Klepp and Bjerck, 2012). Woodward (2009), in a study of clothing being worn and sold to young adults, rejected the notion of "fast fashion", which suggests that styles and consumers are fickle. Rather, she argues that fashions evolve gradually and that items from previous years are often retained and used in different combinations. Thus, the purchase of new garments and the adoption of new styles are always situated in the clothing that is already owned. This suggests that the current content of contemporary styles will, in some way, inform and constrain the trajectories of future styles.

6.4 Thermal 'Competence' and Clothing Systems

When we think about clothing in the context of lowering thermostat temperatures at home, it is often in terms of putting on "an extra jumper". But if jumpers are not within the repertoire of contemporary styles and cannot by convention or physical fit be combined with garments that are, then it is an effectively meaningless injunction.

As outlined above, there are areas where a recent increase in the clo of some fashions appear to have taken place and might be further encouraged, such as layered styles, thermal and body-shaping underwear and UGG boots. There are also more ambiguous developments, such as loungewear, which might take the clo values worn around the house in either direction. On the one hand, cosiness especially during winter is a key part of this trend, and as a discrete wardrobe (if loungewear were to be widely adopted as such) it could be developed largely within its own logic. This might be dramatically seasonal, it might be designed with warmer materials and styles to be comfortably and effectively layered with other loungewear items, in ways that would not be appropriate with more public daywear. On the other hand, loungewear's designation as a specifically indoor set of clothes potentially isolates it from the clothing adaptations that are made in order to get about outside. Moreover, the emphasis on comfort and casual-ness implies a certain freedom from constriction, which is perhaps best achieved with lighter and looser-fitting clothing, rather than body-hugging layers which might offer more effective insulation. In addition, it is largely limited to young women. Thus the opportunities, if they are such, that "loungewear" might present for enhancing clo-values at home are subtle, limited, and potentially double-edged.

I would still be inclined to argue that there are opportunities for energy policy makers to 'intervene' in clo-values in order to raise them. Indeed, it has been suggested that long, synthetic underwear offers a highly effective way to reduce indoor winter temperatures without compromising the clothing comfort and aesthetics (de Decker, 2011). There is a degree to which the home can be treated as an isolated concern in this, as best illustrated by loungewear. But for the most part, warmer garments and styles must also be integrated into conventional, public daywear worn outside the home. Just as this is not simply the case of putting on another jumper, the 're-insertion' of long underwear within contemporary styles and the now warmer indoor climates is not a simple matter. But if new/old ways of dressing warmly are achieved within the contemporary logic of clothing, clo may become more radically seasonal than in the past.

It is perhaps true that clothes are now more differentiated than ever before, on the basis of the practices of which they are a part. Highly specialised garments have been developed to perform in, and symbolically distinguish, particular activities such as sports and other

outdoor pursuits. With clothes for hiking and mountain sports and clothes for the gym and beach, now commonly available to buy on the high street, and owned by many people, it seems plausible that clothes physically provide wider range of clo-values than ever before. For example, Klepp and Bjerck (2012) describe how one Norwegian family of four own 200 garments for walking, running, biking and skiing. Yet these materials exist within systems of clothing with conventions and expectations that tend to fix them to the practices for which they have been marketed. However, as noted, in the case of blazers and t-shirts, garments don't always stay 'fixed'.

In thinking about the material qualities of clothes, and how they have changed, I am drawn to thinking about how competence is distributed between people and materials. It could be argued that the capability to dress warmly indoors in the winter is thoroughly distributed: between the garments themselves and understandings of whether they work together to insulate, between conventions and expectations and the systems of manufacture, fashion and retail by which the range of garments and clo values actually worn indoors may be relatively narrow compared to the types of garments that are acceptable for outdoor wear.

The notion of distributed competence complements that of distributed demand, discussed in Chapter 4. There I discussed how the food products produced and marketed by food industry are implicated in the levels of energy demand associated with cooking. Across this chapter and the previous one, I have set out a similar case for clothing in constituting the demand for heated domestic spaces. Just as with food, this means that a wider evaluation of the sustainability of clothing involves more than the material inputs and outputs in the processes of production, distribution and disposal. It could also include the degrees of thermal competence for winter, that is, the extent to which the clothes can be combined into acceptable, physically comfortable and high-clo outfits.

In the next chapter, I reflect upon the theoretical implications of the micro and macro dynamics of comfort and clothing and consider how the demand for heat can be conceptualised within a practice theory approach. I also ask what this brings to an understanding of the trends and trajectories in heating-related energy consumption.

7. COMFORT AS SERVICE: ESCALATION AND CONVERGENCE

In Chapter 5, I discussed how thermal comfort is 'practised' differently by each of four students in a hall of residence, focusing on clothing 'practices', a topic which I explored on a wider scale in Chapter 6. This focus emerged only when analysing the research, which was designed with a scope broad enough to cover several aspects of comfort. The differences between ways of clothing and heating across the small number of participants were clear, and the relationship an interesting and under-explored one. But there is another reason why I focused on clothing: because I was interested in studying the performative aspects of thermal comfort. The participants did ventilate their rooms frequently, but since only one (at that particular time) was frequently using the radiator, clothing was the most obvious way in which all the participants were 'keeping warm'.

In this chapter, I return to reflect upon comfort in the broadest sense and consider its conceptualisation in practice-theoretical terms and in relation to energy demand. I argue that comfort cannot be analysed as a single practice in a way that is possible for cooking. Instead, I draw on the notion of service in two different ways. As a useful function, the heated air provided by central heating systems can be understood as a 'specific service'. This may contribute to but is not synonymous with comfort, which is an ongoing and composite achievement or 'meta-service'. As such, comfort differs from cooking in that it cannot be delegated entirely to other people: we must each do comfort for ourselves to some extent. Moreover, it is not a discrete and well-bounded practice but dispersed amongst a variety of loosely bundled elements. Within this, central heating systems use energy to provide heat, but the demand for this heat does not closely follow what people do, as in the case of cooking. This is of consequence for how the energy demands of heating evolve. In particular, I suggest it allows for them to escalate and converge in a way that is less likely for forms of energy demand that depend more directly on what people do.

7.1 Conceptualising Comfort: Practice, Service and Material Arrangements

Thermal comfort and the type of energy use with which I am concerned, heating, have been theorised and analysed at length over the last four decades or so. Heating, alongside the other basic functions that energy provides (lighting, power and transport) has been conceptualised as an energy service (Lovins, 1976; Riester et al., 1981) for which levels of demand can be modelled and traced over the past few decades (DECC, 2012) or even centuries (Fouquet, 2008, 2010). In building sciences, a concept of thermal comfort itself as a service (or "product") provided for occupants by the physical structures of buildings and the tightly specified, mechanical control of air, came to dominate (see Nicol and Humphreys, 2009; Shove, 2003). Neither framing invokes an active occupant as a practitioner of comfort. Yet there are other conceptualisations of comfort (e.g. adaptive comfort) and approaches to heating (e.g. in terms of heating practices) that do. However, as I will argue in this section, this does not mean that heating, comfort and even clothing are best understood as overt, social practices like cooking.

Heating as a Practice?

If a social practice is understood as a time-consuming activity in which people are knowingly and explicitly engaged at a given time, it is difficult to conceptualise heating as a social practice. From the research, it was evident that when energy was being used in the process of heating air, this took place without much, if any, performance (i.e. active integration) on behalf of the residents. The same was true if heating wasn't taking place. For instance, an action that was similar in duration and procedure and undertaken several months ago, by both Jack and Zoe, had very different consequences for energy use. Jack made sure his radiator was turned off; Zoe made sure hers was turned fully on. Both took no further action to operate or adjust this heating system on an ongoing basis. So whilst participants were able to talk about whether and how they heated their room, and whilst there is clearly some form of practice that varies in respect to heating systems, I suggest that heating is not a social practice per se.

Instead, I favour the more familiar conceptualisation within energy research of space heating *as a service*. When delivered through central heating systems, this service is provided by

machines in combination with the envelope of interior space provided by buildings. Of course, human input is also needed to construct, configure and arrange this service, but as an automated process, it takes place largely outside, and does not depend upon, the active integrations of practitioners. The notion of service I employ here is a specific one: it refers to a particular, well-bounded process the outcome of which is relatively uncontroversial. For example, it is obvious when the heating system is on, and the radiators are hot, compared to when they are off. As seen in Chapter 5, the challenge for energy demand research is to understand how and why there are variations in the concepts of service attached to heating and heated space.

Following a practice theory perspective, one option is to explore how concepts of service vary in relation to the types of social practices that take place in heated spaces. In this light, heating may be considered to be a part of the many daily practices that take place in indoor spaces. But in my research, there were no obvious differences in the non-comfort-related practices participants undertook in their rooms, which might account for the variations in the control and experience of the thermal conditions. For all, these were spaces for sedentary activities like sleeping, relaxing and working.

Another option is to operationalise the understandings, know-how, procedures and material elements that are implicated in the control and evaluation of heat indoors, along the lines provided by a social practices framework (e.g. Gram-Hanssen, 2010). This focuses on the *practices* associated with heating: the routines and interactions organised around heating and ventilation. To the extent that such activity is socially organised, this may be a useful exercise, even if we accept that heating is not an integrative social practice per se. I have referred to 'clothing practices' in a similar way, and as outlined in Chapter 6, I do consider "the practice of dressing" (Klepp and Bjerck, 2012: 3) to be socially organised through the systems of provision, materials and understanding in which clothes circulate. Yet it is difficult to see getting dressed as an integrative practice-as-entity. At the very least, for the analysis of heat demand, adjustments to clothes continue to be consequential for some time after the "practice of dressing" has taken place. In this sense, clothing resembles adjustments to heating (though undertaken at intervals of hours rather than months).

A further option for conceptualising space heating within a practices approach, may be to focus on what happens with respect to heating and clothing during 'inactive' periods following adjustments. In particular, it may be interesting to examine how 'being heated' (or 'being clothed') is itself an ongoing concern even when it is not the focus of attention and behaviour. For a start, ways of perceiving, understanding and responding to the heat provided by heating systems within buildings, are culturally and spatially contingent, depending upon lifetime experiences of heat, cold and the ways of adapting. In addition, it could be argued that these understandings, know-how and material conditions are *integrated* on an ongoing basis. This may not be active in the sense of behaviourally observable action, and it may not be undertaken in its own right, but there is a still a sense in which it takes an integration of skill, meaning and material to "consume" and evaluate the services that heating systems provide. This introduces the notion of 'passive' practices. But this is not a concept or an analysis that I intend to develop here, since it touches on theoretical debates concerning the conceptualisation of human activity and skill, which are well beyond the scope of this thesis. More pertinently, however, such a focus on 'being heated' per se may still be too narrow a conceptualisation of comfort. How would it extend to clothing, other means of warming oneself up and cooling down, and of otherwise experiencing thermal (dis)comfort? I now move beyond heating and return to the conceptualisation of comfort more broadly.

Comfort as (Meta) Service

Most research that has so far approached thermal comfort and heating-related energy use from a practices perspective refers to broad-brush sets of practices, rather than the practice of heating per se. For instance, "heat comfort practices" (Gram-Hanssen, 2010), "heating and cooling practices" (Strengers, 2012) and "winter warmth practices" including 'practices' such as ventilation, the use of blankets and even clothes (Hitchings and Day, 2011) are investigated. Yet, like heating, these are not necessarily integrative, discrete social practices, which are time-consuming and under-taken as activities in their own right. And although such actions are likely to effect some kind of thermal change, they were not always undertaken for that purpose, or for the sake of comfort per se. For example, clothing directly affects the proximate thermal conditions of the body but participants did not seem to think about that much when dressing, especially if they were going to spend time in their room. The thermal aspects of clothing were only considered relevant when going outside – this

being a place where temperatures cannot be modified to suit. In another example, radiators were sometimes turned on in order to dry clothes, rather than to heat rooms.

Thus, there is a challenge to articulate the inter-connections between these different activities, and their role in constituting the demand for heat. Explicit reference to 'comfort' per se and its pursuit may not help. Indeed, the active pursuit of comfort "as a goal which [occupants] achieve provided they are able to exert the necessary control over their environment" (Nicol and Humphreys, 2009: 70) was not obvious to every participant in the study. When asked, participants did not recognise activities like "making themselves comfortable" or "getting comfortable", and were more likely to associate the experience of "being comfortable" with being at ease socially and psychologically in a given context. This might also be a sense of having close and controllable access to facilities like a kitchen, bathroom or library. Comfort goals and the activities undertaken to achieve them, only really became apparent to participants if those goals were frustrated and the activities became time-consuming. In itself this was experienced as frustrating. In this light, the understanding that participants share, whether they need to actively adapt their conditions or not, is that comfort is largely an absence of practice. It is the freedom from having to do anything to get warm or to cool down.

This illustrates a particular socio-cultural (and not essential) understanding of comfort. In other words, this is a concept of service; but here the definition of service differs from that of a 'specific service' outlined with respect to heating. I refer instead to Shove's analysis of comfort as a "composite accomplishment[s] achievement of which involves the orchestration of devices, systems, expectations and conventions" (Shove, 2003: 191). I refer to this as a 'meta-service,' borrowing from Wilhite et al.'s (2000: 115) term "meta-energy service" in distinction from direct energy services. As the term suggests, a meta-service is a high-level evaluative achievement that arises through a "blend of method, meaning and hardware" (Shove, 2003: 166). As such, comfort may involve the specific services provided by heating systems, buildings and clothes and the actions undertaken to adjust these material arrangements and ventilate spaces, together with the range of practices that take place there. In this light, comfort is an emergent and composite achievement, evaluated in the ongoing experience of the body.

In Shove's discussion, the heterogeneous means of achieving comfort, as meta-service, are organised and integrated at two levels: the meta-system (or system of systems) and "on the ground as people construct their own ways of doing things" (2003: 157). At the level of meta-systems, Shove describes the higher-level organisation of a particular concept of comfort, one that could essentially be marketed in the form of air conditioning systems. Without explicitly drawing on the language of need, charting the development and marketing of a concept of service is effectively that of the higher-level organisation of what might eventually be experienced as need. At this level, comfort emerges, less by plan, but in an ongoing blend of conditions, material systems, intentional activities and other activities that are not about comfort.

The observation that people do not usually recognise comfort as an activity in its own right suggests that it largely achieved 'automatically'. By this, I mean through the functions already embedded within and taken for granted as part of clothing, buildings, seasons, blankets, furniture, food, drink and bodies. It is intuitively obvious, and evident in the research, that people do intentionally configure these arrangements from time to time to achieve comfort. But the key difference compared to cooking is that these arrangements continue to perform for long periods of time outside of any active integrations. Whilst cooking also results in a form of service (warm meals) this is provided at appropriately timed intervals. An appropriately warm body is an ongoing condition and, practically speaking, if it depended on a practice like cooking, there would not be time for much else. The experience of thermal comfort understood as the absence of having to engage in a thermoregulatory goal, then, is a basic 'infrastructure' to other activities, in that it allows for them to take place. The experiences of thermal discomfort recounted by Zoe and Emily help to illustrate just how disruptive a feeling of discomfort is to other activities. The activities undertaken to get warm, at these points, are clearly not necessary preconditions of comfort at other times. Put simply, comfort or being warm, does not always depend upon 'getting warm' nor does it depend on heating or wearing insulating clothes, in the way that a hot meal depends on cooking. Rather comfort emerges at the intersection of these conditions and activities, often more by default through prior configurations (including those of other people), than by an active and ongoing achievement. Any particular way of supporting thermoregulation is clearly a social

achievement (Chappells and Shove, 2005) but not necessarily always an explicit ongoing and individual one.

We might suggest that 'comfort practices' are related as part of a compound practice, as Warde (2013) does for cooking in relation to eating. But this seems too strong, since the degree of alignment amongst say heating and clothing around the pursuit of comfort is always in flux. To say, alternatively, that comfort itself is a dispersed (and potentially 'passive') practice, a component amongst different practices is also problematic. It would neglect the very different procedures and understandings that are embedded in clothing as compared to space heating. Yet, understanding comfort as a meta-service unites ongoing material conditions and sporadic human involvements. Concepts of comfort (as a meta-service) are distributed throughout a variety of non-comfort practices, but also integrated in the form of ongoing experience and expectation. The achievement of comfort emerges, not only from practice, but also in relation to ongoing material arrangements (of clothes, heated air, buildings, weather systems and physiology). This is a loose bundle of diverse elements, linked in highly contingent and dynamic ways by the meta-service of comfort. This highlights the potential substitutability of the ways by which comfort is attained and delivered (for example, in the relationship between clothing and space heating as forms of insulation). Thus, the two concepts of service outlined here (meta- and specific) seem to be important and flexible additions to practice theory-based approaches to heating-related energy demand.

7.2 The Constitution of Demand: Energy and Heating

If we consider that central heating is primarily a machine-provided service, as opposed to a social practice, it follows that the energy consumption of heating follows what machines do more closely than what people do on a day-to-day basis. This dissociation is implicit in the very nature of contemporary space heating: it is designed to be a background process, one that delivers an "infrastructure" of acceptable indoor temperature, without requiring human attention, time or effort. This is perhaps not the case for all heating systems (such as wood fuel). But even where time is required to arrange, set-up and clean heating devices, the purpose of this activity is to provide a 'space' for other activity.

Thus, whilst cooking and space heating both depend on the heating work of energy, they do so in different ways. Where consumption through cooking was largely dependent upon the extent to which people cooked (the duration, the frequency, the number of different foods combined), there is no direct analogy for this in heating. Rather, the consumption of energy depends on the temporal and spatial extent and intensity with which relevant technologies (boilers, rooms etc.) perform heating. Thus, understanding how demand for this heating service is constituted requires us not to look at heating, and heating-related habits, in exclusion but to consider their embeddedness within a loose bundle of processes, practices, habits and concepts of service, which are connected via experiences and expectations of thermal comfort.

By following the variations in ambient indoor temperatures and in the operation of heating systems I can infer that in my small study, demand for heating emerges at the nexus of heating systems (concepts and technology), concepts of comfort, know-how and tools for keeping warm, external conditions, other activities, and systems of clothing. These elements and relations co-constitute demand for heating, as mediated through the experience of comfort. In particular, I was able to follow how clothing arrangements not only respond to the heat provided through heating systems but also structure and moderate the demand for heat and, accordingly for heating. Thus, heating demand is moderated by processes and practices that may appear to have little to do with heating systems and habits.

This study has focused on the individual-level integration of comfort, and shows that it is possible and interesting to do so: we can see that the demand for heating is to some extent defined at this level. The finding that Jack did not want any heating in his room, and used an electric-fan to help cool it, whilst Zoe was content with the heating being on all the time, points not only to potentially large differences in the way individuals understand and organise comfort, but also the potential influence of residents in constituting overall levels of heating demands. Thus, even though the energy consumption of heating follows what heating systems rather than people do, the demand for the service of heating is still co-constituted through the organisations and integrations of residents. However, they are not the only people involved. In particular, the way that architects, heating engineers and university staff

have organised physical systems to provide comfort, both constrained and enabled the differences in heating demand observed between the residents.

7.3 Convergence and Escalation

As noted in Chapter 5, there is evidence that since the widespread introduction of central heating, indoor temperatures in living rooms during a UK winter have risen and at the same time become less diverse (Mavrogianni et al., 2011; Shipworth, 2011). In addition, temperatures have become less variable within the home, as more space is heated. The insights into how heating demand is constituted in practice, as developed from my study of variations in demand, help move towards an account of this change. I suggest that demand for heat, and thus heating and thus energy can be related to the way that space heating is provided by technologies and how it is embedded in a complex configuration of comfort that people mostly take for granted.

In the first instance, because heating is provided by machines its reproduction and growth can be understood in terms of the diffusion and operation of such machines. This makes heating, as a process, much more liable to standardisation than a process such as cooking, in which humans, and their more highly contingent routines and circumstances are implicated in the ongoing reproduction. Cooking calls for a measure of commitment and must 'compete' for human time but central heating encounters no such limitation. Whilst the demand for heating does depend on different organisations of comfort between people and households, these are complex and heavily influenced through other shared practices and systems. This may provide limited options for individual variations, e.g. the range of available clothing, and the temperature of other spaces experienced historically and throughout the day.

I conjecture that the effect of this organisation of heating, in other words its nature as a machine-provided service means that demand for heating can escalate and converge in ways that demand linked more closely to what people do on a daily basis might not. And since heating does not directly result in an outcome that is amenable to social evaluation (e.g. a proper meal) but rather the subjective experience of a relative lack of discomfort, people

might, quite unintentionally, become accustomed to and dependent upon more intensive outputs from heating systems. For example, without the ability to wear light clothing in her room, Zoe might have found the temperature uncomfortably hot much earlier in the year. Through her clothing and past experience of heat, she adapted to the operation of the heating system, rather than adapting, and reducing its operation, when indoor temperatures continued to climb throughout the spring.

As the study suggested, the converging and escalating need for heating does not mean that internal ambient temperatures in homes are necessarily homogeneous, but they are perhaps more homogeneous (and possibly higher) than if alternative concepts (or organisations) of comfort prevailed. For example, without a system that was heating the interstitial spaces in the building or operating in other rooms at maximum capacity, Jack would have been able to lower the temperature in his room closer to what he, in his combination of clothes, would have found comfortable. This suggests that limiting heating operation and heat is an important step in re-distributing some of the 'work' of thermoregulation, for example to clothing. Equally, changes in clothing styles could, quite unintentionally, influence the demand for heating.

8. VARIATIONS IN "ICE": ENTERTAINMENT, COMPUTING AND ENTHUSIASTS

In this chapter, I turn to the last of my three domains of domestic energy consumption and everyday practice: that associated with information, communication and entertainment (ICE) devices. In the UK, government energy models and forecasts tend to group these devices into two end-use categories: consumer electronics (CE) and home computing or information technology (IT) (e.g. DECC, 2012). But when looking at what these devices do, and how they are used, analysts find it is increasingly useful to consider them as a single group. As forms of media content and broadcast infrastructures have become digitised, there is an important convergence in functionality across the category: it is now possible to watch "TV" or make a "phone" call on your computer, and edit your word processed documents on your phone. As Owen writes "you could argue that we are currently in the midst of a new ICE age" (2007: 4).

As with previous domains, this is the first of two chapters addressing ICE-related energy demand. In it, I describe the part of my empirical research which explores variations in what people do and in the energy consumed. I begin by briefly outlining the trends in this area of energy consumption. Then, I introduce the findings from my empirical research that show a pattern of energy use which varies widely between participants. This can be related to variation in the nature and number of devices owned which is in turn related to differences within and between practices. This raises a lot of questions, including the possibility that the energy used by ICE devices in different households might diverge, rather than exhibit generalised and widespread intensification. I develop this discussion in Chapter 9.

8.1 ICE Devices: Escalating Energy Consumption

ICE-related energy consumption is an important and growing component of overall domestic electricity use. In 2009 in the UK, consumer electronics were estimated to consume 20.8 TWh which at 24% of total consumption was the largest end-use category (Energy Saving Trust, 2011). This is even more marked if we add to it home computing, which stood

at 6.5 TWh or 8% of total consumption: a combined total for ICE devices of 27.3 TWh, accounting for almost a third of all household electricity use. In 2007, predictions were made that by 2020 this would rise to 49 TWh of electricity, composing 45% of total domestic consumption (Owen, 2007; based on Market Transformation Programme (MTP) forecasts). The forecast for 2020 has now been revised to 28.8 TWh (36% of total consumption) based on a much more moderate growth of 5% in consumer electronics and 7% in home computing compared to 2009 levels (Energy Saving Trust, 2011, also based on MTP forecasts). This helps to illustrate the difficulty of making forecasts in a rapidly changing product sector. What is beyond doubt, however, is the historic growth in electricity use associated with ICE devices.

In official UK energy statistics (DECC, 2012) both CE and IT related electricity demand have been growing rapidly over the last 20 years (Figure 8.1). They have underpinned an upward trend in total electricity consumption through most of the period since 1970. They continue to grow whilst other end-use categories, such as lighting and cold appliances have recently started to decline. With the exception of washing and drying appliances (dishwashers and laundry), it is the only electricity end-use category still expected to grow in consumption in the UK in coming years.

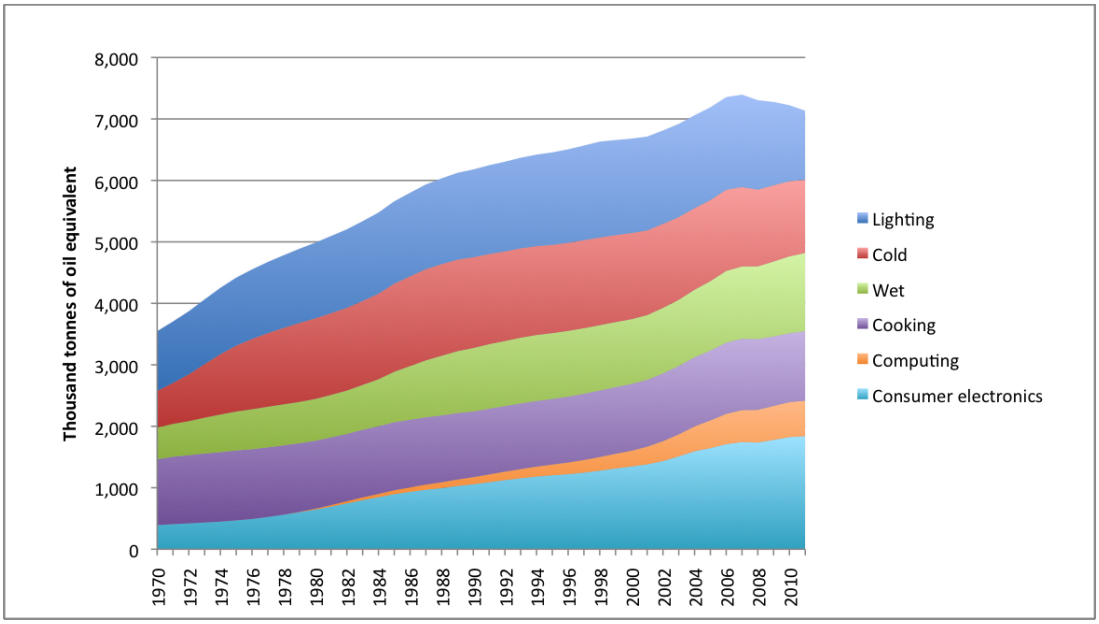


Figure 8.1 Composition of household electricity consumption, 1970-2011 (Data from DECC, 2012).

It has even been argued that IT, in particular, constitutes "a new round of household electrification" akin to the introduction of lighting, heating, broadcasting and mechanical power-based technologies (Røpke et al., 2010). Just as with previous rounds of electrification, Røpke et al. (2010) suggest that data-processing technologies are set to co-evolve alongside profound transformations in domestic and social life. The nature of these changes are not yet clear, but it is important to understand them in order "to develop a pro-active approach to the energy impacts that may follow" (Røpke et al., 2010: 1767). They relate the growth in consumption to date to the general observation that IT has become pervasively integrated into a range of practices, comprising a diversification of those practices. In the next chapter, I return to consider this argument in the light of my own research.

At this point, however, it is worth noting the diversity that is already evident within this general pattern of growing energy use. Firstly, the ICE category is composed by several different types of devices, the consumption of which suggests they are on very different 'paths' (Figure 8.2). For instance, consumption due to desktop computers is declining, as laptop consumption grows (DECC, 2012). The consumption and growth associated with TVs dominates. In combination with set-top boxes and DVD players, TV-watching accounted for 54% of the consumption of the whole category in 2011 (DECC, 2012). There is also a dramatic rise in consumption due to power supply units: a category that includes transformers and chargers for many of the latest digital gadgets, such as tablets, routers and smart phones.

Secondly, monitoring studies report extreme variations between households in consumption due to ICE devices. The HES study of electricity consumption in 251 English homes (Zimmermann et al., 2012) reported that the average consumption for audiovisual devices per household was 553 kWh/year, but this covered an extreme range from hardly anything (10-20 kWh/year) to almost 4,000 kWh/year. The top 10-15% accounted for approximately 40% of the energy consumed by the whole sample. For computing devices, the average consumption was 240 kWh/year per household, ranging from about 10-20 to 2,000 kWh/year. Similarly, roughly 10% of homes consumed 35% of the total energy. In a smaller monitoring study of ICE appliances in 14 UK households, Coleman et al. (2012) found that

29.5% of the total electricity consumption took place in just one home (7% of the sample): a household with a single male occupant.

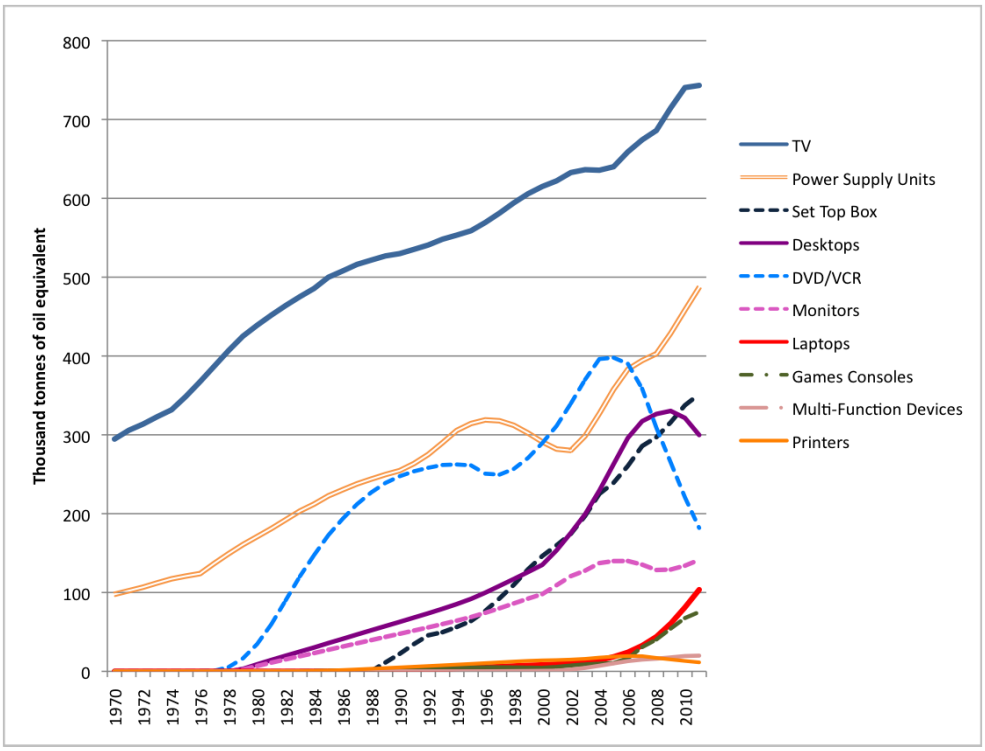


Figure 8.2 Total Domestic Electricity Consumption by ICE Device Category in the UK (Data from DECC, 2012)

As a rapidly changing feature both of everyday life and of energy consumption, the links between what people do with ICE devices and the energy they use have received some interest (Crosbie, 2008; Gram-Hanssen, 2005, 2009; Coleman et al., 2012; Røpke et al., 2010; Røpke and Christensen, 2012, 2013; Spinney et al., 2012). But few studies have yet related qualitative accounts of ICE-related practices to their actual consumption, at least in a way that goes beyond a discussion of stand-by. I now introduce the findings of my empirical research, which does just that.

8.2 Investigating ICE: Methods

In this part of the research, at-the-socket electricity consumption was monitored in 19 of the participants' study-bedrooms in a hall of residence over 20 days in March 2011. This was achieved using Plugwise socket monitors, which are adapter-like devices that fit between the

socket and plug. These were fitted to the four sockets in each room, and an inventory was taken of the all devices that were connected at the time. This included all the devices that were in use, including any non-ICE devices. Where participants used multi-way extensions with more than one device, these were not monitored separately. This is because the data collected by the monitors was communicated via a wireless network to a logging PC installed in each flat, and this local network needed to be configured prior to installation. The number of monitors to be used needed to be known in advance. Power was monitored every 6 seconds, logged on the PC, and at intervals backed up the database to a server on the local university network. We were able to access this back-up to check if the logging was working, and to review the data being collected.

The power socket data was used in the qualitative research. Firstly, whilst the study was in progress, short questions were sent either by email or in a few cases by SMS (text message). These asked what the participant was doing during a particular period in the past day or couple of days when there appeared to be active electricity consumption at the outlets in their bedroom. Where the data itself was particularly hard to understand, for example where the pattern of consumption appeared to indicate a change of devices, we asked about what items were in use. 17 participants were sent a question (not all were queried due to time constraints and gaps). 10 responses were received.

Secondly, the data was also used in the interviews. 12 of the 19 participants were interviewed. These were the same interviews in which cooking was discussed, and they took place mostly in the kitchens of the flats. They included a range of questions about everyday routines (see Appendix 1). Towards the end of the interviews charts of power use recorded at the participants' bedroom sockets were shown. This was to provoke further discussion of the account participants gave of the previous day, but also to provoke discussion about the kinds of devices they own and how they are used. These interviews lasted between 35 and 75 minutes. The same pseudonyms are used as in the cooking section. Those participants I did not interview are also given a pseudonym.

8.3 Extremely Uneven Demand: Electricity Consumption in Student Bedrooms

As can be seen in Figure 8.3, most of the consumption took place in just a handful of rooms: 20% of the rooms consumed 75% of the electricity. Thus, demand is for the most part constituted by the practices of a minority. In addition, at socket electricity consumption was almost entirely due to ICE devices. Other electronic devices such as hair dryers and straighteners, chargers and alarm clocks consumed relatively little. In fact, 77% of all the devices monitored fall into the ICE category: the rooms are, first and foremost, sites of ICE consumption.

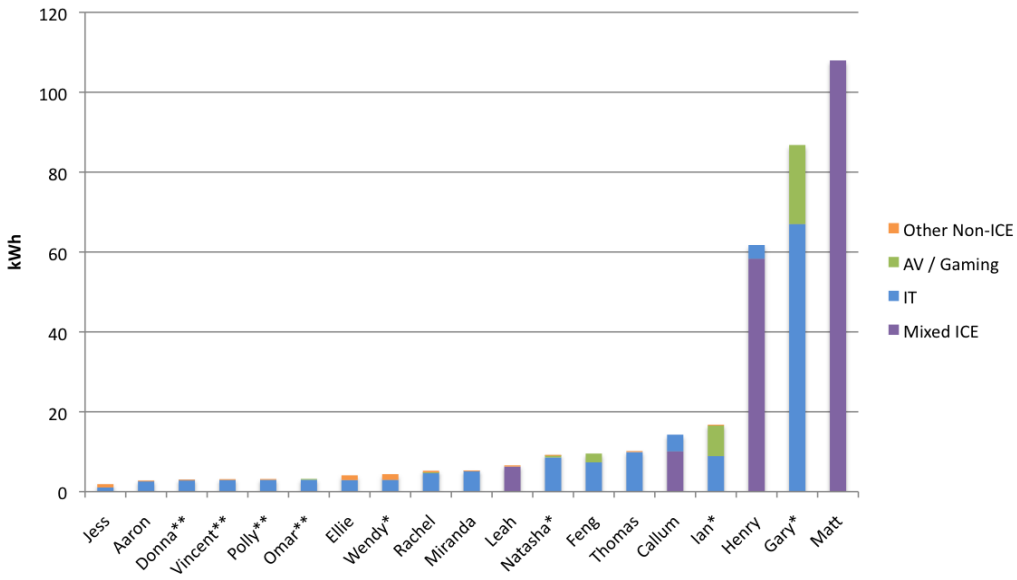


*Figure 8.3 At-socket electricity consumption for 19 study-bedrooms over 20 days. (*denotes an estimate based on actual power readings and patterns of use. **denotes a 'standard' estimate of laptop use at 3 kWh (25 W for 8 hours/day) where it was difficult to more directly estimate from the sensor readings for that room)*

For several of the rooms, particularly those with the most devices, the monitoring method (of sockets rather than individual devices) does not allow for a distinction between different types of ICE device. Accordingly, I am not able to report the consumption for every desktop PC or laptop. But where possible, Figure 8.4 separates IT devices from other audio/visual technologies. It should also be noted that the results include some estimates to account for periods of 'downtime' when the monitors failed to report (this varied considerably from room to room). Nevertheless, a high degree of confidence can be placed in the *relative scale* of

difference attributable to high-end consumption. If anything, figures at the lower end are overestimates.

It can readily be appreciated how the location of certain residents can contribute substantially to aggregate differences in consumption between the flats. As it happens, Gary and Matt both live in the same flat (Blue), which overall consumed the most electricity (twice as much as the lowest consuming flat, Red). Yet together Matt and Gary's bedrooms account for 25% of this total, which is more than all the appliances in their flat's kitchen. Accordingly, electricity consumption related to ICE devices appeared to be much more variable between the flats than that related to cooking.

Ownership of ICE devices

Compared to the previous areas of practice (cooking and thermal comfort), the study of ICE-related energy consumption in this real-life setting cannot exclude variations in ownership. Since the cookers and the heating systems are similar, if not precisely identical, variations in energy / heat consumption attributed to each participant can be related to what they do. Here, variations in consumption are clearly, directly and significantly related to the nature and number of devices in each bedroom. Quite simply, those rooms where most of the electricity consumption takes place contain (substantially) more electricity-consuming devices (Figure 8.4). In fact, the same top 20% (4 rooms) own 55% of all the ICE devices monitored.

That the distribution of the number of devices is not as extreme as the distribution of energy consumption suggests that the nature of the devices and how they are used are also significant in contributing to the variation (or perhaps I should say divide) in consumption. I don't intend to separate these influences. Rather, I follow a line of thought in consumption studies which proposes that 'having' and 'doing' are iteratively and intimately related (Shove et al., 2007). Thus, in keeping practices as the unit of analysis, I ask how the particular practices that depend on these devices vary when comparing the high-consuming participants

to the others[10]. This leads to another distinctive feature of this analysis compared to cooking and comfort: namely, the number of practices that need to be considered.

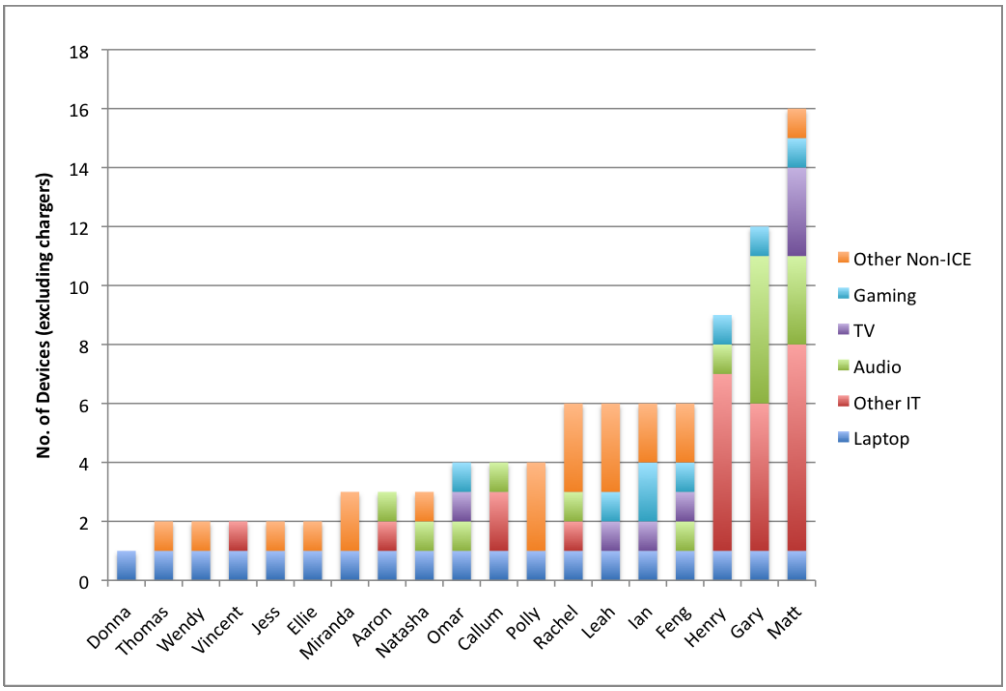


Figure 8.4 Number and type of devices monitored in each study-bedroom. "Other IT" includes computers, printers, monitors/displays, routers, and peripherals such as external hard drives.

But before starting to examine each one in turn, it is worth noting that the three top consumers, those in a different league of consumption, are all studying a computer science-related course. This insight does prove to be critical in the analysis when I come to ask what kind of a practice is "computing". But I do not start here, for the simple reason that another puzzle presents itself: besides studying computing (and playing the electric guitar in Matt's case), there is very little evidence to suggest that this group undertake any other practices that are not shared by some, if not all, of the other participants (Table 8.1).

The simplified overview of the practices implicated in ICE-related energy demand, presented in Table 8.1, emerges from the interview data. 12 of the 19 participants were interviewed and

[10] For ease of language, as with previous analyses, I refer to participants as high- or low- consuming. I do not intend this to be read as an essential, personal characteristic of the people involved but as shorthand for the activities, accounts, sets of devices and monitoring data from each room that are organised and compared on a participant by participant basis.

I include, where relevant, the accounts of those interviewed in other stages of the study (the preliminary round of interviews and comfort study). Since individual devices were not always monitored, it is not possible to explore differences in practice directly with respect to variations in the monitored data. But, as we will see, this is doubly infeasible because most of the practices I am about to outline are not neatly organised by specific devices: rather they form a group of practices that depend on a computer or the other devices which are attached to it. For all but the 3 highest-consuming interviewees (Matt, Gary and Henry) this means a laptop. I begin with one of the most pervasive practices, watching, and then consider other forms of entertainment, listening and gaming, before moving to more "computer-specific" practices.

Table 8.1. The distribution of ICE-related practices amongst the interviewees, who are a subset of the participants. ("?" indicates where a common practice was not specifically mentioned by the interviewee)

	Watching	Listening	Gaming	Keeping in Touch	Studying	Computing	Electric Guitar
Matt	Y	Y	Y	Y	Y	Y	Y
Henry	Y	Y	Y	Y	Y	Y	
Ian	Y	Y	Y	?	Y		
Callum	Y	Y	(At friends')	Y	Y	Y	
Leah	Y	?	Y	Y	Y		
Miranda	Y	Y		Y	Y		
Wendy	Y	Y	(At friends')	Y	Y		
Ellie	Y	?		Y	Y		
Polly	Y	Y		Y	Y		
Donna	Y	Y		Y	Y		
Aaron	Y	Y	Y	Y	Y		
Jess	Y	Y		Y	Y		

8.4 Watching

Considered in terms of distribution amongst the participants and time spent, 'watching' is one of the most prevalent forms of practice involving ICE devices. All of the interviewees talked, without specific prompting, of how they watch films, DVDs, TV and YouTube videos. In their accounts of the previous day, only three interviewees did not mention some form of watching. This indicates that it happens regularly for most.

Types of Watching

There are various forms, or variants, of watching; these are significant for understanding variations within the practice and engagement with it. They include:

1) *Watching a film together* - "watching a film" or "watching a DVD" with friends is a way of socialising and it is the most widespread form of watching. It can be either as part of a planned or special event, a "DVD night" (Donna) or "movie night" (Ellie), or happen more spontaneously as a way of filling in time (Wendy: "it's quite a 'what are you doing? Nothing. Let's watch a film'") or spending time with flatmates, who might not otherwise socialise.

2) *TV with meals* - "watching TV" usually referred to TV content (shows or programmes) rather than the device itself. But TVs were provided in the kitchens, and if the residents brought their own set-top boxes they could watch "live TV" (via terrestrial broadcast). In two of the flats, shared TV-watching in kitchens emerged around the temporal organisation of eating habits: "everyone's normally in the kitchen about five or six and everyone normally watches *Friends*. And there's *Scrubs* on at the same time so everybody watches that" (Henry).

3) *TV in the background* - Some participants also reported having the TV on in the background, whilst doing something else. In the kitchen, Jess says "it's always on… I don't watch, like… I don't sit down and watch a programme but I normally have the music channel on when I'm in here". If only the TV in her kitchen worked, Miranda would do the same "if you're… on your own". It *is* something Miranda can do in her bedroom: she plays TV programmes (soaps) on a laptop when getting ready to go out or tidying her room. Others also play TV or "video" (Matt) in the background as they play on the Wii (Leah) or are "on the computer", possibly doing some work (Matt, Callum).

4) *TV alone* – With the exception of Jess, Wendy and Polly, most of the participants talked about watching TV as well as films. For the most part, this takes place in private and is achieved via the Internet (or on a rare occasion a DVD of a TV show); it is never a case of watching whatever happens to be on 'live TV' but rather specifically chosen programmes. For this reason, I think, Donna, Miranda and Ellie all referred to this activity as "catching up". And, as such, the TV content itself is instrumental in sustaining the practice: Nadia says,

"[I] also make sure I watch my err… set programmes a week. I've got like these two programmes I watch… religiously so (laughs)". However, at times on-demand watching can be just as opportunistic as live TV-watching: Aaron was surprised to find how much he enjoyed a particular documentary, which he watched because his preferred comedies weren't available.

5) *TV in relationships* - A few of the participants (all third year students) talked about watching TV with friends or girlfriends/boyfriends. For example, on the previous evening Ian "stayed in" with his girlfriend watching TV. Callum and Henry talk about watching "TV" or "telly" in their friends' rooms whilst Matt often has friends come to his room: "if there's a regular TV show or something we'll watch that together". He refers, here, to a small number of close friends.

6) *YouTube and telecasts* - other forms of video were also mentioned. Wendy, with her flatmates, can spend "hours" watching YouTube clips. And Ellie sometimes watches religious "telecasts". This is a relatively new form of watching that arrived with the growth of Internet video.

From their accounts, it is difficult to say who really spends the most time 'watching'. This is partly because of the different forms involved. Some participants such as Jess and Wendy (and to a lesser extent Polly, but certainly her flatmates) seem to spend a lot of time watching films, but not TV. Others watch TV on their own, but this might be just in the background (Miranda, Leah) or not much and not everyday (Donna, Aaron) even if there are rare occasions when they "catch up" with a show in back to back episodes (Ellie, Miranda). In contrast, Matt, Ian, Callum and Henry appear to spend time watching both films and TV. Significantly, they share TV watching with others, as well as partake in it on their own. With the exception of Henry, each indicates in their own terms that they watch a lot (Callum: "[I] watch quite a lot of TV"; Ian: "I download lots of films. I like to watch films"; Matt: "I watch TV a lot" "[it's] part of the daily routine"). These interviewees who watch the most are at the higher end of electricity consumption. Three distinctions set this group apart and are worth exploring: they are all in their third year at university, they mention forms of access to TV content that the others do not, and they do not simply use a laptop to watch.

Careers of Watching

Compared to a family home, university life is a very different space for watching to take place. Friends are much closer at hand and other activities are encouraged through the many student societies. The influence of coming away to university appears to differ between the variants of watching. On the one hand, film watching seems to increase because of its role in socialising and in framing time and relationships (Wendy: "I never used to watch films but it's a really… it's social event now we use it as a… just cos we're all bored, there's nothing to do so we all just watch a film and talk through it most of the time"). On the other hand, TV-watching falls somewhat out of favour (Kate: "I think people used to watch a lot of TV before but they came to uni and we're just not really bothered about it now"). This is, perhaps, apart from specific programmes that people like to keep up with, but which may seem more of a personal than shared interest when first at university. At this time, socialising and building friendships are especially important and content that everyone agrees can be talked over or sung along to (Donna) is no doubt better for watching as a group than personally prized programmes. Moreover, the first-year students spend evenings "going out" to socialise (e.g. Leah, Aaron, Wendy and Jess report going out 3-4 times a week). In contrast, evenings are a time when third year students Matt, Henry, Ian and Callum all reported watching TV, including on the previous day.

It seems that TV-watching is resilient and opportunistic. By the third year, these interviewees, and Matt in particular, welcomed the regular alternative to going out that TV-watching can provide. By this time they had also formed closer friendships or even couples, wherein shared interests in particular shows might emerge, or at least a more comfortable possibility for engaging with the show and not each other. For example, in previous years Matt recounts how "there was a lot more drinking and partying and stuff, but I was a lot more busy as well". In other words, the extent of engagement with TV-watching in particular is contingent on the other practices that compete for time. When those become less demanding, or at least less demanding in their own right, TV-watching might re-emerge or merge with them (e.g. if it becomes a shared interest).

Material Basis of Watching

The material arrangements that support TV-watching are also seen to have a role in the nature and extent of engagement. First, I consider the infrastructure which provides content. It is in fact limited in this hall of residence: there is no good access to broadcast TV in the bedrooms (no aerial is provided). So when it comes to TV content, the participants are dependent on what's available on the Internet (there are wired Internet connections in each room), or DVDs they bring with them. In itself, this can be a limiting factor. Aaron finds his TV-watching to be limited, because on the campus network only some of the main TV channels' Internet platforms work (namely the BBC's iPlayer).

The third year students have found other Internet services for accessing programmes and films. Callum talks about downloading content that is not through the BBC, and Henry mentions using iPlayer *and* IPTV, that is, other website services that deliver a variety of television content (Internet Protocol Televison). In one flat (Blue) where Matt and Ian live, the residents share a subscription to such a service. And such good access appears to promote TV-watching: "it's been a thing this year. We've got a free download thing now, so we watch a lot of it" (Ian).

Ellie, a visiting student staying in the same flat, also welcomes this access, as she can catch-up with shows she likes to watch but rarely has time when she's at her own college. On the day before the interview she watched five episodes of a particular show, back to back. This had never happened before. Thus, when there is time *as well as* good access to specific content, TV-watching appears to catch-up with practitioners who at other times and places, are much less frequent watchers. Practitioners, of course, configure these arrangements, for example, by taking out a subscription (apart from those like Ellie who can fortuitously share others' arrangements). This is something they are likely to do if they are already relatively engaged practitioners. Having good access and use are no doubt iteratively related. The same applies for the local infrastructure of devices with which TV-watching takes place.

Not too long ago, watching TV necessarily involved a television. But the practice that this device defined has evolved. Between the 19 participants, there are only four televisions and one, we know from the interviews, is not even used for watching TV but for playing on a

games console (Leah, who watches TV on her laptop at the same time as playing games). For most interviewees, TV and films are watched on a laptop, but not for Matt, Ian, Henry or Callum.

Callum did use a laptop but he also had a separate, larger monitor and played sound through a "tube amp". Henry used his desktop computer, maybe one of his two monitors and a separate stereo. Ian had a large screen TV (50 inch) that sat on the floor, and played content from his laptop, whilst Matt played TV programmes from desktop computer (which "does all my media server kind of thing") onto a big TV (though not as big as Ian's) with a separate stereo. He also has a blu-ray player and an IPTV box. These arrangements, particularly Matt's, signify a stark difference in electricity consumption compared to those who 'watch' on a laptop. And given these are all the participants who report doing a lot of watching, the practice clearly makes an important contribution to the differences in the consumption between the bedrooms. For example, Matt, in the highest-consuming room, uses the most energy intensive TV-watching technique, and he is also amongst those who spend the most time watching TV.

One of Matt's watching devices, the IPTV box, appears to be a particularly energy-demanding innovation in TV-watching. In the interview, Matt doesn't say much about it or how it's used, merely that it's "a trial thing". It is plugged into a socket along with three other devices that between them result in a high and exceptionally steady power consumption of 110-125 W. By chance, Callum also tells me about a "next-share box" that he has as part of a trial: "it's for live streaming of TV but it uses a peer-to-peer protocol to distribute it". It turns out this is part of a research development project taking place in the computing department at the university. It's very likely to be what Matt has, too. Callum doesn't use his: it is not plugged in and since he's not interested in watching live TV he hasn't found the time to set it up. But he explains, with some amusement, what his friends have told him about it:

> "when you like turn it off… it's actually still like… it's almost fully on. I think it only saves about five percent than if it's on full power. Cos it stays on cos it… like it sends… with it being peer-to-peer as well it might be used to send video to other users that are nearby in the network. And it also sends log files and log data back. So

even though it looks like it's off it's actually very much on. Yeah, which I thought, yeah… thought was quite was funny." (Callum)

This helps to illustrate that technical innovations in watching, which may apply as much to the computer-as-media-server as to dedicated NAS (network attached storage) devices, bring in new forms of 'work' for machines, and thus new forms and temporal patterns of electricity demand, which may in time become increasingly widespread. At the same time, these innovations appear to sustain watching and its meanings, perhaps with only subtle changes to the form that it takes.

Investment, Opportunity and Watching

The variations in watching between the participants lead me to suggest that there can be various forms of engagement with a practice such as watching. First, there seems to be a kind of contingent engagement, whereby the time and space for watching emerge through other practices, for example eating, as part of an evening routine, as part of socialising, or even by the absence of other practices. Second, it seems there is a content-related engagement where particular programmes are especially important (perhaps these come of prior contingent forms of engagement). Third, I suggest there is a technical form of engagement, constituted by expectations of the kind of service, and experience, by which watching should be practiced. Where these come together, as I think they do most markedly with Ian and Matt (who have dedicated and large TVs), we witness what must be the most energy-demanding watching.

Watching then is a diverse and diversified practice. Information infrastructures offer forms of watching at this site that were not previously possible. For example, on-demand TV programmes over the Internet can fit into irregular schedules of student living, equally suitable for background when tidying a room mid-afternoon or for late night watching with a friend. These different forms of watching offer different routes through which the practice sustains itself despite evidently different degrees of engagement. New devices do add new elements to the practice. New technologies such as computer media servers, large flat screens and IPTV boxes make higher-energy watching possible. But another technology, the laptop, means that some watching can also be lower-energy, certainly compared to a dedicated TV

and set-top-box. The introduction of IT to watching at this site has diversified energy demands *at both ends* of the spectrum. But it is not the only practice that depends on the hugely diverse configurations of computers, screens and speakers. These elements are also shared by listening, gaming, studying and going on the computer.

8.5 Listening

As with TV, listening to music also appears to be widespread. Again, there are different 'techniques' for listening that have different consequences for energy consumption. These techniques are mostly, but not always, the same techniques as are used in watching, that is, the same speakers connected to the same computers, whether that be integral laptop speakers or separate, sophisticated stereo systems. Each of the 5 highest-consuming rooms have such a system, consisting of speakers and an amplifier and possibly an equaliser. These systems are also used for gaming in these rooms (see below).

Despite the role that listening and associated systems play in other practices, it also seems to be important in its own right; particularly so with those in the highest-consuming rooms. Matt "always listen(s) to music". Henry, also, when asked if he uses the computer most out of all the devices he owns, he responds: "I suppose it's not really my computer I use as much but my stereo". This suggests that at least some of the time his computer is on is purely as part of listening. Ian responds similarly: he thinks he uses his gaming chair the most out of his devices. This is a low-profile reclining seat with built in speakers near the occupant's head which Ian uses when gaming, watching TV and also as speakers to play music from his laptop. Callum also plays music from his laptop, often when he's working, and he uses a tube amp and speakers. Having a tube amp is a matter of some pride: "they're… quite old fashioned. They don't really make them anymore. The actual tubes… they only make them in Russia I think (laughing) so it produces a particular type of sound". Thus, when it comes to sound there are some specialised concepts of service: ideas of how sounds should be produced and experienced. These are technical engagements with listening and they are comparatively energy-intensive when compared to the smaller iPod docks, speakers and integrated laptop speakers that most of the participants use. Moreover, listening perhaps

mostly in its own right (for Matt and Henry and Callum) introduces these higher impacts to other practices of which listening is a part.

Across the participants, even those who are most technically engaged in listening and who report doing it frequently, listening almost always accompanies something else. It forms part of other activities, such as working, socialising, getting ready to go out, doing something in the kitchen or going to the gym. Music is played specifically as a background that creates a kind of animated space. For example, Wendy, mentions that she plays music to avoid the disquieting silence she experiences when alone in her room. I suggest, then, listening is mostly sustained through contingent forms of engagement.

In contrast, for Aaron, listening to music is a specific point of focus and something to which he dedicates time. On most days in the week or so prior to the interview, Aaron used his laptop "to go on the Internet and like look on music blogs and things like that. Just… just to find as much music as I possibly can really on the Internet… erm… cos I'm, I'm quite up with my musical tastes". He finds out about new releases, downloads them, synchs them to his iPod and plays them through an iPod dock which doubles as an alarm clock. In the day before the interview, his account combined with the energy data suggest that he spent about an hour on his laptop, researching, downloading and synching "his" music, and then about an hour listening to it in bed. He considers this activity of "being up with my musical tastes" as a form of leisure.

From one perspective, then, Aaron is much more engaged with (the content of) listening than many others. But this doesn't necessarily map onto higher energy consumption as it does with watching. In time and energy, Aaron's listening is contained in discrete episodes that would not match the listening throughout the day through a desktop computer and stereo system that appears to take place with Matt, Henry and Callum. This dissociation of explicit and dedicated engagement follows from the mostly contingent nature that is characteristic of listening.

8.6 Playing Computer Games

Unlike watching and listening, playing "computer" or "video" games is not so prevalent a practice. As such, it is potentially an aspect of the differential consumption between the rooms. Indeed, half of the eight participants who are likely to play computer games, by their accounts and/or the inventoried presence of a games console, inhabit the four most consuming rooms (Matt, Gary, Henry, Ian). The others (Feng, Leah, Omar and Aaron) are scattered in the consumption distribution. Thus, playing computer games doesn't define high consumption, but it is a shared feature of, and likely contributor to, the moderately high consumption of Ian and the radically high consumption of Matt, Gary and Henry.

Moreover, as with watching and listening, a similar pattern of difference within the practice is apparent: namely that in the highest-consuming rooms playing games takes a more power-intensive form than elsewhere. Aaron has the least power-intensive form in that he sometimes plays "little… short games" on his laptop when he's bored. Others have dedicated games consoles, a variety of which are evident in the study. Some are connected simply to a TV that is itself dedicated to playing games (Leah). But in the higher consuming rooms consoles are connected to the more complex arrangements of separate stereo speakers and screens (the bigger, the better), which are also used in watching and listening. Otherwise, as Gary reports, computer games might also be played on the desktop PCs that (in the three highest rooms) sit at the heart of these networks.

Thus, there are different ways of playing "computer" games and a diversity of specialised, dedicated products. Consoles tend to be more power-intensive than laptops and depending on frequency of use can be more energy-consuming: over the 20 days of the study Ian's X-box consumed 3.3 kWh, which is just more than Ellie's well-used laptop, 2.9 kWh. At the same time, however, game-specific devices are necessarily combined with at least a TV and, in the highest rooms, a number of other generic devices, which are nevertheless very specialised in terms of their functionality (e.g. sound or picture).

This bundling together of different forms of entertainment through an, at least partially, shared infrastructure appears to affect careers of playing computer games; these are at once

linked and distinct. This is illustrated by Aaron's and Callum's justification of not bringing the games consoles that they own and use 'at home' (the family home) to their university residence. Whilst they both watch TV on laptops, playing games would require the separate, dedicated and larger TV. This extra facility for TV-watching and playing games is felt to be a distraction from the kind of things they would prefer to do at University: "I'd probably procrastinate even more if I had an X-box… or a big TV in front of me" (Callum) and "in the long-run I knew I wouldn't benefit" from staying up late to watch TV or play on the console (Aaron). Thus, TV-watching survives at university whilst playing 'computer' games is eliminated or greatly reduced (besides little games on the laptop).

Thus, whereas TV-watching seemed to persist amongst most of the residents if only for a couple of hours a week, gaming can fall almost completely out of favour amongst those who do it. As Henry's workload increased throughout March, it seems (from the monitoring data) that game-playing on his X-box decreased. More generally, this has also changed in his years at University: "I used to play lots of games but not so much anymore" and in the first year "if I wasn't doing something I would be playing games but now if I'm not doing something I'm doing something else. I'm… socialising or… I found other hobbies really".

But under different circumstances, Aaron did fetch his X-box from home: when a flatmate received a TV, and keeping it in his friend's room they played on it together. That is, until the TV broke. That was a "luxury" for a while, and shows how opportunistic arrangements can quickly bring a hibernating practice alive. But it seems Aaron was happy enough to go back "into normal routine" without gaming.

8.7 Computing

Watching TV and listening to music in these study-bedrooms almost entirely takes place through a general-purpose computer, whether that be a laptop or a more complex ensemble. In other homes, this is perhaps not the norm. Other practices might be considered to be more specific to the computer: keeping in touch through email, Facebook, Skype; browsing the Internet and studying. In some form, each of these was evident in the accounts of all the

participants. It is a stretch to consider all these different activities under the general umbrella of 'computing' (Spinney et al., 2012). But some form of technical 'computing' activity *is* taking place with the four participants who are (known to be) enrolled on a computing-related degree course. As mentioned earlier, they reside in four of the top five most consuming rooms: Matt, Gary, Henry and Callum. The sections that follow consider how technical computing is linked to energy consumption.

Going on the Computer

First, I consider the nature of computing projects. These appear to affect the quality and quantity of time spent on the computer. In essence, the computing students appear to spend longer periods of time on the computer and at least some of these periods are spent in a seemingly generic state of being "on" the computer, rather than engaged in any particular task. Moreover, the computer also seems to spend more of its time in an active state. The nature of computing work itself is implicated in this pattern, at least partially.

Matt and Henry both describe computing projects that they are working on at the time of the study. Henry was testing something: "I made the machine and now it's just doing what it wants, it's just doing what I made it do". As this "test bed" runs he checks up on it but "whilst I'm checking up on it I might be doing some programming or I might be reading the news or I could be doing anything. I'm just on my computer for hours and letting the thing run." At least in this computing project, there is a "construction" phase, in which the practitioner is actively engaged, and an "operation" phase where the machine is "doing the work" (Henry). In these periods, the computing practitioner is committed to a supervisory role whilst the computer does its work but one which leaves them largely free to do other things. For Henry this could be a number of different things but they are all on the computer. In a similar way, Matt, who is running software all the time on this computer, talks of how working blends into not-working: "everything kind of mashes together" because "it'll be on. It's always on the screen, if you've got things running on your computer so you just go between". He goes on the Internet, or he might have a movie running or some music. For Matt, "work" is something that emerges from spending time on his computer: "I'm kind of on the computer so if I get bored I might do some work, you know, that's how that sort of happens." Callum, the other computing student who was interviewed, also reported regularly

spending most afternoons "working". Sometimes, he might also have a TV show running and switch between this and his work.

Working explicitly with computing, I suggest, engenders a different relationship in time to computers and the other activities they support: extending times spent 'on' them, the layering of multiple activities into these times, which can be generic and inter-changeable (i.e. could be doing "anything"). Such features are not unique to the computing practitioners: others also think they spend a lot of time on their laptops (Ellie, in particular). For example, they might do other things whilst working or might use their laptops whilst doing something else, and they share the language of 'going on' the computer or laptop. This expression denotes something of the generic nature of computer-based activities, which, I suggest, relates to the gathering-together of these activities that a general-purpose computer facilitates. That it has some currency as a meaningful activity in its own right, as opposed to the other occasions when participants actually express particular tasks or websites (e.g. Facebook), implies that it is perhaps an important part of the way computer-based activities are organised: one might check emails, Facebook, a news website, and some course notes in close succession and in no particular order. But I think the expression also signifies that a computer, such as a laptop, when connected to the Internet, is a way to spend time, and that it feels specifically like a 'place' where you can 'go', even (or perhaps especially) if you had nothing particular to do there.

Whilst spending 'a lot' of time 'on' the computer is not unique to the computing practitioners, they certainly appear to be at an extreme end of the continuum. Others talked about going on their computer at discrete times during the day; but for Henry, Matt and Callum this was, more or less, how they spent their day. This was evident in their accounts, in the monitoring data, and had also been noticed by Ian who shares a flat with Matt and Gary: they "just sit in their rooms all the time" which he associates with their computer science studies. It is also possible however that this time is spent "working" and is related to being in the final year of their course, which they all are. Ian was the only other third-year student, but like the non-computing participants he only worked on his computer when essays were due. Thus, for the other participants 'working' was not regular or drawn out, or something that happened when you were otherwise on the computer. Instead, it represented specific and

discrete occasions on which they tried to focus, and when the other computer-based activities constituted distractions, or at best, a break. However, even within 'computing' this might also apply at other times: when Henry considers *himself* to be working (rather than supervising what the machine is doing), he focuses: "I'm doing something on the computer and I'm not flicking to the news, to BBC news or to Facebook or various other things."

Building Machines for Computing and for Fun

Matt, Gary and Henry each have more than one computer or server, including a desktop computer and laptop. Desktop computers were rare amongst other participants. Unlike laptops, which have been designed to integrate functionality, desktop computers require peripheral devices, notably monitors and speakers. Each of these presents an area of specialisation where standards and expectations can rise. Moreover, we can appreciate how a static, desktop computer might assume quite a different role from a laptop which is taken outside the room: it can run processes all the time and any wired peripherals can stay plugged in. The computers themselves can become specialised.

As for monitors, one might not be sufficient for doing computing nowadays. Henry and Gary both have two monitors:

> "It's more for working with, when I'm programming, it's more for cos I keep my programming on the left screen and then on the right screen I have … any resources I'm using. And like the programme I'm running and… it's mostly for work" (Henry)

Matt and Callum who use laptops also use separate monitors. As Callum explains, this is not essential and provides something of a marginal benefit, but a benefit nonetheless:

> "it's not vital cos I've got the screen on my laptop. But it just helps a bit… I don't have to wear my glasses when I use my computer but… it helps a bit when I'm… writing stuff and coding and that kind of thing" (Callum)

Working with two monitors might be particularly useful when doing computing, such as when programming, but it is not limited to computing. And neither are monitors limited to working with desktop computers. Callum's monitor is always on, he says, if the laptop is on.

For some, there is a certain sense in which the doing of computing entails building networks of devices around static computers. In fact, Matt, Gary and Henry have literally built a network: they each have a wireless router, which no doubt lets some of their devices talk to others (e.g. it seemed that Matt connects wirelessly to his desktop computer from his laptop). In contrast, Callum has taken a different route. He comments on his flatmate and friends: "Henry and a lot of the lads like mess around with PCs and build new ones and that kind of thing but… I don't know, it was just buying a laptop, I'm not really… I'm not really able to do that". Despite building a desktop computer at college to specifically bring to university, Callum soon opted for a laptop with a guarantee that would see him through the course. And because of this the electricity consumption in Callum's room is much lower than Henry's. This is even though they appear to spend a similar time on their computers, they both enjoy listening to music and watching TV through them, and have both run test-bed projects. Besides the computer, extra monitors and router, and games console which Henry doesn't use too frequently, they have similar types of devices. But the electricity consumption is widely different (3.7 times greater in Henry's room). Some can be accounted for by the weekends when Callum is generally not around. But most is likely due to the high power of the desktop computer with its connected devices, which Henry has assembled. From the monitoring data, confirmed by his accounts, Henry turns this whole computer-ensemble on and off as a unit: it is off when he is asleep and out of the flat for a few hours, but on during the time he spends at home (Figure A, Appendix 4). It is then used as whole regardless of whether he is checking the news, revising course notes or listening to some music.

Henry is in his third year, and over the years at University, he describes how he has built-up his computer system:

> "in my first year I had err… I brought a computer, a desktop computer and a single monitor and some… cheap speakers, some fifteen twenty quid speakers. And then in my first year I bought a second monitor and some slightly better speakers and I upgraded some of my computer. Then I bought an external hard drive. Then in my second year I bought…a network switch, then some slightly better speakers (laughing) I've upgraded the speakers as I've gone… and a better second monitor (laughing). Upgraded my computer some more. Then [I] bought another external

> hard drive. Then I bought a… wireless a network, no err… a wireless router. Then in my third year I brought back even better speakers (laughs)."

He doesn't have any further changes in mind. But he's "sure that'll change though… I'll spot something on the computer". For Henry enjoys spending time on the Internet "keeping up with the technology scene". Building a computing infrastructure is something of a hobby. It is "a progression" that has transformed his university on-campus room, over the years, into "a geek's paradise".

Thus, these accounts suggest that the high-electricity consuming rooms are different *places*: places that have been as intentionally crafted and equipped through ICE technologies as kitchens are with work-surfaces, cupboards and appliances. The high-consuming rooms are environments were particular activities can take place frequently, easily and in particularly valued formats. Whilst many apparently similar activities can take place in lower consuming rooms, simply through a laptop, the experience is most probably not equivalent to those who have invested in and built different spaces for action. Whilst Henry's attention has focused on computing technology, Matt's appears to be much broader to include more options for gaming, TV and playing music, which are integrated into his daily routine. He has made sure his room is "a fun place" where there is always something to do.

Always-on-ness

Spinney et al. (2012) refer to the ever-ready property of contemporary laptop assemblies as "always-on-ness", something which Røpke et al. (2010) also observe. The current study supports this observation: only two of the interviewees turned their computers fully off (laptop or desktop). The rest gave a variety of reasons for keeping computers on: frequently wanting to check something, such as a course timetable, Facebook or email, not wanting to have to log back in to the websites they use frequently, use as an alarm clock and not wanting to have to wait whilst the machine starts up.

Spinney et al. (2012) argued that because always-on-ness applies more to the way that laptops were used (in conjunction with Wi-Fi networks) than it does to desktop computers, laptop assemblies may end up consuming more electricity despite demanding less power. However,

this study shows that desktop assemblies can also always be on. Since they tend to be more power-intensive compared to laptops, in part due to the collections of peripheral devices that are on at the same time, this helps to explain the extreme differences in electricity use observed in this study. But this is not simply a question of standby consumption. In fact, because of the kinds of practices in which these desktop computers are used, they appear to be in active use more regularly and for longer periods. Indeed, these participants seem to be always 'on' their computers themselves. Thus, the durations in which standby consumption is incurred may be less than for many of the other participants.

In conclusion, this chapter has highlighted the multiplicity of practices and energy use trends that are brought together analytically and in practice by digital technologies. Whilst these practices might have distinct histories and meanings, they appear to be increasingly blended and their trajectories, and attendant patterns of energy use, are increasingly dependent on complex interconnections. In the next chapter, I discuss the conceptualisation of ICE practices and of the links between them. I also consider how levels of energy demand are constituted and what this means for the interpretation of nationwide energy use trends.

9. ICE AS COMPLEX: HAVING, DOING AND DIVERGENCE

In this chapter, I reflect upon the findings of the empirical research into ICE practices and energy consumption, discussed in the previous chapter, and ask how this domain might be conceptualised within a practice theoretical framing of energy demand. This draws on the conceptualisation of variation within a practice developed in Chapter 4 and the discussion of services and background provisioning developed with respect to comfort in Chapter 7. Here, I argue that there are complex and multiple interconnections between ICE practices, the specific services and devices that are integrated in them and the higher-level meta-services, like entertainment and education that they support. Because of this complexity, there is the possibility for great diversity in the devices that can be integrated in common practices. This helps to explain the diverse patterns of energy consumption that were observed in the research. At a general level, I suggest that patterns of ICE-related energy use are comprised through two broad relationships to practice: one is like that of cooking in which energy consumption is simultaneous and embedded within performances; the other resembles heating in that consumption is ongoing outside of such performances. In the final section, I return to consider the general escalation of ICE-related consumption in the light of the diversity observed in my own research, and the important dynamic between having and doing.

9.1 Conceptualising ICE Practices: Complex Interconnections

In the previous chapter, I discussed a range of varied practices in which computers and other digital devices are used. This by no means covers all of the practices that do so. Yet the ones identified (watching, listening, gaming and technical computing) each depend on the computers and related devices in important ways. To some extent, grouping these practices together under the category of 'ICE-related practices' reflects my aim to link them to energy consumption. That is, because the same device(s) was used in multiple practices, it was simply not possible to separate out, allocate and then compare the proportion of consumption associated with each practice. But the findings suggest that the difficulty in

extricating these practices, one from another, reflects something of their organisation in everyday life. I begin this section by considering how. I then ask how might we conceptualise the role of materials in these multiple practices? Finally, I consider the conceptualisation of variation across this set of practices.

Connections Between Practices

By sharing the same material basis in computing devices and digital infrastructures (the Internet and telecommunications networks), ICE-related practices share a 'site' of performance at which new connections between existing and emerging practices may be made. In particular, the ease with which computers, and other ICE devices, enable people to switch between activities has been linked to their increasing integration into a range of existing practices (Røpke et al., 2010). The nature of any new connections may depend on the nature of the practices in question.

Firstly, as seen in my research, more 'passive' practices like watching and listening can accompany a variety of other activities, including non-ICE practices (getting ready to go out, cooking, eating and socialising) as well as other ICE practices (playing computer games, studying and simply being 'on' the computer). Thus, such blending is based more on the fact that watching and listening can be done at the same time as other activities than because they share the same devices. However, mobile computing devices do increase opportunities for a greater variety of practices to come together in time and space (Røpke et al., 2010, Røpke and Christensen, 2012; Spinney et al., 2012). This may even strengthen the co-occurrence of ICE practices, for example, when laptops, tablets and phones, allow couples and families to 'watch TV' together whilst also engaged in their own, different activities such as checking work emails or 'tweeting' about the programme (Spinney et al., 2012; Ofcom, 2013).

Secondly, whether ICE practices are considered to be work or leisure appears to be relevant for the type of connections that form between them. My research suggests that simultaneous and sequential blending of educational, entertainment and communicative activities when using a laptop or computer-ensemble did occur. At times this occurrence, or the possibility of it, was experienced negatively. For some interviewees, some of the time, listening enhanced study but for most, keeping in touch and watching were seen to be distractions:

rivals that vied for time and attention when working. Thus, most interviewees reported attempts to 'police' work and leisure and prevent them blending in the 'space' provided by the computer. Duncan even specialised the use of his two computers along these lines: reserving his laptop for essay-writing and his desktop PC for entertainment. In contrast, some participants did find the mixing of ICE-related practice to be more conducive to work: for Matt, in particular, browsing the Internet, watching videos, listening to music and generally being 'on' his computer helped to provide a space for work to "happen".

Finally, some practices appear to be connected by virtue of sharing a meta-service, a high-level and composite achievement such as communication and especially entertainment (as introduced in Chapter 7). In particular, if watching, listening and gaming are considered to be alternative ways of achieving the meta-service of entertainment and relaxation, we might think that they compete for time. This would be indicated if those who spend more time listening spend less time gaming or watching, for example. On the contrary, at this particular site of enquiry, my findings suggest that ICE-related forms of leisure co-occur. That is, on the whole, those who spend more time in one ICE-related form of entertainment, also appear to spend more time in others, whilst other participants prefer non-ICE forms of entertainment. Donna, for example, enjoys reading and playing an instrument as leisure because it is specifically time spent *not* on the laptop, which she cannot avoid when working. This tentatively indicates that ICE-related forms of entertainment may 'compete' *as a set* with other, non-ICE forms of leisure. At the very least, they appear to vary as a set between the practitioners in this research.

The Material Basis of ICE

I discuss the ways in which ICE-specific practices vary in more detail shortly; but first, let us focus on the devices and their roles in practice. In one sense "the home computer and the Internet constitute a general infrastructure that can be integrated into a wide variety of practices" (Røpke et al., 2010: 1768). Indeed, the assembly of computer and Internet are considered by participants to be vital, without which they would be "devastated" (Miranda) or "lost" (Wendy). But in other ways, the role of ICE devices in the practices they sustain is more complex than just being infrastructure that enables but is otherwise invisible (cf. Star, 1999). In particular, there is a sense in which computers, TVs and games consoles are explicit

elements that are integrated in practice performances along with attendant skills and know-how. In this sense, we might think of such devices as 'tools', like cookers but with a greater multitude of functions, which are integrated in performances of different kinds. If so, a number of qualifications are necessary in an analysis of how practices in this domain vary, change and relate to energy consumption: 1) 'soft' and relatively-immaterial elements are also important; 2) a variety of single devices or device-ensembles may be used in functionally equivalent ways; 3) some devices are infrastructural in the sense of not being used directly; 4) many ICE devices maintain a state of readiness outside of use; and 5) not all practices integrate the same devices in the same ways. I shall explain each in turn.

'Soft' elements - Digital devices have a huge variety of functions on account of their ability to run software. Software packages or applications, such as for word-processing, photographic manipulations and browsing the Internet, can themselves be specific and important elements in practice, associated with particular skills and know-how. Digital devices also articulate a huge variety of 'content' such as documents, films, radio programmes and websites. I refer to these functionalities as 'soft' services, in the sense of specific services (defined in Chapter 7) that have particular functions of which the achievement is relatively uncontroversial (e.g. whether a film is playing or not). Within certain bounds, the type of device used to access a 'soft' service may be interchangeable (in the research, some participants used BBC iPlayer and Spotify on computers but these are also available on phones, tablets, smart TVs and set-top boxes). As such, the services that ICE devices and infrastructures provide are detached, in a very real way, from the devices themselves. This is important for understanding how ICE-related practices vary and change. For example, many computers, and even laptops, that are currently used to watch TV may have been purchased before on-demand Internet services were widely available. As 'soft' services change, digital devices evolve in their functionality without physically changing. Because of this, and because of the distinctive and crucial role played by websites, email and content services in the reproduction of practices, I propose that such 'soft' services can and should be conceptualised as elements in practices, dependent upon but analytically distinct from the physical devices through which they are accessed.

Diverse 'hard' elements - ICE devices deliver 'soft' services through a number of hardware functions that can be constructed into devices or ensembles in various ways. In particular, display, sound, processing, storage and Internet connectivity can be provided either through a number of separate, specialised devices or a single device (a laptop), or a combination of these. As a result, the same 'soft' service, like watching TV or listening to the radio, can be done variously through TVs, set-top boxes, laptops, tablets and mobile phones, and with different concepts of service (or expectations) regarding the quality and nature of the hardware functions (or 'hard' services), such as screen size, picture and sound quality and download speed.

Infrastructure - Some hardware does appear less like an explicit and distinctive element that is integrated in performances, and more like infrastructure that is generic to diverse performances and only indirectly integrated in them by virtue of connection to other devices. I refer to the "network devices" (Coleman et al., 2012), such as Wi-Fi routers and modems, which some of the participants owned and routinely left on without interacting or thinking about it. In this light, the provision of wireless Internet access appears similar to the background provisioning of an appropriately heated room: a precondition for a variety of practices, the achievement of which is ongoing and largely outside of moments of performance. This is a form of meso-level infrastructure, much like the electrical wiring and plumbing in a building.

Readiness - The expectation that 'soft' services such as web pages, lecture timetables, emails and music should be instantly accessible is a concept of service common amongst the interviewees. Since these 'soft' services are often provided across assemblies of local devices, meso and wider infrastructure beyond the home, 'standing by' is perhaps not so much a function of a particular device but a composite achievement, the successful performance of which is defined by the extent to which the flow of doing is uninterrupted. In this light, the material arrangements of ICE also provide an infrastructural service that relates to practice but is not exclusively embedded within it and incurs ongoing energy use outside of performances.

Multiple practices, diverse integrations – The extent and nature of ICE device integrations in performance varies from practice to practice. In particular, temporal patterns vary: keeping in touch appears to take place frequently in short intervals, whilst practices like working or watching films take place in more discrete intervals of longer duration. Further, not all the ICE-related practices are defined or limited by their dependence on these ICE devices. Whilst watching TV or playing computer games is inconceivable without an appropriate device, keeping in touch can also (still) be achieved in person and by letter, for example. In addition, the profusion of practices in which ICE devices, 'soft' services and general communicative activities have become integrated, such as bird-watching, jogging and singing in a choir (Røpke et al., 2010) are not necessarily connected, as practices, beyond a shared material element. Thus, a myriad of practices may integrate ICE devices but they are not necessarily ICE-*specific* practices, of the kind I discussed in the previous chapter.

In fact, in conceptualising the relationship between the diverse practices into which ICE devices and services have been recently integrated, it may be helpful to focus on the sub-set of ICE-related skills, procedures and understandings they do share. One might even argue that 'keeping in touch', 'learning' and 'finding information' are dispersed practices (as defined by Schatzki (1996)). In contrast, the ICE-specific practices such as watching, listening, gaming and technical computing, are integrative practices in which ICE devices are a core and defining element. Moreover, based on the observation that enthusiasm and time commitment appear to vary between participants across this sub-set of ICE-specific practices, I propose that they may be conceptualised as a complex (following Shove et al., 2012). The term is also an appropriate acknowledgement of the complex relationships between practices and services of different kinds and the potentially diverse material arrangements that support them. As such, ICE-specific practices (and indeed ICE-supported ones) are united more by information, communication and entertainment as meta-services than the (now) interchangeable devices that deliver them. In combination, the term 'web' might best describe the connections between all the practices, both ICE-specific and ICE-supported, in which ICE services are now infused.

Having, Doing and Variations in ICE

Within this complex, there is considerable scope for shared concepts of meta-service and engagement in common practices at the same time as substantial differentiation, specialisation and engagement in relatively niche practices, like technical computing. Thus, variations between practitioners might take many forms. On the one hand, there are variations in 'doing': a) the extent of integration of ICE services (and distributed practices) into other non-ICE practices, b) commitment to the ICE-specific practices, and c) particular forms of engagement across the complex. On the other hand, there are inter-related but conceptually distinct variations in 'having': i) the 'soft' elements, ii) the hardware elements, and iii) the subtending meso-infrastructure. The dimensions of 'doing' have implications for patterns of time commitment, which in turn, have energy implications through periods of active use, whilst the dimensions of 'having' affect the intensity of such use, as well as periods of non-use.

In Chapter 4, I suggested that variations within a practice could be understood from the perspectives of practice variants, integrative approaches (or strategies) that vary by individual and group, and different means of achieving similar concepts of service. In applying these ideas to understanding variations in practice in the ICE domain, we can again appreciate the many small and significant divergences that are possible across the ICE complex. To re-iterate the above discussion in these terms, there are different ways of relaxing, of being entertained, educated, and of keeping in touch, many of which do not involve digitally mediated ICE services and many of which do. Yet for those who do engage more extensively in forms of mediated entertainment, integrative approaches appear to vary roughly by group across a complex of practices. The key groups indicated in this research are technical enthusiasts (defined by higher concepts of hardware service), practice-specific enthusiasts (gamers, music-buffs, film fans mostly defined by concepts of 'soft' services) and those who engage in computing as a practice. In this research, most of these forms of engagement co-occur but this is not necessarily always the case (as illustrated by Duncan and Ian, who do not undertake technical computing projects but have invested in relatively more complex hardware than others). Yet, there does appear to be a group variation by gender, the basis of which is potentially very significant to patterns of ICE related energy consumption (but an elaboration of which must be left for future work).

As observed in Chapter 8, the variations in practice between the participants were engendered in variations in ownership of ICE devices. Since this is significant to the analysis of energy use in this domain, it is worth further considering the nature of the relationship between having and doing through which these differences emerge. In doing so, I return to the observation that a language of 'space' and 'place' was frequent in the interviews in reference to activity with computers, for instance "going on the computer / laptop". This suggests something of the umbrella organisation of activity that a computer makes possible: that when you "go on the computer" a number of different activities may take place there.

Drawing an analogy between kitchens and ICE devices may help to illustrate how their ownership can be considered to provide a 'space' for practices, which in their performance and potential help to transform a study-bedroom into a 'place' with particular qualities. In their account of kitchen renewal, Shove et al. (2008) recount the iterative pre-emptive and responsive relationships between having and doing, where new kitchens are planned around imaginaries of future practices, and current ones are evaluated on the grounds of the practices they do and do not allow. By virtue of the practice for which ICE devices provide opportunity, they can transform an anonymous room into a "fun place" (Matt) or a more socially connected place where there are things to do. When in her room, Wendy says "I like to have a page open or… just so I can look at it every now and again cos otherwise I find myself staring into space". Duncan even thinks of his desktop PC as "somewhere I can relax or somewhere I can listen to music and chill out". In this sense, computers and other ICE devices are implicated in constructing the places we inhabit by 'holding open a space' for particular practices. That practice makes and re-makes place is not surprising. The recent role of information technologies in transformations of homes (Spinney et al., 2012), cafes, airports, trains and offices (Brown and O'Hara, 2003) into places of work have been noted.

The findings show how participants arrange the 'space' or opportunities for future practices, and thereby undertake 'place-making', by assembling, accumulating and updating ICE devices. This might be in a positive sense, as in the way Henry upgraded his computer system and speakers over consecutive years and Matt brought more and more of his belongings from home (his parents house); or it might be in a more negative sense, as in the way that

Aaron and Callum precluded gaming by not bringing their TVs with them to their campus accommodation.

By building material arrangements for the practices they would like to undertake, and the places they would like to inhabit, participants reified their commitments to 'doing' in ways that had lasting implications for patterns of energy use, amplifying the energy intensity of periods of use and non-use. In addition, some practices like gaming or computing have particular material 'requirements', such as multiple and/or powerful computers, screens and sound systems which are then also used when watching TV or playing music. This not only raises the energy consumption of the related practices, but perhaps, also plays a role in promoting and sustaining them. If so, we might consider there to be 'ripple effects' in having, doing and energy demand across the complex of ICE-specific practices and the wider web of ICE-supported practices.

To summarise, the research shows that the radically high ICE-related energy demand of a few participants is related to doing computing, an interest in building computers, an engagement with the 'techniques' of watching and listening, and a general engagement with practices that involve 'technological' devices, such as gaming. These practices and elements of practice co-occur in this sample, and are associated with longer and more frequent periods spent 'on the computer' or otherwise watching or playing, and with the ownership of a greater number of devices. These multiply committed practitioners invest time and money in attaining bigger screens, better speakers, easier connectivity between their devices and the availability of content. This 'arranging' activity configures the material arrangements that are ready to support practices. The evidence suggests that such arrangements (e.g. TV subscriptions, games consoles), in turn, promote the practices and there is an ongoing cycle of reproduction between having and doing.

9.2 ICE Practices and Energy Demand

I now turn to characterise the general relationships between practice and energy use in the 'ICE complex'. As a feature of the material arrangements that support particular practices,

both directly in the form of elements of performance and indirectly as meso-infrastructure for multiple practices, ICE-related energy consumption transpires in two broad relationships to practice.

Firstly, there is the temporally synchronous consumption that occurs when performances take place, or at least, in close relation. In my investigation, I have considered the duration of time commitments from participant reports, but I have not examined the times of day when performances and ICE-related consumption take place (as I did for cooking in Chapter 3). However, other research indicates that electricity consumption associated with audiovisual devices is highest during the evening, peaking between about 20:00 and 22:00 (Zimmermann et al., 2012; Coleman et al., 2012) at a time when TV watching audiences also peak (Ofcom, 2013).

Secondly, energy is also consumed outside of periods when ICE devices are directly in use. This represents a base-load that is detached from temporal patterns of activity. As an overtly 'wasteful' form of energy use the standby consumption associated with ICE devices has been a particular concern in the popular and academic press (e.g. Meier, 2005; Gram-Hanssen, 2009) and as of 2010 is subject to European legislation that restricts standby and off-mode consumption of new devices. It is not insignificant: Coleman et al. (2012) observed that around 39% of all ICE energy use, in 14 households, was related to standby rather than periods of active use; this accounted for about 7% of total household electricity consumption.

Yet, this 'standby' consumption is not just of one type. Depending on the device, there are different forms of standby consumption that include maintaining a readiness for use (when the device is placed on standby or sleep), consumption when the device has been turned off (but not at the socket) and infrastructural, network provision. In addition, the laptop battery means that such devices can 'offset' periods of use and periods of consumption. The consumption that provides readiness, networking and battery charging, provides potentially 'useful' services and is implicated in the practices supported. As Røpke et al. (2010: 1771) note it becomes "impractical to turn off the computer(s)" because of the pervasive integration into a range of practices. This appeared to be especially related to (what I identify

as the distributed practice of) 'keeping in touch' and laptop use which Spinney et al. (2012: 2640) found to be "opportunistic, frequent and often for shorter durations" compared to desktop use in households that owned both. My findings also suggest that it was relatively rare for computers of all kinds, and especially laptops, to be turned off completely. Although this portion of consumption is asynchronous and ongoing, it still exists in relation to what people do. As such, it is part of the changing 'service demand' engendered in the use of ICE devices and infrastructures.

In my research, I was not able to isolate variations in 'service demand' from the energy efficiency of devices in the way that was possible for cooking and comfort. Thus, the energy consumption data also varies according to variations in efficiency and these differences can be considerable, both in use and out of use (Owen, 2007). This adds yet another dimension by which energy consumption in the ICE domain varies: the energy efficiency of similar services as part of similar practices using similar devices may vary substantially. This was most obvious in the present research in the differences in laptop power when apparently out of use (reported in Bates et al., 2012). In addition to the range and variety of devices that can deliver similar functional capabilities and soft services, and the different roles these devices perform in practice ('hard' and 'soft' elements in performances, readiness and infrastructure for performances), the relationships between ICE-related energy consumption and patterns of (time) commitment to the various ICE practices are complex. Whilst the differential patterns of having and doing appeared to roughly tie differences in practice to differences in energy use in my research, the way this relationship evolves over time would appear, on this evidence, to be full of nuance.

9.3 ICE Flows: Diversification and Divergence

In this final section, I return to consider the long-term national growth in ICE-related energy consumption, outlined at the start of Chapter 8, in light of how ICE-related energy demand is constituted and varies at a micro-level. In particular, the iterative relationship between having and doing emphasises the amplifying interaction between time commitment, technical enthusiasm, and the energy-intensity of material arrangements. This was observed across

practitioners, but how have patterns of time use and energy-intensity changed over time at a macro-level? And do the variations observed in my research offer any insight into how these changes have taken place? I shall briefly consider these questions with respect to the trends in TV and computer-related energy consumption.

TV Consumption: Increasing Standards and Time Use

According to the ECUK model, as shown in Figure 8.2 (in the previous chapter), the energy consumption associated with TVs in UK households outstrips any other type of ICE device, and has more than doubled since 1970 (DECC, 2012). In fact, at 743 ktoe, the energy used by domestic TVs in 2011 exceeded that of any other electrical device category. It accounted for roughly 10% of total household electricity consumption (excluding heating) and exceeded that associated with electric cookers (hobs and ovens with a combined total of 536 ktoe) but not cookers overall (which including gas ovens account for 1,117 ktoe) (DECC, 2012). In terms of time-use, TV watching is also one of the most consuming activities, accounting for about 17% of the average day (BARB, 2013). But in contrast to the rising trend in energy consumption over the last few decades, the evidence suggests that average time spent watching TV has been relatively stable, fluctuating between 3 hours 35 minutes and 3 hours 45 minutes per day in the period between 1995 and 2009. In more recent years, this has increased to about 4 hours per day (BARB, 2013; Ofcom, 2013). But nevertheless, the rise in the electricity consumed by TV sets does not appear to directly mirror time commitment to the practice over the last couple of decades.

Instead, the rising energy consumed by TVs in the ECUK model relates to an increase in unit numbers (as the number of TVs per household and the number of households has grown (DECC, 2012)) and a change-over to flat-screen technologies of increasing screen size (Harrington et al., 2006; Crosbie, 2008; Ofcom, 2013). The latter development reflects how the "choice of television [sets] tends to co-evolve with the development and promotion of new technologies and services" (Crosbie, 2008: 2196). The digitisation of broadcast infrastructures accompanied a change in the format of broadcasts (widescreen and HD) which accompanied the development of flat-screen technologies, which meant that bigger screens were possible without the bulk required in CRT versions, and in combination this has encouraged the adoption of larger-screen, HD-capable TVs, which tend to be more energy-

intensive (Crosbie, 2008). In other words, a diversification in the types of device that support a widespread practice, in combination with a change in the provision of 'soft' services, has facilitated a redefinition, and escalation of the concepts of service for TV functionality.

This diversification in the material basis of TV watching was also seen in the forms of variation between participants in my research. Some of the highest-consuming participants owned large flat-screen TVs (Matt, Ian) that they used for on-demand, Internet-supported watching. Others watched TV on the terrestrial broadcast CRT TVs provided in the kitchens and many watched TV on their laptops. The latter reflects a further diversification of the material elements and infrastructure of TV watching, but in this case in a less energy intensive direction. This suggests that the energy used to support performances of TV watching has also diversified. In other words, even whilst the energy used by TV sets in UK households may, on average, be increasing, energy use associated with the *practice* of watching (including on laptops, tablets and phones) appears not to be increasing in a uniform manner.

There are signs that performances of TV-watching are also diverging. It seems that differences in time commitment across age groups have grown over the last decade. Older age groups have been watching for longer hours; whilst for those under 35, average TV watching times have either been stable or declined (Ofcom, 2013). A similar age-related divergence is also reported for radio-listening time amid an overall decline (Ofcom, 2013). This raises some interesting questions regarding the dynamic between having and doing: Do older age groups also undertake the most materially-intensive TV watching and listening? That is, do they also have the bigger screens, larger collections of AV devices and more powerful radios? Intuition suggests not, at least not in the same way as the technology enthusiasts in my research. Nonetheless, it is an important question for understanding patterns of energy consumption. If older adults spend twice as long watching TV on average, than younger adults, do these households consume twice as much TV-related energy? Or do groups of enthusiasts far outstrip the 'average' consumption within each age group? My research suggests this might be possible.

Computers: Increasing Ownership, Divergent Consumption?

The energy and time-use associated with home computers has been growing. The former has grown dramatically from next to nothing in 1980 to 576 ktoe in 2011 (DECC, 2012). The evidence concerning time-use appears to be slim (or at least harder to find). But between 2000 and 2005, the Office for National Statistics reported a growth in the number of people who use a computer outside of the workplace on any given day, from 12% to 16% of the population (ONS, 2006 cited in Hamill, 2011). Plus, including work, the time spent on the Internet, on a computer, rose from 30 hours a month in 2008 to 34.7 in 2012 (Ofcom, 2013). This no doubt reflects the increasingly pervasive integration of Internet-supported services into a wide range of practices (Røpke et al., 2010) and the spatial and temporal integration of the laptop into the lounge and alongside TV watching (Spinney et al., 2012; Ofcom, 2013). Yet any increase in average time spent online must also reflect a growing participation rate in computer- and Internet-mediated practices, as evident in the growing proportion of households who own computers and have Internet access (now roughly 80%; Ofcom, 2013). In fact, an increase in the numbers of digital devices is also implicated in the sharply increasing consumption associated with external power supplies (the transformers and chargers used for mobile phones, tablets and other lower power devices) (Figure 8.2; DECC, 2012). On average a household now owns 7 devices with external power supplies, 3 of which can connect to the Internet (DECC, 2012; Ofcom, 2013).

Røpke and colleagues link the growing number of devices to the growth in direct (and indirect) energy consumption through a discussion of diversification in practices (Røpke et al., 2010; Røpke and Christensen, 2012). Defined as "the addition of new features to a practice or complex of practices" they argue that diversification "often tend[s] to make the practices more energy-intensive" (Røpke and Christensen, 2012: 354). For instance, an individual can now keep in touch with a relative using a variety of IT-mediated means, such as instant messaging, Skype and sharing photos. In this way, the integration of IT technologies in pre-existing practices results in an increasing number of ways to do something like keeping in touch. In turn, those new IT- and energy-dependent options may become increasingly standard as a practice evolves to routinely incorporate them. Thus, when it comes to practices, diverse ways to do something may be followed by convergence around

more intensive standards. If so, performances of such practices would appear to evolve in an ongoing tension between divergence and re-convergence.

Yet, as with TV watching, the process of diversification followed by convergence on more energy-intensive options is easiest to appreciate in the material arrangements that support practices. I also suggest it is more likely. For example, wireless Internet provision was evident in my research amongst the highest consumers who had installed their own routers. But Wi-Fi provision in these halls of residence is now becoming standardised. This reflects the co-evolution of global and meso-Internet infrastructures, the devices that use them, the services they provide and the practices in which they are incorporated. It provides another example, akin to heating, of how background provisioning (or heat or Internet) becomes to be expected and taken for granted.

However, as technologies, infrastructures and practices diversify, my research indicates that the result is not always increased energy-intensity. The laptop, developed to enable mobile computing, has facilitated a diversification in ways of studying, watching and listening, that compared to the other ways of doing these activities can be significantly less energy-consuming. I strongly suspect this is also true compared to *previous* ways of undertaking such activities in these halls of residence (desktop computers, monitors, dedicated TVs, separate stereos). The further adoption and use of smart phones and tablets for opportunistic, short and infrequent Internet browsing, checking emails and Facebook would seem to extend the potential for lower-energy forms of 'computer-use'. Thus, notwithstanding the escalation of standards relating to the background provisioning of wireless broadband Internet in homes, nor an increase in time spent on the computer, it is possible that energy consumed by IT-related devices between households has diverged over recent years. Without more systematic monitoring data, it is impossible to know for certain.

However, current energy data does suggest that, beyond increased household participation rates in IT-mediated practices, the energy intensity of IT per household is not necessarily increasing. Calculations from the ECUK data show that the average annual energy-consumption of home computers for those households that own them was actually higher in 1993 than it was in 2010 (Figure 9.1; DECC 2012). Once a household owns a computer, an

intensification in energy consumption due to increased integration in daily life appears far from certain. Rather, at the very least, it is not represented in this model.

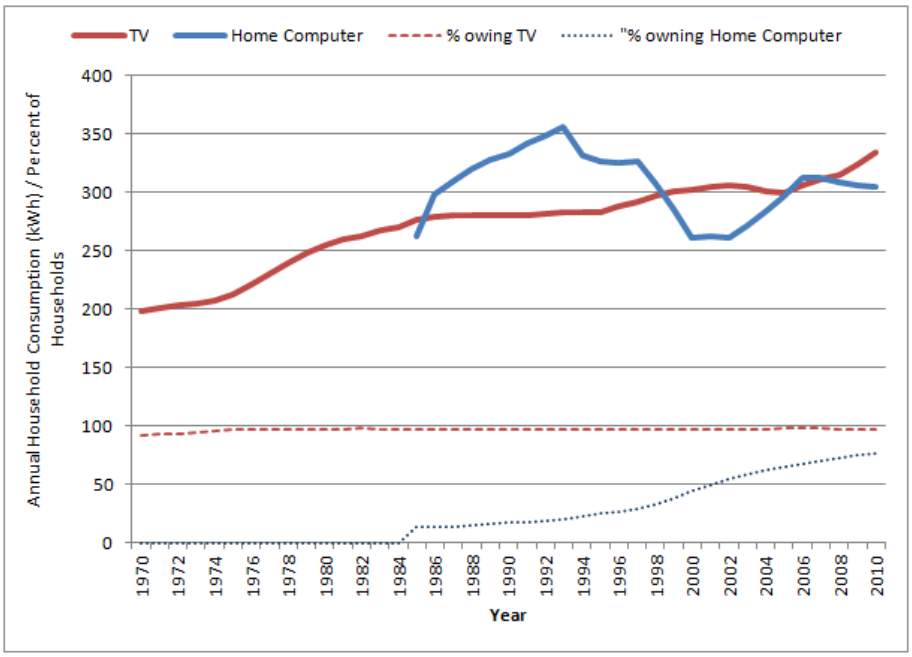


Figure 9.1 Electricity consumption by home computing devices and TVs calculated per owning household (Data from DECC, 2012)

In conclusion, by focusing my investigation on ICE-specific practices, a slightly different picture of the relationship between energy use and practice emerges than in previous research focused on the integration of computers into the spaces and imaginaries of the home (Spinney et al., 2012) and the myriad of ICE-supported practices (Røpke et al., 2010). Namely, indicators of generalised growth in computer-related electricity consumption across the sample were not so apparent. Indeed, with the exception of consumption related to background provisioning (standby), the signs of intensification that Røpke et al. (2010) identify were limited to a minority of practitioners. This illustrates the potential for very different currents within what may still be a general growth in consumption, more widely. It also suggests that a minority of radically high consumers (enthusiasts) may have an important role in overall trends. In summary, beyond the increased expectation for and background provisioning of wireless broadband, which undoubtedly increases energy consumption, the ongoing growth in IT-related domestic energy consumption would appear to be far from certain.

10. CONCLUSION: THE DIVERSE DYNAMICS OF DOMESTIC ENERGY DEMAND

At the outset of this thesis, I discussed Wilhite et al.'s (2000) claim that, in large part, energy research has failed to consider the nature and causes of energy demand. As I went on to explain, the conceptualisation of energy demand - what it is, how it changes and how it might be shaped - is surprisingly controversial. In this context, I reviewed the argument that domestic energy demand is an outcome of social practice and, as such, can be understood and analysed in relation to what people do from day to day and how that is socially organised. In particular, practice-specific understandings may provide new evidence-bases for policy-making and other interventions to shape and reduce domestic energy demand (Shove et al., 2012). This thesis aims to develop such understandings of energy demand and its basis in social practices. Yet, unlike other energy-related research into social practices, which tends to focus on general patterns of development and change, I argued that a much greater attention to variation within practices was warranted. I also argued that it is important to connect these understandings directly to patterns of energy consumption since a general escalation in demand cannot always be assumed, especially when considering and identifying the consequential variations in what people do. I suggested that such an approach lends itself to a deeper understanding of the subtle dynamics by which practices might change and may also help to interpret the huge variations in consumption that prior research and statistics have revealed but struggled to interpret. I identified three broad and overlapping lines of enquiry:

1) The development of detailed, practice-specific understandings of energy use patterns
2) The study and interpretation of diversity in practice and energy use
3) The nature of the relationship between what people do and energy use

I sought to address these themes through a programme of research in which I could combine evidence of energy consumption with evidence about doing, thinking and saying. The approach needed to be sufficiently fine-grained to relate variations in each, energy and practice, one to the other. It also called for focusing on sites in which variations were limited to differences in doing rather than attributable to pre-existing physical infrastructures. Finally,

it needed to permit identification and comparison of different relationships between practice and energy use. I chose to study cooking, comfort and ICE or computing devices in student halls of residences at a UK university.

In this concluding chapter, I reflect on the contributions of this research. First, I briefly recap on my findings concerning variation in practice and energy consumption in each case. This is the empirical basis through which I have considered what energy demand is and how it can be conceptualised in relation to social practices. Second, I reflect on this relationship. In this respect, my research makes several contributions: I show just how manifold, diverse and distributed energy demand is; I reveal the challenges of actually relating energy consumption to specific and well-defined social practices; and I argue that whilst both everyday life and energy consumption are, by nature, highly varied many variations are socially and systematically organised through social practices. Third, I review the specific dynamics of demand in relation to different domains of practice, in each case illustrating how combined qualitative and quantitative understandings of variation can be used to help interpret trends in energy consumption over time. Fourth, whilst it is by no means the only method to build practice-specific understandings of energy demand, I outline the methodological contributions of my approach. I also consider some of the directions my work points to for further research. Finally, I conclude by considering some implications for policy and reflecting upon how diversity in everyday practice supports or hinders the transition to lower-energy ways of living.

10.1 Summary of Findings

In relation to cooking (Chapter 3), I showed that performances varied over time and between participants by mode, type of meal and degrees of commitment, all with implications for the energy consumed. In terms of timing, more cooking was undertaken in the evenings, when meals tended to be more complex and took longer to cook, resulting in higher electricity-consumption at a time when load in the electricity network peaks. Regarding the types of meals, oven-baked 'convenience' products such as pizza, chips and frozen chicken products, consumed more energy to cook than quicker cooking yet still 'easy' hob-meals such as pasta

and curry. Beyond this common 'quick and easy' mode of cooking, some instances of 'proper' cooking were also observed: meals with more components or requiring more preparation usually cooked as a shared undertaking with friends or partners. Such 'proper' meals often included the oven and were amongst the most energy-intensive performances of cooking. These dimensions (mode and meal-type) differed between chefs, some of whom cooked notably more oven-baked or 'proper' meals than others, suggesting differential patterns of recruitment to different modes (or variants) within the practice. There were also considerable differences in the frequency of cooking displayed by different chefs, which indicates a certain commitment to, though not necessarily enthusiasm for, cooking.

With respect to comfort (Chapter 5), I focused on the demand for heated space (rather than energy consumption per se) and demonstrated how this was constituted on an ongoing basis through material arrangements in combination with short, infrequent 'adjustments'. Through a close comparison of four participants, I identified that room temperatures in very similar spaces varied in line with how these climates were adjusted (through radiators and windows). Although interactions with radiators, in particular, were infrequent and short, they nevertheless articulated demand for heat, which varied accordingly between the participants. It was also apparent that the level of clothing usually worn inside (and the insulation offered by these garments) varied in line with the climatic control i.e. lighter clothes and less layers in the warmer room, more layers in the cooler room. It is widely understood that clothing is an important aspect of thermal comfort. However, from this study I am able to show that this is more than an adaptation *to* the different indoor climates. Rather, evidence suggested that participants also adjusted the indoor climates in relation to their clothing, so that they can be comfortable (thermally) in what they are comfortable wearing (sartorially). This implies that changes in clothing styles could affect demand for heated air.

The case of information, communication and entertainment (ICE) devices (Chapter 8) differed from the other two cases in that the energy consuming devices/arrangements were not provided with the accommodation as were the cookers and heating systems. It was no surprise, then, that the number and type of device owned varied between participants in ways that clearly related to variations in energy consumption. Yet the study was able to demonstrate how these differences in ownership related to differences in what people do on

a day to day basis: it revealed a link between 'having' and 'doing'. Simply put, ownership of greater numbers of ICE devices, which were also carefully chosen and function-specific, was more apparent amongst those who did more with them, both in terms of time spent and the range of activity. In my research, such enthusiasts tended to be computer science students. The ICE-related energy consumption in most of the ICE enthusiast's study-bedrooms was of a different order compared to the rest of the participants. This was not simply on account of the additional time spent doing computing work, investment in the tools with which to do it and an evident 'techie' enthusiasm for ownership: such people were also amongst the most enthusiastic and committed TV watchers, listeners and gamers. Since their many ICE-devices were used together, as a set, in each of these activities, investments in devices made to enhance any one activity, such as computing or listening, 'rippled' throughout the energy consumption entailed by other activities. In contrast, many other participants demonstrated that it was possible to use a single device, a laptop, for most of the same activities, which resulted in dramatically lower consumption.

10.2 Domestic Energy Demand is Manifold, Diverse and Distributed

It is beyond doubt that different areas of energy demand are comprised in very different ways. Although in all the domains considered in this thesis there are links between variations in consumption and variations in what people do, these are of different kinds. The energy consumption associated with the use of any particular device may take place in relation to different numbers and types of social practice. Energy demand associated with the cooker is primarily related to the practice of cooking; however, the energy consumption of the laptop, PC, speaker, or TV/display may be implicated in multiple social practices. These social practices also differ in how they 'use time': some can be understood as work, which can be avoided and minimised if done by someone or something else; others are counted as leisure in which time must be directly invested. On the other hand, the energy consumption of radiators and space heating systems stands at one remove from any particular social practice, even though, in a highly contingent fashion, it helps to provide a 'space' for them.

Thus, patterns of energy consumption vary in how closely they reflect the patterns of what people do. Cooker consumption is closely tied to when people do cooking and how they do it. ICE-consumption shares some of this 'embedded' connection in activity, but this plays out across many devices. For some devices, in particular, e.g. Wi-Fi servers, the provision of a state readiness mean that some aspects of energy consumption are ongoing and not synchronous with how people spend their time. In the case of space heating, consumption is not 'embedded' in heating-directed activities: there are some adjusting actions to radiators and windows, but this can be very infrequent and short, whilst heating-related energy consumption can be relatively continuous. Moreover the level of activity (its duration or complexity) may have little bearing on energy consumption: for example, with heating a single adjustment, on or off, made several months ago has huge implications for the energy consumed. In summary, I have characterised the consumption of these different devices as 'tools in a single practice' in the case of cooking, 'machine-provided service' in the case of heating and 'material arrangement for a complex of practices' in the case of ICE-devices. There are different implications for how the demand for energy varies, changes and might be affected by policies in each case. I explore this later in the chapter.

One shared feature is that the demand for energy, as it is comprised through practice, depends on multiple, diverse elements and relationships. For example, in cooking, the types of food and meals, the time of day, the type of occasion (social or not), modes of cooking, ideas of what cooking should be, and frequency of cooking are all important and interacting aspects of the demand for cooker-related energy consumption. Beyond these endogenous elements, inherent in cooking, are the inter-relationships to other practices, such as washing up, shopping and eating out / elsewhere. It is therefore this level of attention to the specific nature of what a practice is, and importantly the different forms it can take, that is needed if we are to understand more fully how domestic energy demand is comprised and how it changes.

Another feature the cases share is that even though energy demand is constituted in different relationships to everyday practice in the home, such practices nonetheless emerge at the crux of many different systems of supply and provision *beyond* the home. In this sense, domestic energy demand is co-constituted at systemic levels as well as, and in relation to, the ongoing

reproduction of daily life. It has previously been argued that production co-constitutes demand (e.g. Southerton et al., 2004) but this is not simply energy production. Rather, my research has highlighted the connection between different 'objects' of consumption, all of which play a role in levels of energy use. Although the provisioning of these objects, services and industries is removed from the site of energy consumption in the home, such processes are nevertheless deeply implicated. Fabric manufacturers, underwear retailers, Internet entrepreneurs, software developers, film and TV producers, TV chefs, and the food industry all play a role, as well as the more obvious industries which produce and market the devices, such as computers, cookers, and heating systems, which actually consume energy directly. Just how important these indirect cycles of consumption and production are in the ongoing reproduction of domestic energy demand depends, again, on the area of practice in question. I have argued that for comfort and cooking the indirect consumption of clothing and food, respectively, is decisive for patterns of consumption; more so than the various forms of 'soft' content consumed in ICE-related practices, where difference in hardware appear to matter more. Whilst this claim partly comes about because the hardware implicated in cooking and comfort were fixed in my research, this fact actually reflects the more stable nature and slower cycles of replacement for cookers and central heating systems compared to ICE devices.

In summary, these observations underline the point that it is no simple task to understand the demand for energy that is embedded in everyday life. Domestic energy demand is manifold, emerges at the crux of multiple systems of production and consumption and is an outcome of diverse sets of dynamic processes, most of which are not obviously 'about' energy at all. This suggests that research into the 'nature and causes' of energy demand should be a correspondingly diverse undertaking conducted at different scales and not limited to explicit 'energy' topics. An interest in the basis of energy demand in everyday life does not end with 'what people do'. But it can start there. Through the evidence in my empirical research, this thesis adds to the argument that understanding how energy demand changes requires knowledge of the different dynamics of particular practices. In this, the thesis emphasises the value of close attention to various forms of energy consumption and their relation to practice. In the next section, I turn to consider how a practice theoretical framing of energy demand furthers our understanding of this relationship.

10.3 Connecting Practices and Energy: Material Systems, Service, Complex Outcomes

Prior to conducting this research, the prospect of detailing the energy footprints of social practices appealed to me as a way of holding practices to account and tracing their development (Morley and Hazas, 2011). I am now sceptical about the prospects of 'measuring' energy consumption on a practice-by-practice basis. Whilst some devices, and the energy consumption associated with their use, do map well onto specified practices, others do not. Even for those that do, as is the case with the relation between cooking and cookers, other energy-consuming devices are also involved (e.g. kitchen lights, freezers, kettles, mobile phones, TVs) but not all can be simply attributed to the practice of cooking. In the case of ICE consumption, devices were variously shared by a closely connected complex of practices. Other forms of consumption, like space heating, appeared to be only tangentially related to recognisable social practices. The differential degree to which energy consumption is embedded in material arrangements poses a further challenge for framing energy demand in terms of practices.

Unlike other forms of consumption, often conceived of as the *use* or *using up* of products and services, the use of energy is only rarely 'a moment in practice' (Warde, 2005). Rather, it can be conceptualised as part of 'dynamic' material arrangements which are bundled together with practices in varied, complex and co-constituting ways. This draws on Schatzki's (2002, 2012) distinction between practices and material arrangements and does not prevent those materials or their energy consumption from being very much a part of what people do (a constituent element in practice), but conceptually this distinction helps avoid the assumption that this is necessarily or simply the case. It is essential, then, to explicate the relationships between practices and material arrangements: that is, to understand what energy consuming devices *do* as part of material arrangements that are variously tied up with what people do, both inside the home and beyond.

Conceptualising Materials: Tools and Infrastructure

Materially, the cooker does something similar to central heating systems: both heat a space. But the cooker's 'work' is carried out in much closer relation to human actions i.e. only ever

at the direct behest of them. In this sense, the cooker and its energetic work of heating food are a direct and necessary part of the practice of cooking: they are 'tools' in the production of hot meals. In contrast, central heating systems are often automated, what they do is mostly indifferent to what residents are doing and they are not always necessary for the production of comfort, or even heated air. Being comfortable, in this research, is an ongoing concern that is dispersed throughout the different activities that people undertake, rather than being a discrete activity undertaken in its own right. Thus central heating systems are a form of infrastructure that sustains many practices at once. Heating systems are part of dynamic material arrangements of buildings, clothes, weather and the sun that create 'space' for social practices. The relation between what heating systems do and what people do is not only indirect and multiple, but also in a sense, inverse. The residents in my research did not have to do much to be warm. In contrast, other devices figure as 'tools' shared by several practices, that is, they are integrated directly and explicitly, for example, laptops in studying, listening to music and watching TV. This does not necessarily make them 'infrastructure' but such devices might take on infrastructural properties, when, and in so far as they provide a 'space' for new and different forms of practice to take place. Other ICE devices such as Wi-Fi servers are not used directly, but only ever indirectly within networks of devices and, as such, can be conceived as infrastructure. This distinction is useful in that it helps locate energy use and better understand its role as 'material arrangement' in the context of which multiple practices transpire and/or as a more discrete element directly implicated in the performance of one or more practices.

Conceptualising Practice: Object-Practices, Passive Practices and Time-Use

In analysing my data, I found that some of what people do is difficult to conceptualise in terms of bounded, discrete social practices. This was most obvious in the case of 'thermal comfort', where interactions with heating and ventilation systems, and to a lesser extent clothing were short, sparse and not always 'about' thermal comfort. If social practices are understood as activities with which people engage in their own right, this implies they are recognised as such by those who undertake them, are the focus of attention and require some time to undertake. A practice theoretical approach does not necessarily imply that the entirety of what people do be chunked into social practices. But this does pose problems for the framing of energy demand in terms of social practices, especially if comfort is not an isolated

case. Indeed, there may be similar challenges for lighting, and refrigeration / freezing which are implicated in several practices at the same time. One solution is to refer to heating practices, clothing practices and freezing practices; I would differentiate such an approach as considering 'object-practice relations' (or 'object-practices' for short). Indeed, in writing about the activities associated with clothing, such as getting dressed, I found it difficult to avoid making reference to 'clothing practices'. We can appreciate that, likewise, much energy-related research that queries 'practices', is organised in reference to objects of interest. There is a danger here, however: in neglecting what such objects are used *for*. In focusing on the thermal aspects of clothing, I am to some extent guilty of this: clothes are tied up in many other aspects of everyday lives. There are no doubt richer links to be made between energy consumption and overt *social* practices, as mediated by clothing. However, my research has taken a significant step in this direction, which goes beyond the narrower scope of heating practices per se.

In response to the difficulty of connecting space heating, an exceptionally important form of consumption, to social practices, I briefly considered the idea of passive practices (chapter 7). This suggests that people are involved in some form of integration of elements even when they are not visibly 'doing anything'. Even the lack of physical movement can be considered as a form of 'action' that takes a particular cultural shape, such as watching, listening and sleeping. There are, however, certain relevant differences. For instance, someone can be interrupted when watching TV or sleeping but there is not a direct equivalent for heating. As a result, someone who is interrupted when "being heated" would probably not use these terms, but they might stop "being comfortable". Thus being comfortable might be considered as a dispersed integration of material conditions, physical responses, competence and ideas of appropriate environmental heat and clothing, and since it is ongoing, forms a background part of many other practices. Even so it can be characterised by distinctive patterns of understanding and responding in that ways of being comfortable are socially organised, even if they are not undertaken as activities in their own right (and hence are not entities as social practices are).

The status of a practice (object-, passive or overt) matters for how practices change and how these changes can be traced. Object- and passive practices are not necessarily time

consuming in their own right, so they do not 'compete' with other practices for attention. Similarly, some of the more 'passive' social practices like watching and listening can easily be combined with other practices like socialising, studying, cooking and online shopping. This begins to touch on debates concerning the nature of human activity, intentionality and the role of conscious or practical knowledge with practice theoretical approaches and beyond (e.g. Harrison, 2009), which are beyond the scope of my research. Nevertheless, distinguishing between more or less passive practices, in the context of relations amongst practices and to material arrangements is useful when conceptualising energy consumption.

Conceptualising 'Service': Useful Functions and Heterogeneous Achievements

At the outset of this thesis (chapter 1), I noted how the important distinction between energy and the services it provides shifts the focus of energy research whilst also expanding its scope. I discussed the argument that services and not energy are the objects of consumption. Thus, I queried how 'services' should be included within practice theoretical analyses of energy demand. Various understandings of 'services' feature in energy research. In analysing my findings, I found it was useful to define two further types of service: specific services and meta-services. The former refers to specific, useful processes, the status of which is *relatively* uncontroversial, for example, Internet connectivity and space heating. The latter refers to more composite and evaluative achievements, such as comfort. Both can be judged in relation to 'concepts of service' such broadband speeds, room temperature and not having cold hands.

In my analysis, both senses of 'service' (specific and meta-) proved to be particularly helpful in conceptualising comfort: it is useful to think of heating as a specific service, a set of processes or material arrangements that produce warmed air. This might well include the ways that central heating systems are adjusted and operated ('object-practices'). But although central heating would feature in an analysis of comfort it is not synonymous with it. As the research showed, comfort was an implicit second-order evaluative state that only emerged in the inter-relations of heated air, clothing, eating, experience of different spaces in the near and extended past, physiological functioning, expectations and interpretations. So whilst 'being comfortable' might be understood as a passive, ongoing and subsumed practice, it is perhaps more appropriate to think of it as a being part of the meta-service of comfort, which

also encompasses the connection to material arrangements that reach far beyond the scope of any one practice. In this way, the notion of meta-service can help us think about the blends of practice and material performances that underpin valued conditions and experiences. It can help articulate connections between apparently disparate aspects of everyday life that fall outwith social practices (as discrete entities and performances).

In this respect, too, the notion of meta-services can help to describe connections between elements that are distributed across multiple practices. For example, 'eating well' may only be defined and achieved in the relationship between shopping and cooking and a variety of social practices such as sports, weight loss, parenting, working and eating out. Eating well is not the same as cooking well. Thus, meta-services point to accomplishments that are only possible through the co-ordination of multiple practices.

Further, there are some cases in which it is useful to consider specific services as an element within social practices, distinct from the means (especially material arrangements) by which they are provided. I have discussed the relevance of this distinction in the analysis of ICE-related consumption (Chapter 9) where digital devices can provide new services without physically changing.

In abstracting outcomes from means, both senses of service may support the analysis of variation and of change. For example, there can be different ways of achieving similar outcomes, or meta-services: different people may equally value comfort or entertainment or eating well but these can be understood and achieved in very different ways. This 'substitutability' also applies for specific services, for example gas-fired central heating systems provide heated air. But this is not the only means of providing space-heating or heated air. In this way, these services are, or at least can become, analytically distinct from the particular material arrangements with which they have previously been synonymous. This 'service' can become a point of continuity as other elements, materials and competences, change.

This is complicated: concepts of service may change when and if the means by which an outcome is achieved are extended or diversified. For example, it is only when there is an

alternative way of providing hot meals, that there can be any question about what really counts as cooking, and the experience of what it is to cook (well) changes since different 'choices' have to be made. Likewise, it is only when comfort can be achieved through central heating systems that there can be any discussion of turning thermostats down and putting on extra jumpers. Introducing diversity in the ways of achieving a service, simultaneously, changes how that service is understood.

In summary, the notion of 'service' does provide a useful supplement to practice-centred approaches, providing a way of exploring achievement and outcomes which are distributed across a number of activities, and crucially of identifying relevant elements which do not readily fall within overt or clearly bounded practices. In this way, it helps to connect what people do, no matter how small and apparently unintentional with what material arrangements do. It also helps to articulate connections across different practices: as such, it supplements the notions of complexes (ICE), compounds (eating) and bundles (comfort) in the analysis of energy consumption.

Energy demand as a complex outcome of social practice

Framing of energy demand in terms of social practice remains a significant development, taking the analysis of energy demand beyond 'a sociology of energy service consumption' (Wilhite et al, 2000: 115) and even beyond a discussion of meta-services like comfort and cleanliness (Shove, 2003). Focusing on social practices brings into view a much wider range of services (not just energy services), products and systems that are implicated in the constitution of energy demand but do not themselves directly consume energy in the home: for example, food products, clothes, and websites. Just as Wilhite et al. (2000) argued for a shift in focus from energy to the services it provides, I argue that expanding that focus to a diversity of other forms of 'consumption' - including consumption of products, services and time - is necessary to understand how different forms of energy demand are constituted through the practices of everyday life. Social practices represent a key analytical unit with and through which to make these connections.

It is important to re-iterate the distinction between energy demand and energy consumption. In this thesis, I have taken the concept of demand to refer not simply to the scale of

consumption but also to its nature, that is, its basis in everyday life. So whilst social practices do not *consume* energy, and energy consumption does not always map cleanly onto them, this does not mean to say that social practices, and their constituent dynamics, do not engender *demand* for energy. This observation highlights the need to pay close attention to the very specific ways in which what people do, firstly, connects to energy consumption and, secondly, how that 'doing' is itself organised and shaped through much wider systems within the bounds of everyday life, and extending beyond it. This perspective is rooted in an 'elemental' theory of practice which asserts that what people do is indeed organised into relatively discrete entities comprised through the inter-relationships between different elements which have extensive lives beyond the performances in which they are integrated. In other words, a huge complexity of connections are expressed through the simple, mundane and routine things we do from day to day, including the more or less direct relations to energy-consuming material arrangements. Thus whilst social practices are an important analytical unit, it is likely to be particular relationships or dynamics that are important in the demand for energy. In particular, it may not always be obvious when a change in practices relates to changes in energy consumption.

In summary, the relationships between practice and material arrangements are complex and varied. Energy consumption inheres in material arrangements, taking place in ways that may or may not form a part of what people do. Thus some forms of consumption, such as heating, do not directly reflect the extent and nature of human activity and, thus more generally, energy consumption is not organised in units of social practice. Nevertheless, the demand for energy does reflect practice, even in the case of heating, where the relationships to what people do are multiple, indirect, dispersed and inverse. A practice theoretical framing articulated in this way, centres *the relationship* between what energy does, what people do and the material arrangements that are integral to both. This account differs from previous conceptualisations of energy use in terms of social practices as it does not assume that all energy consuming devices and aspects of their consumption are elements within a social practice. As such it departs from the analysis offered by Gram-Hanssen who writes about standby practices (Gram-Hanssen, 2009) and indoor climate control practices (Gram-Hanssen, 2010) as if these are meaningful units both of doing and energy demand.

10.4 The Social Organisation of Variations in Energy Demand

Energy Demand is Unevenly Distributed Between People

For each form of energy demand studied in this thesis, the scale differed from person to person. Thus, when attributed to individuals, the demand for energy is unevenly distributed. Prior energy consumption studies have revealed often extreme variations between households, both in aggregate and end-use consumption, but few studies have elaborated the basis of such variation in everyday life. In this research, I set out to do just that. I found considerable diversity. In the case of cooking, amongst 31 participants over one week, the most consuming quarter accounted for over half of the total cooker electricity consumption. For heating, over a 4-week period in February-March, 2 participants did not have their radiators on at all, 1 participant turned it on for a few hours to dry clothes and another left it on all the time, on the highest setting. If translated into gas consumption figures this contrast would likely be very stark. At this particular point in time, one quarter of the participants accounted for almost 100% of the consumption. For ICE-related energy consumption, measured over 3 weeks, 4 of the 19 participants (20%) accounted for 75% of the electricity consumption.

These distributions in energy consumption reflect the fact that the demand for energy, as expressed through performances and through material arrangements, varies substantially from person to person. In this research, I have intentionally simplified the potential sources of variation so that these relationships could be traced to variations in aspects of everyday life. This allowed me to show that certain aspects of performances, materials and relationships are more highly consequential for overall energy demand than others. In the next section, I contextualise the dynamics of demand (i.e. the change and variation in how demand is constituted) with reference to wider trends in consumption and practice. In this section, I focus on how variations in energy demand come about. I argue that although they may be expressed through performances, variations in demand are not simply a feature of performances. Further discussion of this relationship helps to make sense of variation in social practices.

Variations in Practice: Performance, Elements, Service, and Entities

In the case of cooking, the clearest example of a single practice, all the performances I recorded were to a degree unique. When compared person by person, performances of cooking varied in frequency, timing, duration, the type and range of meals cooked, and whether the cooking process was shared or not. In interviews, accounts varied in the understandings and definitions of cooking and in degrees of enthusiasm and affinity. There can be a tendency to think of the variations between performances as entirely inherent in individual-level integrations, when people in different contexts with different experiences interpret, improvise and adapt. My analysis indicated that whilst this is certainly so, variations were not so much introduced by individuals as enabled by practices. Specifically, variations were also apparent in the elements, in the ways that those elements often already cohere in different forms (or mini-entities) and in the 'concepts of service' that defined and organised specific integrations.

In many of the performances of the practices I studied, the elements were not just heterogeneous (meaning, competence and material) but many of them were also highly diverse. In particular, there are many different kinds of food products and meals. There are also many different kinds of music to listen to, things to watch, websites to follow and hardware to deploy. And there are several ways in which different types of product can be used together, especially amongst ICE-devices. There were also different ideas about how devices should perform and what they should do, and what meals should be like. In other words, there were multiple concepts of service, and these were reflected in how these requisite elements were defined and arranged. At the same time, some of these materials and meanings were closely related: they coincided most of the time. For example, ideas of 'proper meals' implied particular types of meals, products and occasions. Being a technology 'enthusiast' also means to be committed to several 'technology-based' activities.

It follows that there are different variants *within* social practices. For example, it is common to differentiate between 'proper' and 'quick and easy' cooking. Practitioners might adopt and switch between such modes at different times, and / or they may be committed to more mutually exclusive patterns of participation, for example, as with ICE-enthusiasts. These modes and strategies of participation are characterised by different 'rules', sets of knowledge

and materials; in other-words, they are like mini-entities, identifiable patterns within a pattern, in which participants are knowingly engaged at any one time or in a more enduring fashion.

Thus, when it comes to understanding how variation comes about it helps to recognise that individuals bring together heterogeneous elements, co-ordinated across a number of practices, when undertaking purposeful activities or evaluating and maintaining 'appropriate' conditions for them. At the same time, variations in the elements of practice - clothes, concepts and experience of 'cold', food products, meal concepts, computing devices and so on - cannot be accounted for by reference to the ways in which individuals construct meaning and acceptable practices, at least not directly. Rather they reflect systems of production, which may also include some 'systemic' integration of these elements. Such pre-formations are, for example, evident in the way that products are developed and marketed for particular types of occasion (quick and easy cooking) or enthusiasms ("techies"). In other words, the nature of a practice is described by a) the forms it takes, b) the concepts of service which are common and which vary, c) who undertakes it, in which forms, d) how frequently and e) for how long. In these ways, variation within a practice is part and parcel of what that practice is.

Material Arrangements Can Amplify Variation in Energy Demand

At this point, it is worth saying a few more words on the role of material elements in the variations within practice. Firstly, different material arrangements can be very much involved in defining the variations in what people do. For example, different sets of food product are required for proper cooking compared to oven-ready convenience, or even quicker cooking lunchtime 'snacks'. At the same time, variations in material arrangements can have cross-cutting effects on a host of different practices, as in the case of ICE-devices. Whilst I have argued that these differences are related to different ways of doing some ICE-related practices, it is also apparent that this is not always to an equal extent. Thus, investments in the material arrangements for listening affect the performance and concepts of service within gaming and TV watching. This emphasises the 'arrangement' of materials: underlining the point that materials rarely feature in practices as discrete and singular items. In my research, they were always positioned in relation to other things, networks and conditions. Thus, by

looking at material arrangements we can appreciate the capacity for diverse relationships amongst things, and this adds to the possibilities for diversity within practices.

The Relationship Between Variation and Change

Diversity *within* social practices is intimately connected to processes of change. Firstly, any changes that are seen to take place *across* a practice can only do so through the different forms that it currently takes. Thus, it seems unlikely that changes emerge consistently such that, for example, changes in cooking would take hold equally through the different forms of 'proper' cooking or 'quick and easy' cooking. Secondly, when there are variants within a practice, and indeed, when there are different ways of achieving similar meta-services, it seems that there are tensions that can (and often do) transform definitions and experiences of the practice or meta-service. Thirdly, in my research, energy consumption appeared to vary primarily according to variations within practices, rather than differences in participation in different practices. Admittedly, this finding reflects my work with a very select group of practitioners but it also refers to what are, no doubt, very common domestic practices. This suggests that, for purposes of understanding change in *domestic* energy demand in relation to particular practices, binary patterns of participation *per se* may not be as useful as thinking about the extent and forms of participation, and the recruitment and defection between variants. It follows that if we are to understand the dynamics of social practices in relation to energy demand, we will need to pay attention to variants and variations within them. Practices change as they split and reform, and as elements diversify and narrow down. These characteristics and patterns help to define what a practice is, and, by the same token, help to determine the extent and forms of energy demand with which it is associated.

Interpreting Variation in Household Consumption

One of the 'puzzles' which informed the direction of this work was the evidence from previous research concerning extreme differences in energy consumption between households, even those that live in structurally equivalent homes. If such differences can be taken to represent differences in what people do, then the 'everyday' or largely common endeavour that is 'everyday life' would seem to be more varied than we might at first imagine.

To some extent my research suggests that variations in consumption do map on to differences in what people do. People clearly engage in different practices: some spend time on computing projects, others embrace cooking and baking as forms of leisure and some get changed into light cotton pyjamas for lounging around at home. Additionally, even when people undertake the 'same' activities, they do so in different forms, with very different outcomes, concepts of service and material arrangements and with different frequencies. Where energy consumption is directly linked to specific devices that are necessarily involved in the accomplishment of a specific practice variations in consumption map onto differences in how that practice is enacted. Moreover, although variations in energy consumption often correspond to variations in practice this is not always direct or linear. For example, the iterative relationship between having and doing in ICE-related practices amplifies the consequences of variations in what people do in terms of energy consumption. This is so in that those who are more intensely engaged in ICE-related practices tend to acquire and in a sense 'need' more intensive material arrangements. Further, by virtue of the indirect and multiple relationships between meta-service, activities, specific services, sets of devices and the energy they consume, large differences in consumption can result even when people spend similar amounts of time doing what are recognised as broadly similar practices e.g. cooking or watching TV.

Relating these findings back to the differences in aggregate energy consumption between households suggests that there are many possible sources of variation, some of which have to do with how practices are constituted and enacted, and some of which concern the material arrangements and configurations involved. Comparing households in terms of energy consumption data alone disguises what is likely to be complex mixture of various and potentially contradictory practice dynamics.

10.5 The Specific Dynamics of Cooking, Comfort and ICE

By identifying features of day-to-day practice, and how these relate to material arrangements that co-vary with energy consumption, I have identified aspects of how energy demand is constituted in the three domains of cooking, comfort and ICE. Analysis of how these

constitutive features have changed over time in the context of energy consumption trends has allowed me to generate ideas about how forms of energy demand are tied up with the very processes by which they change. In keeping with my focus on variation, I have been particularly interested in whether practices and related patterns of energy consumption diverge or converge. Below, I briefly summarise how my analysis helps to pinpoint directions of change in each of the domains, and provides clues as to the energy implications that follow.

Cooking: Decline in Demand Linked to Diversification

My research demonstrates that, within my sample, cooker energy consumption is closely connected to what people do (Chapter 3). Abstracting from this observation, we can expect this type of energy consumption to change as the practice of cooking changes. Moreover, since it is an overt, well-bounded practice, cooking competes for time with other such practices. I argue that a related differentiation in modes of cooking (into 'proper' and 'quick and easy' cooking) and diversification in the food products available has simultaneously enabled and accompanied a reduction in the duration of many cooking performances over the last several decades. This has accompanied, and is plausibly implicated in, a dramatic decline in energy consumption associated with cooking since 1970 (DECC, 2012). This provides one example, then, of a practice that seems to have diversified resulting in a decrease in energy consumption. I suggest that this is principally because (routine) cooking has increasingly become defined as work that can be delegated or minimised, by the increased availability of convenience products (a different type of cooking), take-aways and increased eating out (not cooking at home yourself).

If this is accurate, the decline in energy used for domestic cooking reflects a systemic re-organisation in the practice of cooking through the activity of the food industry. In this context, the provision of food products remains important in how energy consumption associated with cooking in the home changes. Related degrees and forms of participation in (and in the evolution of) variously energy-demanding variants of cooking are also important. Further innovations in 'quick and easy' products, for example, might sustain energy demand if they employ oven-cooking. Equally they might support an ongoing reduction in energy demand if they call for the use of single hobs and for shorter periods than before. On the

other hand, the increasing frequency of 'proper', enthusiast and discretionary forms of cooking and baking as a form of leisure are likely to increase energy demand. Also, beyond cooking itself, changes in other practices in the eating 'compound' (notably eating out and shopping) as well as the various practices (family and work) in which cooking is co-ordinated, could change cooking practice. Amongst these diverse dynamics, the future trajectory of cooker-related energy consumption as a whole remains far from certain.

Heat: Escalation and Convergence Linked to Background Provision

Central heating systems are not integrated in the pattern of daily life in the same way that the cooker is embedded in the social practice of cooking. Rather they provide background conditions for a range of activities that happen to take place at home. Changes in these practices result in changes in the demand for heated air but since these connections are indirect they are difficult to establish. However, my research did indicate that the way heating systems were 'used' (adjusted), articulating the demand for heated air, varied between participants in accordance with the type of clothing worn at home. It is possible then that changes in clothing styles have been implicated in the trend towards and convergence in warmer indoor temperatures over the last few decades.

In exploring the broad historical development of clothing over the last century (Chapter 6), it appears that styles were already shifting towards more casual and lighter forms by the time central heating started to become widespread. These newer, lighter styles of clothing may have been one aspect of the growing demand for central heating in homes. In relation to comfort, clothing and heating remain linked: changes in one might easily influence the other, but without any intentional adjustments for the sake of 'comfort' or 'energy'. Thus, new fashions might feasibly change heating demand, and levels of heat might increase or decrease, thereby instigating change in clothing without significant changes in 'comfort'. I argue that because heated air is not the direct or necessarily intentional outcome of any one human activity, that levels of heat may quite easily escalate, further entrenching trends towards lighter clothing. Moreover, the technologies through which heated air is provided (heating systems) have become widespread and have relatively long lifetimes, suggesting that the material arrangements through which this service is provided have perhaps converged.

ICE: Divergence in Doing and Having

By virtue of the recent and continuing digital convergence of systems for providing ICE 'content', computers can now be used for diverse activities that previously required dedicated, stand-alone devices e.g. TVs. ICE-related energy demand is thereby constituted through an inter-related web of multiple practices that draw on multiple services, which can potentially be provided through multiple devices. This means that, on the one hand, a single device, a laptop, can now be integrated into multiple practices which, on the other hand, can also be undertaken with a number of highly specialised and function-specific devices. In this case, the material arrangements of ICE-related practices have diverged. At the same time, the overall energy consumption associated with this category of devices has increased (DECC, 2012).

10.6 Towards Practice-Based Policy: A New Research Agenda?

In each different area of practice and energy consumption, I have sought to identify the energy-relevant dynamics of what people do on a day-to-day basis. My methodological approach has helped to develop an understanding of energy demand that is rooted in the specificities of social practices, the ultimate goal of which is to inform a practice-oriented policy making. In bringing this thesis to a close it is appropriate to briefly consider what these findings might suggest for such an approach to energy policy and to demand reduction in particular. I then consider the kinds of research that will further help to support such an approach. I conclude with a thought on the role of diversity in transitions towards more sustainable ways of life.

Insights for Shaping and Reducing Domestic Energy Demand

Cooking - The energy demand associated with cooking has rarely ever been considered as an important prospect for demand reduction, and indeed models show it has declined dramatically over the last four decades. Yet by proportion of total domestic consumption, a criterion that is commonly used for justifying attention to particular end-uses, cooking is just as relevant as most other major end-use categories. Any deliberate attempts to manage and reduce energy consumption related to cooking would do well to take heed of the distinctions

explored in this thesis: not all 'cooking' is the same. In the student flats, many *relatively* low energy forms of cooking were observed: in particular, certain kinds of hob-meals were made that were both 'quick and easy' and low energy. Many of these types of meals are already hugely popular and have already been enabled by the sale of products like pre-prepared sauces for accompanying pasta, rice or noodles. Single pan dishes and stir-fries were also observed, and could potentially be more strongly promoted. Quick soups were also prevalent and in forms with which I was not personally familiar e.g. dumpling soup. Energy demand reduction programmes might therefore be designed to encourage more regular and widespread adoption of particular types of meal by working with the food industry and retailers. Whilst this might seem like a long step from 'an energy' remit, it is a fairly logical implication from my practice-centred research. Moreover, it is even conceivable that such a policy be pursued in order to help manage peak loads on the electricity network. This is especially so, if the increasing adoption of gas hobs continues, thus further helping to reduce peak electricity load by fuel substitution.

The flip-side of the highly temporal patterning of cooking is the potential impact of peak-pricing tariffs. As my research showed, even students, who have more flexible schedules than most, cook during peak evening hours. This supports an intuitive understanding that cooking is a strongly temporally organised practice, and whilst punitive pricing during peak cooking hours may well change the practice, this would no doubt disadvantage some (e.g. those who do the cooking) more than others.

Comfort - My research suggests that warmer clothing styles are related to a lower demand for heat, as provided in winter by central heating systems, and that, conversely, lighter clothing allows for warm, and indeed warming, indoor climates. It follows that fashions and changes in the general style and structure of clothing may change the range of what are experienced as comfortable indoor temperatures. It also seems that since this experience, for the most part, emerges in the ongoing and back-grounded inter-relationships between heating systems, ventilation and drafts, indoor temperatures in the home and elsewhere, outdoor weather, eating, health and activities, that such changes already take place on an individual level without being a topic of explicit attention. It seems there is a possibility then to 'adapt clothing', not at the level of individual and daily adaptations but at a broader and more

societal level, using 'systems of clothing' to lower energy demand associated with the indoor climate.

One implication, amongst others, is that practice-orientated policies would involve working with clothing and retail industries. Understandings of 'sustainable' clothing may be extended to include the embodiment of seasonally appropriate demand for heat. Such an agenda would include an understanding of what clothing is and how it 'works' both in everyday life, and in the commercial systems that design, manufacture and sell it. My research suggests that there is a variety of dynamics already within the system of clothing which trend towards more seasonally adaptive clothing systems whilst others appear to do the opposite. These features may be highly specific to particular social groups. For example, some promise may lie in the differentiation of loungewear as a category of comfy and potentially warm clothing specifically for the home. But this is currently ambiguous as loungewear also includes very light, pyjama-like styles. Others, still, wear the same clothes in and out of the house. This points to another challenge for clothing systems: that of managing the very different climates that people might experience throughout the day. Whilst there is an obvious category of 'outer' garments, there may be less scope for adapting clothing that is considered appropriate for inside wear. Layers of clothes are not infinitely adaptable: jumpers and cardigans do not feel comfortable over every type of 'top' and layers that are worn as under-layers often 'cannot' become outer layers. This points towards the cyclic and iterative nature of lowering heat demand in homes. One obvious point here is that if heat in public places is comparatively much higher than in the home, no one clothing strategy will suit both climates.

It is through modifying clothing that people manage and move between temperatures encountered at home, in offices, shops, cafes, trains and so on. This implies that policies aiming to reduce heat consumption domestically may also do well to consider ways of limiting the extremes of heat that can be encountered in public places during the winter months. In other words, if the demand for heat in homes is to reduce over the long term, the challenge is to shape the organisation and achievement of winter comfort, through clothing and heating systems, at a societal level.

Computing - My research demonstrates that many things are possible with a laptop and that using it for watching, listening as well as more established uses such as word processing and Internet access consumes less energy than established alternatives such as TVs and desktop computers. In this sense, one suggestion is that laptop use is to be encouraged. However, beyond the world of student halls of residence, it appears unlikely that laptops will replace TV sets in the living room, especially in light of the trend towards bigger screens. Rather, I would suggest that the key insight to be gained, and that may be useful to explore as a potential basis for policy-making, is the role of enthusiast hardware consumers: those who buy and use multiple, specialised and highly specified devices and who sometimes set energy intensive trends that others sometimes follow.

Developing Practice-Based Understandings of Energy Demand

In this thesis, I have studied the links between energy consumption and everyday life at a micro scale, and at a site that would not strike most readers as an 'average' domestic location. Yet in doing so I have generated insights into how some forms of energy demand in the home are comprised through a variety of elements which at first glance are not related to 'energy' at all. These elements have extensive 'lives' beyond the home and include the production and integration of materials, meaning and competences that relate to clothing, food products, meals, TV programmes, Internet infrastructures and computers. But they are also integrated in the home, as part of local systems of practice and experience that comprise everyday life. In this way, these elements have a 'dual' life and much more work is needed if policy-driven interventions are to be informed by suitably detailed understandings of the many trends and detailed differentiations within these and other areas of energy demand. To me, that calls for a number of different approaches, and for their integration.

I have attempted to follow such a methodological strategy in developing this research: the combination of accounts of practices in daily life and detailed energy use data allowed me to identify particular elements that were important for the resulting levels of energy consumption. Since these elements are not necessarily shared by all performances, this approach has allowed me to move beyond general statements regarding the development of the practice over time and general assumptions about how those developments then link to (growing or declining) energy demand.

This thesis has consequently demonstrated the considerable potential of studying practices close-up. Whilst I would agree that caution is required to avoid equating performances with practices (Shove and Spurling, 2013), and thereby isolating them from the wider perspective inherent in practice theoretical approaches, much can be learnt from performances concerning the diversity of trends and undercurrents, and their implications for energy demand. Specifically, and as I have demonstrated more fully in the case of clothing, such studies reveal relationships and patterns which can then be considered at much larger scale. I argue that the type of fine-grained work reported here can provide clues about some of the less obvious changes in everyday life (e.g. what we eat, what we wear) through which changes in energy demand have taken place. Working outwards from connections and associations that can be established at the micro-scale, it has been possible to engage with a more 'macro' agenda to do with the changing lives of the elements of energy demand.

At the day-to-day level, detailed, ethnographic research of a kind familiar in material culture studies could speak to new concerns, framed by energy demand. How, for example, is seasonality achieved through clothing? And in what ways does it differ, say, between men, women and children? Are there limits to the workability of 'layers' and extra jumpers within currently common styles and sizing systems? In what ways is the cultural competence of dressing warmly limited by ways of designing, making, selling, buying and thinking about clothing? Sociological understandings of the systems of production, narratives and other social relations are also, clearly, deeply implicated. The inclusion of 'energy' in social studies of these elements poses different questions, to current more cultural research, and thus a new research agenda emerges.

Diversity and the Pursuit of Sustainability

This thesis has been deeply informed and inspired by Elizabeth Shove's 2003 book *Comfort, Cleanliness and Convenience*. As in that work, I have discussed the different ways in which practices, technologies and services are integrated in three areas (three "C's") of daily life. In bringing this discussion to a close, I would like to take up a practical conclusion from Shove's book. She suggests that in the pursuit of more sustainable ways of life "social and cultural diversity", "multiple meanings" and "diverse conventions" of comfort and cleanliness should be encouraged (2003: 199). When investigating diversity in energy consumption with a small

group of participants, I have been less convinced that diversity might in itself be such a good idea. Greater degrees of diversity appear to cut in both ways, engendering both lower and higher consumption. Indeed, my research has identified lower energy forms of cooking (e.g. quick hobs meals), comfort (e.g. multiple layers of shirts and t-shirts) and computing (e.g. laptops). I have also argued that forms of convergence and divergence, of diversification and narrowing down can both go hand in hand and back to back. Indeed, it is only out of a diversification in the material arrangements of computing, that the very possibility of a future convergence on lower-energy forms has emerged.

Shove's advocation of diversity is made in the face of a global convergence in conventions and meaning and relates to the retention of local and cultural diversity. That is perhaps very different from the innovation and introduction of new and different technologies. Yet, in the cases I have considered, diversifications in the material elements of practice have very plausibly been implicated in changing the associated concepts of service: that is, their meaning. Depending on the particular dynamics involved, such diversification may be associated with an escalation in energy demand (as with TVs and arguably computers) or a decline (as with 'quick and easy' cooking). The point is that these dynamics can be complex and distributed, applying for some practitioners or forms of practice and not for others. Understanding, managing and reducing domestic energy demand may be as much, if not more, a question of specific variants of practice and specific groups of practitioners as of general patterns and commonalities.

Appendices

Appendix 1. Interview schedule for Stage I

Preamble
Background, purpose, consent and confidentiality

You and Your Accommodation
- Which year of your studies are you in?
- (If not first) have you stayed in this hall in any previous years?
- Where were you living previously?
    - House share? Parents?

- In general, how much time do you spend in the flat?
    - At what times are you here? Day? Evenings?
    - Do you have any commitments out of the flat? Courses/clubs?
    - Are you around at weekends?

- Who is in the flat?
    - Years? Know each other previously?

- What's life like living in this flat?
    - Sociable, lonely, noisey, organized, chaotic
    - Do you see much of your flat mates? Kitchen?
    - Do you spend time in kitchen or in flatmates rooms?
    - Do you enjoy spending time in the flat?
    - Do you find it comfortable or homely?
    - Do you do anything to make it more comfortable or more homely for yourself?

- How about your room? How would you describe it?

Typical Day
So now, I'd like to understand what a typical day is like for you.

- Could you tell me what you did yesterday? From the moment you got up in as much detail as possible.

- Was this a typical day for you?
- Was there anything unusual about yesterday?
- What would be different if it was another day of the week?
    - What do you do on a weekend day?

Work
I'd now like to find out about specific routines and activities in your day: work, play, eating

- Do you have much work/studying to do outside of lectures?
    - How much time do you spend studying?
- How do you study? What does studying mean for you?
- Do you study in the flat?

- What do you do in order to study?
    - Do you use a computer? For reading?
    - Anything more than books and PC? Media? Experiments?
    - What conditions do you like?
- Do you do any other kind of paid/voluntary work or projects in the flat?

Interests / Leisure

- What do you do when you're not studying?
    - Hobbies? Any societies or clubs?
    - Any activities in the flat?
- Have you taken up or dropped any activities now since coming to university?
- Do you socialize in the flat?
    - Do you ever have visitors? Do any stay over?

Eating

- What did you eat yesterday? – breakfast, lunch, dinner
    - What times?
    - Was there anything unusual about what or how you ate?

- Do you eat differently at the weekends?
- Do you eat out or get take away in a typical week? When?
- How often do you cook in the flat?
- Do you like to cook?
- What do you cook?
    - What do you like to cook?
    - When?
- Generally how do you cook?
    - Use the hobs? Oven? Microwave? Toastie machine?
- Do you use any special appliances when you cook, anything you've added or brought to the flat?
- Do you ever cook for or with flatmates?

- How many hot drinks do you make in a day?

Grooming and Cleaning

- What kind of grooming or health and beauty routines do you have?
    - Anything else to be presentable?
    - Ironing? Hair? Showering?

- Do you do any cleaning? How often?
    - Where plugged in?

Stuff

- You will have bought some things with you. Out of those, which do you use most regularly? This could include electronic devices and equipment but doesn't have to.
    - How? What for?
    - What else?
- Is there anything that you could you not live without?
- Since you first arrived / compared to last year - have you brought different things with you?
- Is there anything that you're missing or would really like to have here?

    - Either to buy or bring from somewhere else?
    - Anything different planning to have next year?

Electrical Devices

- What electrical devices to you own and use here?
- Do you unplug electrical items at the wall or switch them off?
- Is there anything that you leave on?
- Is there anything that you think is on standby?
    - Why?
- What about lighting? Do you switch it off when not in the room?
    - Around the flat?
    - Is there anything else you may do to save resources – energy or water?

Tailored Questions, With Socket Monitoring Graphs

- How did you get on with the plugwise adapters in your room?
- What's plugged in?
- Move items around?

- Discuss yesterday's Data
- Show range of traces
- Discuss any different, unusual data

Missed?

- Generally, how found being part of the study?
- Is there anything else that we've not talked about that is important to your daily routines in the flat?

Appendix 2. Interview schedule for first interview in Stage II (Comfort)

Preamble
Background, purpose, consent and confidentiality

You and Your Accommodation

- Which year of your studies are you in?
    - Where is home for you when you're not at university?
    - Is that where you grew up?

- Did you move into this hall in September?
    - Have you lived anywhere like this in the past?

- How do you find it living here?
    - Do you spend much time here?

- Do you find it comfortable?
    - What's most comfortable about it?
    - What's most uncomfortable about it?

- What does comfort mean to you?
    - What does "discomfort" mean?
    - Is comfort important to you?
    - Do you ever intentionally try to "get comfortable"?
    - What do you think is most important to your sense of comfort when living in a place?
    - Are there times when it's ok to be uncomfortable?
    - Are you comfortable now?

- Is there anything about the indoor climate in this room that is important to your sense of comfort?
    - How does it compare to other places that you've lived?
    - Do you have to cope with it in different ways?
    - Do you have any problems or concerns about it?

Temperature

- Is there anything about temperature that's important to your sense of comfort?
    - How does temperature here compare to other places that you've lived?

- In terms of temperature are you comfortable now?
    - How would you describe your own personal temperature now?
    - How would you describe the temperature in the room now?

- Do you ever feel hot in here?
    - Can you remember the last time? Does this happen much?
    - How did you respond? Did you do anything?
    - Do you ever feel uncomfortably hot in other places?

- Do you ever feel cold in here?
    - Can you remember the last time? Does this happen much?
    - How did you respond? Did you do anything?

    - Do you ever feel uncomfortably hot in other places?

- How does this room compare in terms of your feelings of temperature to other places that you go, on a daily basis?

- Do you have a thermometer?

Control

- Do you do anything to manage or control your sense of comfort?

- Are you able to create the kinds of conditions that you like in this room?
    - Do you ventilate the room? Or do you prefer not to?
    - Do you heat the room? Or do you prefer not to?
    - Do you have enough control over the conditions in the room?
    - Is there anything you would like to do, but can't?

- Did you notice any really cold spells this winter?
    - How did you cope?

- Have you noticed or had any warm spells yet?
    - How did you cope?

- So tell me (a little more) about the **window**:
    - I notice its shut/open now…
    - When? How often? What for?
    - How important is it?
    - How well designed is it for what you want to do with it?

- Tell me about the **door**:
    - I notice its shut/open now…
    - When? How often? What for?
    - How important is it?
    - How well designed is it for what you want to do with it?

- Now, tell me something about the **bathroom** and how you find it:
    - What's it like to have an ensuite?
    - Does it cause any problems? Anything that you don't like?
    - What time of the day do use hot water?
    - How do you find the temperature of the water?
    - Do you ever have a shower to warm up? Or to cool down?

- Now, tell me about the **radiator**:
    - Is it on now?
    - When? How often?
    - What setting is it on now?
    - How important is the radiator?
    - How well designed is it for what you want to do with it?

- Do you have any other control over the **heating system** more generally?
    - Do you know how it works?
    - What are the hours of heating? How do they suit you?
    - What are you expecting to happen as we move into spring and summer?

    - What do you think the University should provide in terms of heating?

- Do you have anything **else** which heats the room?
    - Have you noticed other sources of heat?

- Do you experience anything else which warms you up when in here?
    - Food? Have hot meals everyday?
    - Hot drinks?
    - And how about cold drinks? Do use them to help cool you down?
    - Do you get the sun in here?

- Have you ever discussed heating with flatmates or friends?

Clothes

- Tell me a little about the clothes you are wearing now…
    - What have you got on? Describe them to someone who wasn't here?
    - Do wear these clothes often?
    - Do you like wearing them?
    - Are they comfortable?

- Does it matter to you that your clothes are comfortable?
    - What does comfort mean in terms of clothing?
    - Or there times when it matters more?
    - Or there times when you don't mind if they are uncomfortable?

- Tell me a little bit about your wardrobe…
    - Do you have a lot of clothes?
    - Did you bring all the clothes you had from home?
    - Have you bought many new clothes since September?
    - Do you have clothes that you specifically like to wear around the flat?

- Do you change clothes during the course of a day?

- Does the weather affect what you choose to wear?

- So tell me what you would wear on a cold day?
    - When was the last time wore that?
    - Would you wear what you're wearing now?

- Do you wear **layers**?
    - Would you take a layer on or off to help feel comfortable?
    - Have you worn any thermal layers or thermal underwear this winter?

- What is the most in the way of clothing that you've worn inside this winter?
    - Either here or elsewhere

- Thinking about summer, imagine a hot day, what would you wear?

Missed?

- Is there anything about your experience of comfort that we've not talked about?

Appendix 3. Diary extract from Stage II (Comfort)

SUMMARY Day.....2.....

If you like, use the pages following these sheets tell us more about clothes, comfort and temperature in your day.

1) YOUR CLOTHES TODAY

A) Did you get a photo of your main outfit(s)? No

B) How many times did you change clothes? 6-9 times

C) Other than coats, did you adjust your clothes to get warmer or to cool down? If yes, where were you?

took off my scarf, hat and cardigan, and occasionally trousers

D) How did you decide what to wear today? Mainly the weather

SUMMARY Contd.

2) YOUR THERMAL EXPERIENCE TODAY

A) Did you **enjoy** anything about your thermal environment / experience?

felt oddly comfortable today. without much need to continually opening and closing the window

B) Did you **dislike** anything about your thermal environment / experience?

Not much, apart from waking up to a really stuffy room. I felt severly dehydrated and I needed a glass of water as soon as I woke up

C) Did you notice anything **unusual**, interesting or a change from previous days?

The ~~tempera~~ room temperature at night has become considerably stuffy, for reasons I do not know.

3) YOUR COMFORT TODAY

A) Did you do anything to "get comfortable"? opening the window + drinking a glass of water after waking up, + during the early hours. I woke up with the most horrendous night sweat + I was in dire need for water

Appendix 4. Sample socket electricity use charts used in interviews (Stage I)

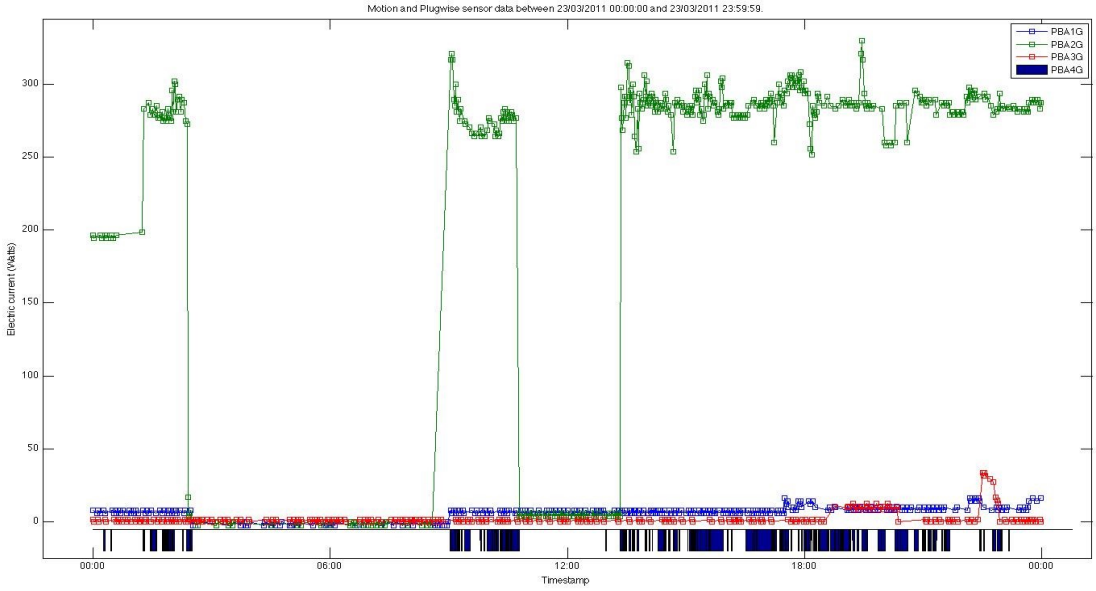


Figure A. Socket electricity data for one day in Henry's room (Green data points = Computer, Stereo, 2 monitors, laptop, games console; Blue data points = 2 Hard Drives, Wi-Fi router; Red data points = unknown, Bar under axis = motion detected)

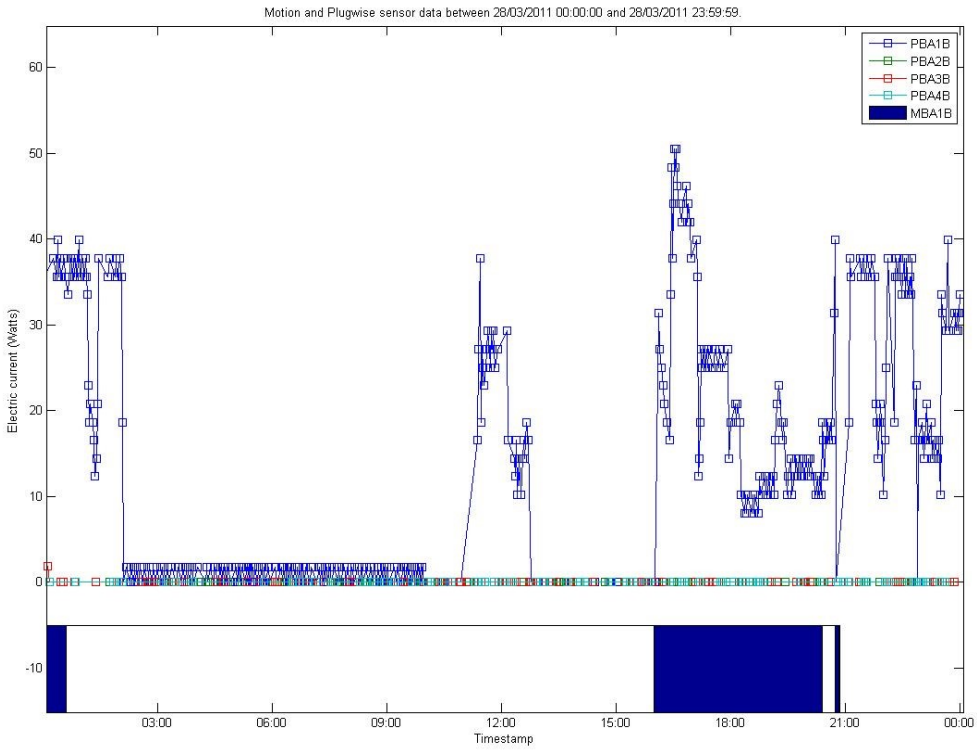


Figure B. Socket electricity data for one day in Ellie's Room (Blue data points = Laptop, phone and camera chargers; Bar under axis = motion detected)

Appendix 5. Participant information sheet for Stage II (Comfort)

LANCASTER UNIVERSITY

Participant Information Sheet

We are conducting a study into thermal comfort in campus accommodation. We would like to invite you to participate. This sheet provides information about the study and what participation will involve.

We hope it answers any questions that you may have but if you do have any further queries please feel free to contact:

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Project Title: Comfort and Your Home on Campus

Aims of the research:
This project aims to explore the experiences, practices and conditions of thermal comfort in your everyday life on campus, with a particular focus on your campus accommodation.

Study procedure and the participant's role:
The study includes a combination of interviews, a journal and the addition of some simple sensors to your bedroom.

Interviews

We ask that you participate in two informal interviews to discuss your experiences and practices surrounding comfort. Each interview may last up to an hour, and we ask that they take place in your bedroom so that you have ready access to anything that you might wish to show us. In the second interview, we hope to show you some of the data from the room sensors (discussed below). Interviews will be arranged at convenient times to suit you. Interviews will be recorded and later transcribed. Quotations from what you say during an interview, or answers you give to questions asked during the study, may be used in publications. But they will be used anonymously.

Journal

For 3 consecutive days, we'd like you to keep a journal. The purpose will be to log some of the things you do and stuff you use to stay comfortable. The journal might include photos and notes. Some suggestions will be provided, and we hope to offer an interesting and fun way of doing this. The level of detail will be entirely at your discretion.

Room Sensors

In order to monitor conditions in your bedroom, the researchers will fit some simple sensors consisting of:

- Temperature and humidity sensors – these will be placed in a number of places including the radiator, hot water pipes and room spaces (main room and bathroom).
- A motion sensor – (main room) similar to those found in standard household burglar alarms, these periodically signal if they have detected motion. They are **not** capable of recording images, video, identity or number of occupants or their position in the room.
- Window and door sensors – again similar to those from burglar alarms, these will help indicate air exchange in the room.
- Electricity meters – these will be added to sockets in the room. Here, we're interested in the contribution of activities and heat associated with electrical devices.

In order to log the data from these sensors, we will need to place a data-collecting computer in your room. The computer is small and quiet and we will install it in a way that you are happy with.

This part of the study will last for several weeks, ideally finishing just before the Easter holiday. It requires your co-operation in arranging convenient times to install and remove the sensors. We may need to return during the study period, in case of any problems or to collect data from the sensors, but otherwise this element of the study only requires that you go about your daily life. But please do not adjust or remove sensors and please avoid turning-off the data-collecting computer. But do note: you may contact us **at any point** if you would like the sensors to be removed and we will endeavour to collect them as soon as possible.

Participation in this study is **entirely voluntary**. You may withdraw at any point - even during an interview - and you need not give a reason. If you request, any data collected up until that point will be destroyed. Your continued participation in the study should be as informed as any initial consent, so you should feel free to ask for clarification or new information throughout.

Before the study commences you will be asked to sign a consent form to confirm that you have received and read this information sheet and that you are willing to take part in the research.

Confidentiality and anonymity:
Any information collected from you or about the use of your bedroom or flat will be treated with confidentiality. This means that only the research team will have access to any raw information that can be specifically associated with you. Any information that is shared beyond this team will be made anonymous. This means that details of your name and your room will be removed, and a pseudonym will be used instead. This will apply to any publications or presentations or any discussion with other colleagues in the University.

This research is conducted with the consent of the administrators of the building. However, any information connected to you personally will not be shared with these parties. This research is not related to any monitoring, use or planned intervention by these parties or the University, and we won't pass on any information on particular issues or problems with your room or flat without your express consent.

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How will the data be used and protected:
We will treat data that you provide or that is collected from your room in accordance with the Data Protection Act 1998. This means that any personal information stored in physical format (paper, readily playable recordings) will be stored in a locked filing cabinet in a locked office on Lancaster University premises. Any personal information stored electronically will be stored on a secure, password-protected server. Any personal information that is transported electronically on a mobile device (a laptop or memory stick) will be encrypted and/or password-protected.

The information collected will be used to inform the development of further research and may be included in publications, presentations and PhD theses. Only anonymised information will be retained indefinitely for ongoing research purposes.

Risks of participation:
The risks of participating in this study are minimal. However, despite concealing your name and room number, there is a risk that you may be identifiable from the information provided in your interview by those who know you personally and your flat may be identifiable by those, such as your immediate neighbours and friends, who could see the study taking place. In this case, the impact on you is likely to be negligible since the study does not aim to explore any particularly sensitive topics.

In relation to the room sensors, we realise that you may have concerns over your privacy. Please be aware that our research protocol precludes any observation of real-time data collection *except* for the purposes of testing the sensors. We will also take appropriate security measures to ensure that others do not inadvertently access the data. If such inadvertent disclosure should occur, this could include information about occupancy of your room at particular times and use of particular appliances. To reduce the risk posed by inadvertent access, we will ensure, as far as possible, that the collected data is not explicitly linked to your room.

Benefits:
As a thank you for taking part, we'd like to offer you a £15 voucher at the end of the study. We also plan to share the room sensor data with you in summarised form.

The research that your participation makes possible will help to inform the academic research community and policy makers about the relevance, potential gains of, and suitable techniques for, studying domestic comfort. Ultimately, it may also help shape the ways that the University provides for the comfort of residents, against a background of climate change and a changing energy agenda.

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About the researchers:
The research team are based primarily in the School of Computing and Communications (SCC) and the Department of Sociology at Lancaster University. It is funded by a research grant from the EPSRC (Engineering and Physical Sciences Research Council).

Research Team:
Dr Mike Hazas (SCC)
Dr Adrian Friday (SCC)
Dr Adrian Clear (Research Associate, SCC)
Janine Morley (PhD student, SCC and Sociology)
Oliver Bates (PhD student, SCC)
Professor Elizabeth Shove (Sociology)

Concerns:
If you are not satisfied with the manner in which this study is being conducted or if you have any concerns regarding your participation, you may contact (anonymously if you so choose):

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