The Rhythm of Life is a Powerful Beat:

Demand response opportunities for time-shifting domestic electricity practices

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Abstract

The 2008 Climate Change Act set legally-binding carbon reduction targets. Demand side management (DSM) includes energy use reduction and peak shaving and offers significant potential to reduce the amount of carbon used by the electricity grid. The demand side management (DSM) schemes that have tried to meet this challenge have been dominated by engineering-based approaches and so favour tools like automation (which aims to make shifting invisible) and pricing (which requires customer response) to shift demand. These approaches tend to focus on the tools for change and take little account of people and energy-use practices. This thesis argues that these approaches are limited and therefore unlikely to produce the level of response that will be needed in future.

The thesis therefore investigates the potential for time-shifting domestic energy demand but takes a different angle by trying to understand how people use energy in their daily lives, whether this use can be shifted and some of the implications of shifting it. The centrepiece of the work is an empirical study of eleven households' energy-use practices. The interdisciplinary methodology involved in-house observations, interviews, photographs, metered energy data and disruptive interventions. The data was collected in two phases. Initially, a twenty-four hour observation was carried out in each household to find out how energy was implicated in everyday practices. Next, a series of three 'challenges' were carried out, aimed at assessing the implications of disrupting practices by time-shifting food preparation, laundry and work/ leisure.

A practice theory approach is used to shift the focus of attention from appliances, tools for change, behaviour or even people, to practices. The central finding of this work is that practices were flexible. This finding is nuanced, in the light of the empirical research, by an extended discussion on the nature of practices; in particular, the relationship between practices and agency and the temporal-spatial locatedness of practices. The findings demonstrate that, in this study at least, expanding the range of demand response options was possible. The research suggests numerous possibilities for extending the potential of practices to shift in time and space, shift the energy used in practices or substitute practices for other non-energy-using practices, though there are no simple technological or behavioural 'fixes'.

More profoundly, however, the thesis concludes that 'infrastructures of provision', such as the electricity grid and the companies that run it, underpin and facilitate energy-use practices irrespective of the time of day and year. In this context technology-led demand response schemes may ultimately contribute to the problem they purport to solve. A more fundamental interrogation of demand and the infrastructures that serve it is therefore necessary and is almost entirely absent from the demand response debate.

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Acknowledgements

Dedication

This work is dedicated to all those who are working to combat climate change.

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1   Introduction

Climate change policy in the UK requires reducing the carbon impact of the electricity grid. This will involve reducing the amount of energy being used and increasing the amounts of renewable generation connected to the electricity grid. The challenge is to manage electricity usage so as to reduce absolute and peak demand in the short to medium term and find a means to deal with the intermittent supply implied by a high percentage of renewable generation in the longer term. The task, in managing peak demand and responding to intermittency, is to shift the time of use of electricity (known as demand side management, demand side response or demand side shifting) rather than the absolute amount of electricity used. This chapter will look at why demand side management is important and why current approaches to it are unlikely to result in the level of demand side shifting required. This will lead to the framing of the aims, objectives and research questions that will structure the rest of this thesis.

1.1   The context for conventional demand side management (DSM)

The 2008 Climate Change Act commits the UK to an 80% reduction in greenhouse gas emissions by 2050 compared to 1990. Accordingly, the 2009 Renewable Energy Directive sets a target for the UK to achieve 15% of its energy consumption from renewable sources by 2020. The decarbonisation of the electricity sector will entail the addition of significant amounts of renewable generation to the grid (Hawkes 2011). A substantial percentage of renewables challenges the constant balance between supply and demand that is required if the electrical power system is to work properly. The result could be system outages.

In the current system, this balance is achieved through flexible generation because conventional power systems contain an inherent energy store in the form of coal, gas, uranium or water which can be fed into the system quickly. This system allows demand to proceed unfettered and is called the 'predict and provide' model. Renewable energy presents a challenge to this model because it provides an intermittent energy source that cannot be turned on at will, so reducing the flexibility of generation. At times this may lead to a shortage of power, while at other times it may necessitate dispatching down (or curtailing) renewable generation. A large percentage of renewable generation on the grid therefore threatens the 'predict and provide' model.

There are three possible solutions. One option is to maintain conventional plant back-up for when renewable generation fails but this is very expensive because would be used infrequently and so has a low load factor (Barnacle et al. 2013). A second option is energy storage: such as pumped hydro, which is both expensive and only possible on a limited number of sites, or compressed air, a newer technology which is at

an early stage of commercial development. The third possible solution, demand response, would therefore be valuable if its potential could be realised.

Demand response, also known as flexible demand or time-shifting demand, is achieved by re-timing the use of electricity to match the available generation. It is part of a broader strategy called demand side management (DSM), and sits alongside demand reduction (using less electricity) in helping secure a low-carbon future, as shown in **Figure 1**. Energy reduction is a self-evident way of reducing carbon emissions and has been well researched across various disciplines over a long period. However, much less has been done, particularly in the social sciences, to find out how domestic users will react to demand response. This thesis speaks to both of these agendas.

Figure 1: Demand side management
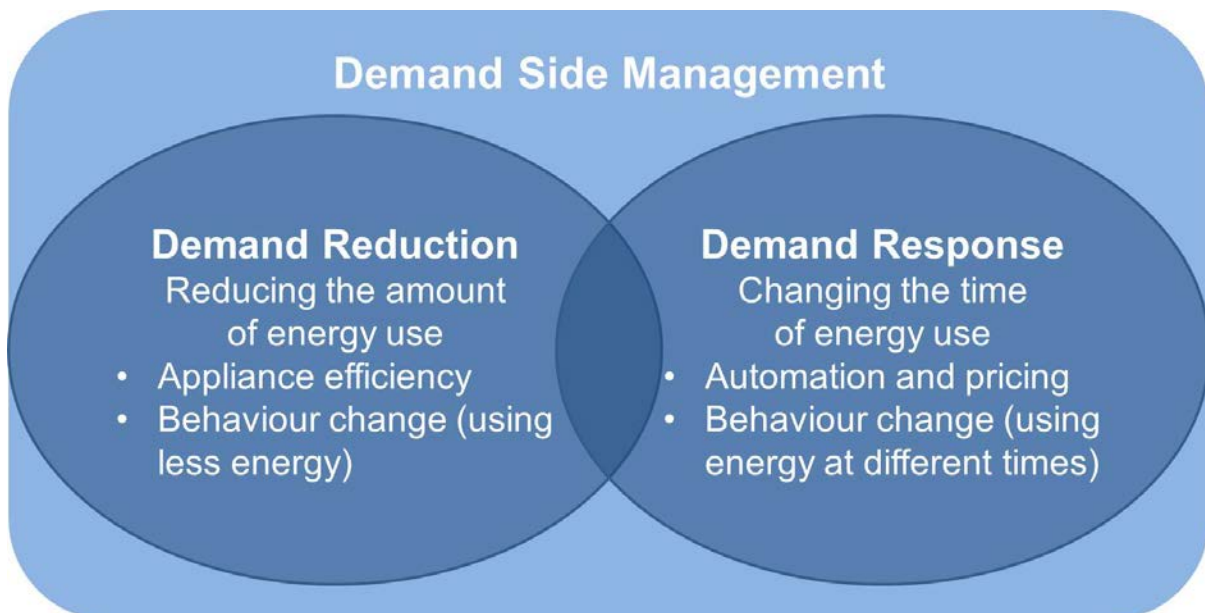
In comparison with other options, demand response reduces the necessity of investments in added conventional generation capacity (Strbac 2008) in a cheaper way than storage. It can help lower carbon emissions in two ways: initially by alleviating the need to switch on high carbon generation at peak times and in the longer term by facilitating the addition of renewables to the grid by providing part of the solution to intermittency. It also helps to reduce the country's dependence on imported fuel sources as it utilises locally available renewables so improving at least this aspect of security of supply.

Assessments on how possible it is to achieve demand response range from the optimistic: that all demand is flexible and could be fully accessed just by setting appropriate real-time prices (Mohsenian-Rad, Leon-Garcia 2010), to the pessimistic: that users will not accept flexible demand and so measures must remain invisible

(Di Giorgio & Pimpinella 2012; Finn et al. 2012, Hamidi et al. 2009). Those pushing the technology approach tend to claim that pursuing demand response through a mixture of price signals, technology (some of it smart) and automation will shift elements of future demand, e.g. heat pumps and electric vehicle charging, by up to a few hours with very little impact on the user. Ultimately, however, the need for flexibility will apply to most demand in a renewables dominated future (Barton et al. 2012) and the flexibility required may be more substantial than is currently envisaged. Although it is a rapidly growing area of research, shifting demand in time is currently little understood from a social sciences perspective. This thesis primarily examines demand flexibility relevant to peak shaving and critical demand response (where energy use is reduced or shifted on days of particularly high overall demand) but also suggests some tools that, if developed, might help in dealing with renewable intermittency. Within this, it is particularly interested in non-automated demand response (in other words, where practices need to actively change rather than the response being technology enabled), especially where this is not triggered by a price signal.

Table 1 summarises a variety of typical, currently available, demand response tariffs and tools from the user's perspective. In several of the tariffs listed here customers are required to be quite involved. In all of them, they are expected to respond to a price signal. Many of these are also quite complicated at a time when simpler bills and tariff structures are being advocated. It is clear that these sorts of tariffs and the technologies that facilitate them will become (or already are) a crucial part of our energy system. In 2009, for example, the UK government announced its intention to install fifty million Smart meters (a complete rollout) for all gas and electricity customers in the UK by 2020 (DECC 2009), demonstrating their belief that feedback is the key to tackling demand side management and paving the way for further development of a smart grid which would give automation an increased role as well. **Table 2** is based on a discussion with an expert from the energy industry and highlights the value of demand response mainly from a current system perspective and was instrumental in shaping the research undertaken for this study. It is clear in both tables that the energy industry benefits are well articulated (supply-side benefits are identified as reduced annual demand, peak load reduction, reduced network demand and reduced losses, network management and better availability of data (Enviros Consulting 2008)). However, the claims that consumption will be reduced and the nature of energy demand changed as a result of these tools need further interrogation. The next section reviews some of the problems with the conventional approaches to demand response.

Table 1: Description of Residential Demand Options from the User's Perspective

Tariff or tool	Demand response option	Description	Level of user involvement, and comments
Overall (grid) demand reduction	Energy efficiency and conservation programmes	Encourages the purchase of energy-efficient appliances or building improvements, thereby reducing overall demand.	Invest in home retrofitting and efficient replacement appliances; switch appliances off; alter settings; change practices in relation to clothing, curtains etc.; invest in microgeneration and renewable heat technologies.
Static price response	Economy 7or'bioraria'-type pricing (two price bands only)	Some may be obliged to adopt this type of tariff because they have night storage heaters, in which case heating is switched on and off automatically.	Some may choose it after calculating that they have enough shiftable load to justify washing, etc., in off peak hours. Then they have to remember to do so manually or it can be done through automation.
	Static time-of-use pricing (may have more than two price bands)	Electricity prices vary according to the period of the day—prices are low when the demand is low (at night) and high when the demand is high (during the day). Prices do not vary on a day-to-day basis.	Active customer involvement can vary considerably. Potential for automating some end-uses, e.g. water heating, wet appliances, even some space heating, to optimise use of cheap electricity. User can cede control to supplier/network operator. Manual override makes this more acceptable.
Load response	Critical day pricing	Similar to static time-of-use pricing, but where prices are considerably higher, throughout the whole day, on a 'critical' day compared to a non-critical day.	Choose tariff, watch for day-ahead notification of high demand and reduce demand as far as compatible with comfort.
	Critical peak pricing	Similar to static time-of-use pricing, but where the prices are considerably higher during the peak period on a 'critical' day compared to a non-critical day.	Choose tariff, watch for notification and reduce demand at critical peak times.
	Peak time rebates	Similar to critical peak pricing, though where customers receive a rebate if their consumption is below a given threshold during the critical peak period.	Choose tariff, watch for notification and reduce demand. More suitable than CPP for people on low incomes.
Dynamic pricing	Real-time pricing	Electricity prices vary throughout the day, typically on an hourly basis. Prices are, in theory, unpredictable, and follow some of the volatility of wholesale electricity prices.	Requires good understanding; customers may be able to set maximum prices they are willing to pay, and/or may install backup capacity or storage. Possible to reduce risk through forward contracts, in some regulatory situations. RTP is likely to involve high degree of automation of response, to keep pace with price changes.
	Demand aggregation	Offers advantages of real-time-pricing, with low threshold for customer involvement. Aggregators take financial risk (low at present, though likely to become more significant) and pass on some profit to the customer.	Consumers participate directly in the electricity market by bidding for their expected demand ahead of schedule. Typically, this would be an automated process performed by consumer appliances.

Source: Derived from (Darby, McKenna 2012)

Table 2: Likely scenarios from the energy industry point of view, what these might be worth and how they might be implemented

Response	Value of response		Actors and likely implementation strategy
Guaranteed/ at least pretty likely response	Important over the whole population but not on an individual basis unless there are particular network issues (in which case community approach may work better)		National Grid – interested in balance of overall system so most valuable to them Local network operator – see previous column Supply company – only relevant to minimise costs but not essential
Immediate response	Will increase in value as intermittent supply increases. However, it's thought probably not worth the aggravation to stop something mid-way and so next day response the most likely scenario.		National Grid again most interested. Response in seconds more valuable than minutes. Currently felt that technology the best solution here though there is an example of a traffic light system being used on TV which mobilised people (air raid sirens also provoke immediate response but a bit drastic)
Next day response	90% of supply is sorted out the day ahead so this may be most useful. Also gives people time to plan.		Likely to be able to do day ahead warning asking for a 2-4 hour response the following day on current system
Four hour reserves	Wind errors are significant at this level so this would be valuable		At the moment this is served by pump storage because wind is not significant. In future open cycle gas turbines will be used because they're fast (10 minutes) and cheap to build. At the moment coal could be used because it would be fairly warm and could be warmed fully in about 4 hours but, again, in a windy future where it might not have been used for a few days, the warm up time would be too long so open cycle gas turbines most likely.
Shifting forwards	Normally for a period of 2-4 hours in which case the value partly depends on the time of day. Whole days also of value	In a more wind dominated future grid, being able to shift forwards when wind is rapidly increasing or when it's likely to die out within the next day is useful	Price is currently the main thing people talk about to manage demand side but it is felt that the level of payment may be prohibitive. Other strategies like vouchers, community schemes, social network development may be more useful.
Shifting backwards		We're more used to thinking of deferring load	Taking a market approach may render a different strategy unavailable but little is known in this area.
Shifting by a week	Value at the time it is required very significant but it would not occur more than once or twice a year or maybe only every two years so payment when required might be the best strategy. Probably more likely to be a series of 3 hour periods at peak times for a week, on weekdays. Best to move back out of peak, worth about £50.		In investment terms this is similar to the concept of cold weather shutting things down vs. preparedness to invest in equipment that will spend more of its time idle.

1.2   An overview of work done on shifting demand

Residential users in the UK have a significant impact on diurnal peak demand, but until recently involving them in load-shifting has not been deemed worthwhile (Shaw et al. 2009). However, as more distributed generation, electrical space and water heating and electric vehicles come on stream, this situation is changing, partly because of local network management issues (Darby and Pisica 2013). The business plan for the UK government's smart meter rollout programme assumes that 20% of residential consumers will adopt static TOU tariffs by 2030, in addition to the approximately 15% who are already paying for electricity in this way (Consumer Focus, 2012). Recent data show that 25% of all Great British residential usage is subject to a basic time-of-use (TOU) tariff, some of which can be controlled by some form of remote switching (Hesmondhalgh and Sustainability First 2011). As Darby and Pisica (2013) point out, therefore, a version of residential demand response is already in place, but little is known about how its usefulness can be extended and made more sophisticated.

There have been a number of overviews of demand response programmes. Darby and McKenna (2012) review residential electrical demand response and discuss examples from around the world in order to assess the main considerations for cool climates. They point to the fact that the combination of small loads and numerous actors implies a large effort to response ratio, particularly in the short to medium term. They also highlight the significance of thermal loads in a cooler climate with gas heating and limited air conditioning, as well as of the supply mix, demand-side infrastructure, market regulation and the framing of risks and opportunities associated with demand response. They note that customers will effectively be enlisted as (possibly unwitting) co-managers of the system and point out that this is a significant shift in the nature of electricity systems and their governance. Despite the difficulties, however, their review reports several successful demand response pilots in Europe and beyond.

Response in non-European trials varied from a slight to an 8% overall reduction in demand, a 3-30% reduction at peak or critical peak times and overall customer satisfaction with the demand response programmes. European programmes were perhaps more mixed but there was still evidence of reductions, particularly at peak. These pilots were testing a variety of tariff types and direct load control options, either on their own or in various combinations. There was some response to price but the variation in cost rather than the difference in cost seemed most influential. However, peak usage was seen by some pilots as highly inelastic.

It seems difficult to draw straightforward conclusions from the pilots but the paper proposes some principles and suggests that customers would be willing, overall, to contribute to network flexibility but require: feedback and education, proper data protection and carefully structured tariffs. The paper draws out the 'functional contrast' between 'active occupancy' models with an aware user at the centre and more passive load-response with largely automated systems. It also highlights the significant difference, from the users' point of view, between static and dynamic tariffs. However, it is cautiously optimistic about demand response, suggesting a phased approach in which TOU pricing is used to shift loads in the short term and to habituate users to the concept of variable tariffs, so paving the way for real time pricing (which is more useful for systems with distributed energy resources, such as those that might exist in a high renewables future) once demand response infrastructures are more in place. This thesis will attempt to shed light on some of those areas the report found inconclusive, namely the response to non-economic incentives and the way in which energy loads are shifted, that is, what demand might be shiftable beyond thermal loads by means of an aware user, rather than through an automated response.

Another overview of demand response programmes was done by Frontier Economics and Sustainability First, who were commissioned by DECC to review the evidence on Demand Side Response (DSR) trials in the domestic electricity sector, in the UK and internationally (Frontier Economics and Sustainability First, 2012). Their review of 30 trials concluded that it is possible to shift the time of energy use in response to price signals accompanied by even basic information and this is true in relation to both regular peak demand and irregular critical peak demand. However, the size of this response varies dramatically, from 0-22% in relation to day-in-day-out shifting and from 5-38% in response to irregular shifting. The size and sustainability of the response depends on the existence of significant shiftable loads like air conditioning or electric heating. Economy 7 in the UK, accompanied by an appropriate tariff and automation allowed load shifting away from peak demand, and air conditioning with automation could be responsive to critical peak demand. Over and above automation, economic incentives and enhanced information (including in house displays that provide interactive information and detailed billing that breaks consumption into different tariffs) delivered additional flexibility. Feedback from those in the trials about attempts to shift energy use in this way was generally positive. The review also reported inconclusive evidence in relation to a number of areas: responsiveness amongst vulnerable and low-income users, the effect of real time pricing, the persistence of the response over time, the response to non-economic incentives, and the way in which energy loads are shifted beyond air conditioning and storage heating (Frontier Economics and Sustainability First 2012). They identified two areas of future research which this

thesis will help to illuminate, namely: what appliances consumers actually move when required to be flexible and better understanding non-economic signals.

A third overview of demand response programmes is currently being undertaken by the International Energy Agency (IEA) sub-group researching DSM (Task 24). The review focuses on 40 case studies across four themes: retrofitting, transport, smart metering and SMEs (Small and Medium Sized Enterprises) and aims at drawing out initial observations and lessons of interest to behaviour change experts. **Figure 2** summaries the practical implementation lessons learned from these case studies so far.

Figure 2: DSM smart metering interventions

- In many instances it is clear that economic gains or losses are not necessarily the only trigger necessary. TIME ISN'T ALWAYS MONEY.
- The successful implementation of smart metering is dependent on the creation of an intervention that goes beyond acceptance and aims at creating multiple benefits through the introduction of a smart meter. TECHNOLOGY ISN'T EVERYTHING.
- Who benefits and who pays (e.g. with assumed loss of privacy)? MAKE SURE THERE IS CLEAR VALUE FOR THE CUSTOMER.
- Information isn't everything - it needs to be coupled to active or shared learning. AUTOMATONS DON'T TEACH AS WELL AS REAL PEOPLE.
- If they want it, they're already convinced it's a good idea and not your main target. FIND AND CONVINCE THE 'LUDDITES' THAT YOUR TECHNOLOGY IS A GOOD IDEA FOR THEM.
- Don't just tackle the behaviour of people, but also of their home. THE HOME AND THE HOUSEHOLD DYNAMICS HOLD YOUR KEY.
- Beware of the strong effect of personalities when using intermediaries, champions or advisors. SOCIAL CUES ARE MORE POWERFUL THAN TECHNOLOGY.
- A home is not where energy is used, it is where people live (comfortably, thanks to energy). MY HOME IS MY CASTLE.
- Use trusted champions and advisors. SEEING IS DOING.
- The technology solution needs to match the technology literacy/maturity of the target. DON'T SELL IPHONES TO PEOPLE WITH NO POWER.
- Focus not on individuals but on their practices. IT'LL TAKE A LONG TIME TO CHANGE 7 BILLION PEOPLE ONE BY ONE.
- Engage your customers through multiple channels. PARTICIPATION IS KEY.
- Being wasteful can feel worse than spending money. NO ONE LIKES WASTE.
- I wanna know what others are up to and where I stand. TELL ME HOW I'M DOING COMPARED TO MY NEIGHBOURS.

Source: Mourik, R., Rotmann, S. 2013

Amongst other projects, **Table 3** includes many of the pilots reviewed by the IEA, some of which were also reviewed by the reports above. Unusually, the review specifically highlights the impact of the theoretical approach or model of behaviour change underpinning particular programmes trying to conserve energy or promote energy efficiency (Mourik, Rotmann 2013). This concern with theory has been picked up in **Table 3** because this thesis will take its own theoretical approach.

Table 3: Selection of DSM Trials relevent to this Study

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
Jouw Energie Moment (Your Energy Moment), The Netherlands, http://www.jouwenergie moment.nl/ (from IEA overview study)	Enexis ran two 24 month pilot projects on smart grids in two parts of Holland. Participants were given an energy meter, an energy computer, solar PV panel and a smart washing machine/ dryer/ heat pump. They were also encouraged to talk to neighbours about energy use.	Participants were given a variable tariff and then asked to set their smart appliances to run according to their selected preferences. These then ran under favourable conditions (such as when the sun was shining or when the electricity tariff was low). They could use the energy computer to shift other appliances as well.	The objective was to gain insight into energy flexibility and test the efficacy of environmental and financial motivations. Customer feedback on the website is positive – they saw it as a 'good deal'. However, it is not clear how much load was shifted or how sustainable the new behaviours were.	Expectancy Value Theory; Design with Intent, Interpretation for sustainable behaviour	Seems to have focused more on changing the technology and less on the social, structural and knowledge-based aspects of changing energy-use.
PowerMatching City Hoogkerk, Netherlands http://www.dnvkema.com/innovations/smart-grids/powermatching-city/default.aspx (from IEA overview study)	Run in 2007 as part of the EU-funded INTEGRAL program, the project developed, built and demonstrated an integrated smart grid solution. The objective of this project was to gain insight into distributed generation and the dynamic, intermittent supply of renewable energy sources.	Power Matching City offered a real life experiment in 25 households, using technology such as solar panels, micro CHP, smart appliances and electric vehicles to test the feasibility of dynamic demand on a small scale	The project reports success in terms of the technical feasibility of the project. They stabilised and optimised the network by trading energy on a local market based on a RTP signal using PowerMatcher smart technology. They also report customer satisfaction – price was optimised, technology used to minimise disruptions	Value action gap theory	Customers are not actively engaged in this project and their practices are not interrogated.
Responses to Time Varying Prices for Electricity, New Zealand, http://www.business.otago.ac.nz/econ/research/discussionpapers/DP_1116.pdf (from IEA overview	This study, undertaken by Mercury Energy and Otago University, focused on household response to weekday differentials in peak and off-peak electricity prices. Mercury	Face-to-face survey assessed house, appliances, energy-use behaviours and attitudes and demographic information. Four groups treated differently – information only and then price differentials (small, medium	On average, there was no response to TOU tariffs except in winter. In winter, participant households reduced electricity consumption by at least 10%, took advantage of lower off-	Classical Economics and marketing	Household characteristics had largest explanatory impact. Hardly any houses conformed to aggregated profiles – little uniformity in the

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
study)	was in the process of replacing conventional residential electricity meters with meters that send readings wirelessly every half hour. Worked with 400 of these households (who opted in) in Auckland, New Zealand, where peak residential electricity consumption occurs in winter for heating.	and large). Households also received information via bills.	peak prices but did not respond to the peak price differentials. Response varied with house and household size, time spent away from home, and whether water was heated with electricity. Significant response to basic information provision.		way people live. Size of price differential not significant in determining responsiveness.
Demosteinkjer, Norway http://smartgrids.no/wp-content/uploads/2012/11/Sluttrapport_fase_1_del prosjekt_2_Demo_Steinkjer1.pdf (from IEA overview study)	In the light of the complete smart meter rollout in Norway by 2017, one grid operator in Nord-Trøndelag county (responsible for rolling out meters to 4,500 households), piloted various types of meters in 700 households. An energy reduction project rather than shifting.	Customers given information comparing current and previous usage, and their usage with that of neighbours.	Benefits of meters to customers unclear. Some evidence of initial reductions but soon meters were ignored and practices restored.	Theory of Planned Behaviour	Suggests the 'stickiness' of practices requires stronger interventions than feedback alone, particularly where feedback is not targeted at practices themselves but at energy use.
CoopRoriz, Portugal http://www.erse.pt/eng/engefficiency/Paginas/default.aspx or http://www.cooproriz.pt/ (from IEA overview study)	Working with CoopRioriz, a cooperative supplying electricity to around 1900 customers with 5MW of capacity. They did a 7 day test (2 hours each) in March 2013 of DSM, aimed at measuring the difference between	Initial opt in was only 1% and so they changed to an 'opt out' strategy and achieved 38% participation. Both test groups were invited to a meeting to explain the project. Both were subjected to higher prices during the peak hours. One was told that participating was good	Both groups curtailed use by about 10% with no statistical difference between them in terms of participation.	Combination of participatory and sociological approaches	Interesting experiment into the use of non-financial incentives, suggesting that they might be as effective as financial incentives in influencing energy-use

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
	economic incentives against communication on its own using a device that could cut off current and so manage demand.	for the community and the other was entered into a raffle where they might win a monetary prize			
Opower Home energy reporting, USA http://www.opower.com/ (from IEA overview study)	A behavioural demand response programme, now one of the biggest and longest running of its kind in the world. Their results are based on 218 large-scale behavioural feedback programs conducted across more than 8 million households and 88 U.S. utilities. They find that behavioural programs similar to Opower are cost-effective for 79 million households, or 61% of the US population, which, at their full economic potential, could generate 19,000 GWh in annual electricity savings and $2.2 billion in end-consumer savings per year, representing 1.6% of current residential use.	Customers are welcomed to the programme with a pack that recommends small changes they can make. They are notified prior to peak events through a medium of their choice, encouraging them to 'join their neighbours' in responding. After the event they are given personalised feedback on their performance and advice on how to improve in future. They claim this delivers improved demand response results and participation at scale, without the need for devices.	Opower claims that utilities can engage all customers in demand response through behavioural demand response. They claim this is possible through the use of smart meters, big data analytics and personalised communications. They claim 16-20% savings during peak events (Opower, 2013).

According to them there are 5 universal truths in dealing with customers, namely that: utilities are not meeting customer expectations, everyone wants lower bills, people look to utilities for energy information, customers value personalized energy insights and everyone wants to know how they measure up | Cialdini's social psychology theory. This approach consistently found that normative beliefs are correlated with behaviour and that normative messages can cause a change in behaviour, despite the fact that people claim they are not influenced by their perceptions of others (Caldini and Schultz, 2004).

Also evidence of segmented marketing approach | Based on the US where air conditioning is fairly widespread. However, they make a strong argument for reaching the 'low-hanging fruit' with relative ease. |
| CHARM, UK http://www.projectcharm.info/studies/#energy (from IEA overview study) | Funded by the RCUK Digital Economy Programme, the programme investigated the novel use of digital | Based in Bristol, where 400 households were recruited door-to-door from one richer and one poorer area with an £80 incentive to participate | The project monitored how much electricity participants used and recorded how often they looked at the feedback | Social norms approach, used injunctive norms, practice theory | Looks at energy reduction rather than shifting but of interest because it uses practice theory and is based in |

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
	technologies to achieve behaviour change. Three areas of research: health, social networks and energy. Energy reduction rather than demand response.	(316 participated in the study). Fed back hourly energy information using GPS, smart phones, energy monitors, websites, emails and text messages about their own usage (group 1), the average usage in the area and the best 20% (group 2) and a control group with no feedback. Also used emoticons to apply injunctive norms. These methods were complemented by ethnographic interviews and focus groups	provided. Found that feedback did lead to long-term energy awareness but only short-term reflection and change. Showed less interest in the concept of saving money (or energy) than in the concept of not wasting commodities. Waste shown to be a more powerful discourse than visibility in terms of changing behaviour		the UK
LEEDR (Low effort energy demand reduction), UK http://www.leedr-project.co.uk/ (a project on the TEDDInet site)	LEEDR is an interdisciplinary 4-year research project that seeks to situate and understand the detail of domestic energy consumption and how it relates to everyday activities energy consumption within the context of families' everyday lives and routines. It also hopes to gain insights into how digital media can be used for energy reduction	Participating households were 'forensically' monitored and modelled – gas, water, circuits and plugs were monitored, temperature and window opening measured. Participants were interviewed on video, had meals with researchers, mapped their activities in the home using dots and maps. Technical surveys were done of each home and photos were taken of houses.	Still doing final analysis of results, building personas based on archetypal practices. Found three sets of user groups in relation to how people interface with controls: 1) people who don't use at all, 2) techies who control everything, 3) reactors who turn something on if too cold or off if too hot	Multiple approaches. Social sciences: Sensory ethnography (mapped activities, photos, video diaries, relationship between energy behaviour and use), Engineering: high resolution whole house energy monitoring, Design: interviews, workshops and thematic analysis to design better intervention measures for the future home	More interested in energy reduction than time of use shifting but used similar approach to that taken in this thesis, though more sophisticated due to its access to financial and human resources which allowed over 4 years of empirical data collection in multiple homes
Intelligent Agents for Home Energy Management, UK	This project seeks to apply novel artificial intelligence approaches to develop	One aspect of the research provided personalised home heating advice to households	Variations in the buildings meant that the thermal model's advice was not	Not explicitly discussed. Appears to be fairly rationalist approach	This project is concerned with energy reduction. The

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
http://www.homeenergyagents.info/ (a project on the TEDDInet site)	intelligent agents that will enable domestic consumers to visualise, understand and manage their energy use.	based on a thermal model of the home (derived from an intelligent algorithm that analysed data from a temperature logger). The model then attempted to calculate the impact of actions by householders (such as turning down the thermostat) (Rogers et al. 2013). The research also tried to understand the mental models that users had of their heating systems by using concept maps, interviews and self-reported behaviour amongst 6 households (Revel et al, 2013 and 2014).	always accurate and so the impact of user actions could not necessarily be calculated. The mental models research uncovered a variety of mental models, differing between users and between users and experts, which were felt to be useful in designing future interventions.	with some social norm theory	interventions are highly technical and concerned with thermal and mental models (buildings and people) rather than practices.
ADEPT (Advanced Dynamic Energy Pricing and Tariffs), UK http://www.oerc.ox.ac.uk/projects/adept (a project on the TEDDInet site)	An EPSRC funded, TEDDInet project, ADEPT looks at how the information potentially available from smart meters may be exploited to the advantage of both the distribution network operator and the customer. We are looking for the best overall outcome in terms of energy demand reduction, not the best 'engineering solution'.	Participants were involved through a series of 6 UK-based focus groups. Householders discussed the general principle of time-varying pricing, and considered six options including a static time-of-use tariff, critical day pricing, real-time pricing, and capacity charging/load-capping. They were asked to consider workability of the tariffs in the context of household routines and any concerns around issues like privacy, control and safety.	Static time of use pricing the most popular because routines could be adapted but then restabilised. Laundry and dishwashing were seen as flexible but cooking was non-negotiable. Concerns around complexity of tariffs, being worse off financially and untrustworthiness of suppliers. Ownership of alternative energy technologies led to different concerns rather than allaying them completely.	Not explicit. An interdisciplinary project but this summary is only concerned with the focus groups.	Participants only being asked to consider the implications of flexibility rather than being asked to try it out
Hook Norton Low Carbon Community Smart Grid,	Hook Norton is a dynamic rural community in	A number of activities were originally planned around	Hook Norton represents a particularly engaged	Not explicit but the village had previously	Parts of projects that have failed are rarely

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Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
UK https://www.ofgem.gov.uk/ofgem-publications/86288/tier1hooknorton-closeoutreportdec2013final.pdf (a project funded by the Low Carbon Network Fund)	Oxfordshire with around 2,500 residents and 800 properties. One of the objectives was to develop and explore customer engagement and incentive programmes, which included a small scale domestic demand response trial	domestic demand response whereby customer would have been asked to alter their energy usage and retrospective investigation would have looked for the effects in the data. However, due to the issues with data inconsistency, it was decided not to pursue this work as the data would have provided inconclusive results.	community, yet rates of uptake have been significantly lower than expected. Issues with data consistency led to the removal of the small scale demand response trial from the project scope. This was primarily due to the lack of confidence that changes in customer behaviour could have been accurately identified and reported on.	been awarded £400k from DECC's Low Carbon Communities programme to help its residents 'decarbonise'. It seems to have been assumed, therefore, that they would be easier to engage but this was not the case.	reported and so are doubly valuable for that. This project demonstrates the danger of assuming that even engaged people will welcome demand response programmes as well as the difficulties of good data collection.
Ashton Hayes Smart Village, UK https://www.ofgem.gov.uk/ofgem-publications/86286/ashtonhayescdrv3.pdf (a project funded by the Low Carbon Network Fund)	The work undertaken was split into three areas: community engagement, network monitoring and data analysis. The project aimed to support Ashton Hayes towards its goal of becoming a carbon neutral community through examining the feasibility of connecting a range of low carbon technologies to the network. It also aimed to explore the relationship between the DNO and the community, establishing a blueprint for community engagement that could be adopted for projects across the country and integrated into normal business practice where	The project sought to engage directly with the community on methods for reducing and optimising total energy consumption, install additional metering to help improve the accuracy and granularity with which total energy consumption was measured, and introduce new techniques to support DSM, including domestic energy-use behaviour changes. The project encouraged the maximum adoption of low carbon technologies without compromising the network. It developed a 'blueprint' for successful between a DNO and a community engagement which is available for use by other projects.	Building a trusting relationship between a DNO and a community takes time and effort and is aided by the use of a trusted 3rd party. The community engagement work was an overall success. However, the planned Demand Side Response (DSR) trial was not achieved due to a delay in the role out of Smart Meters and hence a lack of any means by which to accurately measure individual customer demand and observe the effects of demand shifting.	Not explicit. However, based on community engagement, peer learning, building cooperative relationships. Found that this may save time and costs in other parts of the business (such as the cost of reinforcement and time spent on network planning but that unpaid community volunteers' levels of engagement may fluctuate. The community also benefited from engaging with the DNO, though there was some need for expectation	Although engagement was successful, the DSM aspect of the project was not possible because of a delay in rolling out the Smart meters. It is difficult to know how this successful engagement might have translated into 'non-automated' DSM.

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
	appropriate. The project included monitoring, providing customers with information on renewable generation in the village and promoting demand-side response.			management. It was also very difficult to measure the impact of the engagement except through anecdotal evidence and proxy indicators	
Customer-Led Network Revolution (CLNR), UK: http://www.networkrevolution.co.uk/ and https://www.ofgem.gov.uk/ofgem-publications/45878/clnr-progress-report.pdf (a project funded by the Low Carbon Network Fund)	Part funded by the Low Carbon Network Fund. The largest smart grid project in the UK, worth £54 million. Partners: Durham and Newcastle University, British Gas, Northern Power Grid, EA Technology, Sustainability First and National Energy Action	Working with the 14,000 homes involved in British Gas smart meter rollout. Offering a mixture of interventions including offering solar photo voltaic panels, combined heat and power boilers, air source heat pumps and electric vehicle charging to test effects of dispersed generation and new loads on the grid. Also tested smart meters by offering customers 3 fixed rate tariffs to shift them off evening peak (99% above standard rate) onto daytime (4% below standard rate) or weekend/ evening (33% below standard rate)	Trials only ended in September 2013. Participants received £50 M&S voucher on completion of trial. Initial results suggest participants were willing	Practice theory, economic rational. Testing impact of different tariffs, providing information, automated energy storage. Some customers completed a survey about attitudes towards energy usage.	Smart meter data used to test energy shifting behaviour as well as energy impacts of new technologies.
Community Energy Action, UK https://www.ofgem.gov.uk/ofgem-publications/85014/wpdt1008revised.pdf (a project funded by the Low Carbon Network Fund)	This is an ongoing project, due to end in 2015, the objective of which is to ascertain whether DSM is effective for communities that have demand information and incentives available to them.	They are accessing 10 communities with different characteristics by working with 5 charities in their area specialising in energy, Community Energy Plus in Cambourne, Marches Energy Agency in Shrewsbury, National	They selected communities with a level of low carbon technology adoption so as to assess the impact on demand profiles and how these affect the low voltage network. They are collecting community level electricity	Not explicit but they are incentivising peak reductions and will look to interact with the community to understand key findings and, in particular, to look at the	Using a combination of financial incentives, feedback and engagement to achieve demand response.

Name and location of project	Project summary	How participants were involved	Success of involving them (either in terms of energy or satisfaction)	Theoretical approach	Comments
		Energy Foundation in Milton Keynes, Severn Wye Energy Agency in Gloucester and the Centre for Sustainable Energy as the coordinating charity partner.	network and energy flow data. They will display community and individual energy data which will be shared with the community via a website that will also display energy advice from the charities.	effectiveness of the demand response.	

The IEA report identifies two main design characteristics of interventions from a theoretical point of view, namely, economic and psychological. Under economic approaches, they cluster economic theory, technology push and distributional issues. Some of these are discussed in more detail in **Section 2.1.2** but will be mentioned here. Economic theory is based on the idea that people act rationally when stimulated by the right triggers and that financial penalties and incentives offer such triggers. Strategies for altering behaviour focus around variable tariff structures. The second approach is to push the technology deemed necessary for a more robust or resilient smart grid but where the benefits to consumers are less obvious. Challenges for these approaches centre on adoption and educating consumers to realise the economic benefits of changing their behaviour. The third set of issues, though considered less often by most interventions, is those around the distribution of costs, risks, rewards and benefits. The problem tends to be that current DSM approaches do not adequately consider or benefit consumers.

Moving onto psychological theories, they group a fairly diverse range of approaches which will be mentioned here in very quick succession. Value/ action gap theory tries to explain and then deal with the difference between an individual's values and the way they act. This approach assumes that people always act in accordance with their values. Providing energy feedback on the other hand, is based on the notion that making energy use behaviour visible and then providing the necessary information required to improve that behaviour will lead to an automatic change. The idea here is that lack of information is the barrier to change. Price incentives and the creation of new norms also inform this approach, the latter in particular when linked with active and peer learning (for example, involving individuals or groups in measuring and comparing energy use with each other with a view to altering their behaviour). Targeting behaviour in context is another type of intervention and recognises that people inhabit homes. As such it targets three kinds of actions: habitual (how appliances are used day-to-day), one-off (usually around purchase decisions, changing energy settings or replacing old items and generally based on the notion of efficiency) and retrofitting (focused around insulating and ventilation). These are 'people focused' interventions, relying on people taking actions. However, some projects in this category had experimented with providing technology and appliances like solar panels and washing machines to enable them to really test their ideas.

Another approach tries to turn the smart meter into something meaningful for those who feel they do not need it, referred to as meaning attribution. This means focusing on the mutual and collective benefits of DSM, which requires that these are effectively communicated. However, this can be a

very intensive process, involving engaging people through energy champions, workshops, individualised support and problem solving, often based in the home and on understanding small differences between users which are credited with key explanatory power. There are other ways of making energy part of something meaningful, such as connecting it with role models or making it a part of a larger project that people want to participate in. Moving on again, the social norms approach is quite well known and increasingly widely used. It involves trying to influence behaviour by providing information about what most people do. This can be combined with other approaches like practice theory, which is the approach this thesis takes and will be described in detail in **Section 2.2**, or social capital theory, which works through getting people to involve others like them in projects they participate in. The report also describes OPower's segmentation theory approach, which allows them to target their communications with customers in order to maximise their motivational impact using four key principles, making sure that their messages are simple, relevant, actionable and motivating. Finally, they discuss design theory, specifically design with intent, which states that through the design of products and/ or services, behaviour is designed as well. The report does not try to promote one particular approach but does serve to highlight the importance of selecting a theoretical point of view, which is what this thesis will do.

Meanwhile, there is current work going on in this area. Huge amounts of energy research have been funded, usually focused either on understanding how to improve the energy infrastructure or on understanding how to get people to reduce the amount of energy they use. Increasingly, however, interdisciplinary research is being funded, combining engineering approaches with work that is trying to understand the nature of demand and how flexible it might be from a social sciences perspective. In addition to the projects reported on in the overview papers mentioned above, **Table 3** also lists some current projects in two particularly relevant programmes, namely: the Low Carbon Network (LCN) Fund, Ofgem's low carbon innovation fund for Distribution Network Operators (DNOs) (https://www.ofgem.gov.uk/electricity/distribution-networks/network-innovation/low-carbon-networks-fund), and the Transforming Energy Demand through Digital Innovation (TEDDI) programme (http://teddinet.org/), funded by the Engineering and Physical Sciences Research Council (EPSRC). These will be briefly discussed.

The LCN was announced by Ofgem (the Office for Gas and Electricity Markets) in August 2009 to help drive innovation and new technology to deliver the electricity networks of the future. The LCN provided up to £500 million over five years. A further £100 million was made available as a discretionary award for projects which were particularly valuable in helping the networks adapt to

climate change whilst also providing security of supply and value for money to consumers. The objective of the fund was to encourage DNOs to try out new technology, operating and commercial arrangements. The fund wanted to replicate the incentives on unregulated companies to innovate so as to enhance the business case for low carbon technologies (such as renewable generation), allowing DNOs to capturing the benefits of DSM and active network management on their networks (Low Carbon Network Fund 2013). Four projects have been selected to highlight the 'people-based' aspect of the LCN fund and are outlined in **Table 3**: Ashton Hayes Smart Village, Hook Norton Low Carbon Community Smart Grid, Community Energy Action and the Customer-Led Network Revolution (CLNR) project. Of these, the last is the most pertinent and so is discussed in a little more detail here.

In the context of this work, CLNR is a highly relevant, interdisciplinary study taking a socio-technical approach and using practice theory to understand, amongst other things, the flexibility of domestic energy-use practices. This is the UK's biggest smart grid project, worth £54 million and is a collaboration between academia and business, led by Northern Powergrid, the electricity DNO for the North East and Yorkshire. Learning outcome 2 or this project evaluates the extent to which customers are flexible in their load and generation, and the cost of this flexibility. Three types of customers are identified: domestic, small and medium-sized enterprises (SMEs) and customers with low carbon technology installed, including heat pumps, electric vehicles (EVs) and smart appliances.

This project was conducted in parallel with the study reported in this thesis but obviously had recourse to a much higher level of resource than the study reported here. The project was able to conduct surveys, as well as 250 face-to-face interviews and had 131 residential participants (Cardwell, J. 2012). Interviews about electricity use and flexibility were conducted in people's houses and included a tour of the household to understand how appliances and rooms were used in everyday life. Researchers found that the bulk of electricity use was associated with the following practices: cooking, heating and hot water, lighting, bathing, chores, entertainment, standby and 24 hour loads. Electricity use peaked between 4pm and 8pm, a finding which was not dependent on the household type, tenure or location although these did influence the flexibility to move electricity use out of the peak period, with rural, off-gas participants and lower income groups being less flexible than urban and high income groups. Apart from these, other demographic variables and attitude did not appear to influence flexibility. However, it did vary depending on the practice being undertaken. Dishwashing, chores and laundry were the least fixed practices and responded well to TOU incentives to shift them out of peak times, whilst cooking and eating were more rigid, particularly in

households with children (though there was limited flexibility amongst those who did not work a conventional work day week).

There was some evidence that TOU tariffs were able to reshape energy-use practices more generally, as the longitudinal study revealed overall reductions in energy use, as well as shifting out of peak, but this finding had not been fully understood yet. There was also evidence of huge variations even within the peak period and within the same household. Participants reported that connectivity was increasingly important, the traditional distinction between work and home was becoming less obvious and that concern about rising energy prices was a prominent feature of how people thought about electricity use. They also found that household occupancy was the most significant indicator of energy use, with an emerging trend in 'step families' meaning that occupancy could vary a lot even within single households, making energy use sometimes difficult to predict (or to understand without investigating households more closely). Similarly to the study in this thesis, they discovered four ways in which practices could be made flexible: shifting the time, shifting the place, changing how the practice was done or stopping the practice altogether. Where practices do not respond to the time of use tariff, this appears to relate to: practices needing to be carried out in a conventional way, the rhythms of daily life (such as leisure time at home in the evening) and activities that connect householders to external structures or social groups, such as work, school and social activities. This finding suggests that TOU tariffs need to take into account other schedules and structures if they want to maximise flexibility (Cardwell, J. 2012).

Another relevant group of projects is being funded under TEDDI. These projects are now grouped under TEDDInet, a network for the TEDDI Projects. Started in September 2013 for four years, TEDDInet is an EPSRC-funded network to support the work of the twenty two individual TEDDI projects, which include four year projects (mostly finishing in 2014), shorter two year projects and (Build)TEDDI projects. TEDDInet involves TEDDI projects through workshops, a website, contributions to reports, a newsletter and general networking. This is not a demand response programme as such but a network of projects looking at the issue. There are twenty two projects listed on the TEDDInet site but only a few of them facilitate a greater understanding of active demand response (as opposed to automated demand response). A selection of these has been listed in Table 3. Of these, the most relevant in terms of methodology is the Low effort energy demand reduction (LEEDR) project, an interdisciplinary four year research project that sought to understand domestic energy consumption and how it relates to everyday activities. This project was more interested in energy reduction than time of use shifting but used a similar combination of

methodological approaches to those taken in this thesis, though they were more sophisticated and spread across more households due to the projects access to far greater resources which allowed four years of empirical data collection. The project also had a design focus so that observations were used to design products that might help to lower energy use in ways that were sympathetic to the learning that had taken place during the project.

The main theoretical perspective was that of sensory ethnography, which takes an ethnographic approach to data collection but also attends to the "experiential, affective, material and social elements of the persons and environments" (Pink, et al. 2013: 28) being researched. This approach recognises that energy is consumed within households, which they describe as a "constantly evolving ecology of place" (Ibid: 37). The aim is to move away from constraining participants to view the meaning of their lives and homes through a 'green' lens towards constructing meaning and knowledge about what is going on in negotiation with participants in the context of their everyday lives. They claim that the home is a "subjective sensorial, intangible concept, which cannot be described, but can be re-enacted as a sensory experience… Therefore rather than trying to 'persuade' participants to set a lower temperature on their thermostat in response to persuasive prompts (which would be unlikely to endure beyond the first cold period, or the reaction of the first occupant who senses thermal discomfort), (they) have based (their) understanding in the question of how participants already use technologies and resources in their homes to produce comfort along with their existing uses of digital media" (Ibid: 37). This results in some ingenious design concepts such as the Acclimatiser (a mobile phone app to increase the responsiveness of heating systems while lowering energy consumption) or Heat Me bags (heat retaining bags full of warm clothes, blankets and other 'snuggly' objects hung on radiators which offer a trade-off between cooler household temperatures and the sensory anticipation of contact with warmed items). The designs are informed by the sensory ethnography and use what is already being done in the home (such as engaging with the phone whilst moving through the house, warming clothes on radiators) to create solutions.

Having reviewed some of the approaches taken so far, the thesis will now explore why a study like the one currently being reported offers a valuable contribution to this area of study.

1.3   Demand response's technical challenges

Despite its importance, DSM has been slow to take off. This section and the next will outline the technical and social reasons for this, so highlighting the fact that there is scope to broaden the range

of approaches to demand response, particularly when applied to domestic, rather than industrial and commercial, settings.

There are several technical reasons for the slow spread of demand response. Firstly, according to (Torriti et al.2010) there are technical and infrastructural issues: energy reduction capacities are not well understood and the technologies and infrastructures required to achieve them are expensive. Strbac (2008) suggests that an absence of metering, information and communication infrastructure, lack of understanding of the benefits of DSM, its lack of competitiveness in relation to other approaches, the required increase in the complexity of system operation and inappropriate market incentives have hampered the uptake of DSM. Secondly, highly liberalised energy markets in Europe mean the benefits of investments in one part of system often accrue to those in a different part of the system (Shaw et al. 2009) which makes incentivising particular schemes highly complex. Reforming the energy market is an important part of implementing DSM and should not be underestimated but is an issue for the energy supply industry and government so will not be dealt with here.

Thirdly, the objectives of demand reduction and demand response sometimes work in opposite directions. While one of the overall aims of DSM is to reduce energy, the focus of demand response tools is on the size of the shifting potential or saving rather than the absolute level of demand. As there is no necessary link between demand response and reduced energy usage (Alexander 2010, Boshell, Velosa 2008), demand response strategies sometimes lead to increased overall demand. Related to this is the fact that high levels of consumption provide bigger loads and so increase shifting opportunities, as well as increasing overall energy sales, both of which serve to disincentivise the energy supply industry working to make reductions (Alexander 2010). However, although shifting the time of electricity use may not reduce the absolute amount of energy being used or may even entail a slight increase in energy usage, the fact the energy being used would be from low carbon generation would still imply lowered emissions, which mitigates these concerns somewhat. Darby also warns that the more demand reduces within a 'time of use' pricing scenario, the lower prices will drop, in turn lessening incentives for customers to participate (Darby, McKenna 2012), (though this may equally well be seen as an indicator of success, as it would imply a strong uptake of demand response).

Fourthly, Albadi, El-Saadany (2008) summarise the different demand response programmes and their costs and benefits from the stakeholder point of view in **Figure 3.** The figure refers mainly to business stakeholders and shows that while the range of currently available schemes have reasonably substantial benefits to the electricity supply industry (price reduction, capacity increase, deferred infrastructure costs, reduced outages, customer participation and diversified resources , there are limited benefits to energy consumers (incentive payments and savings). These set against significant upfront and running costs (the most significant of which, for residential consumers, is probably inconvenience). In a domestic setting where practices are fairly rooted and energy is both invisible and cheap (relative to other domestic expenditure and the fuel poverty debate notwithstanding), it remains to be seen whether these costs are acceptable.

Figure 3: Costs and benefits of Demand Response Programs for Stakeholders
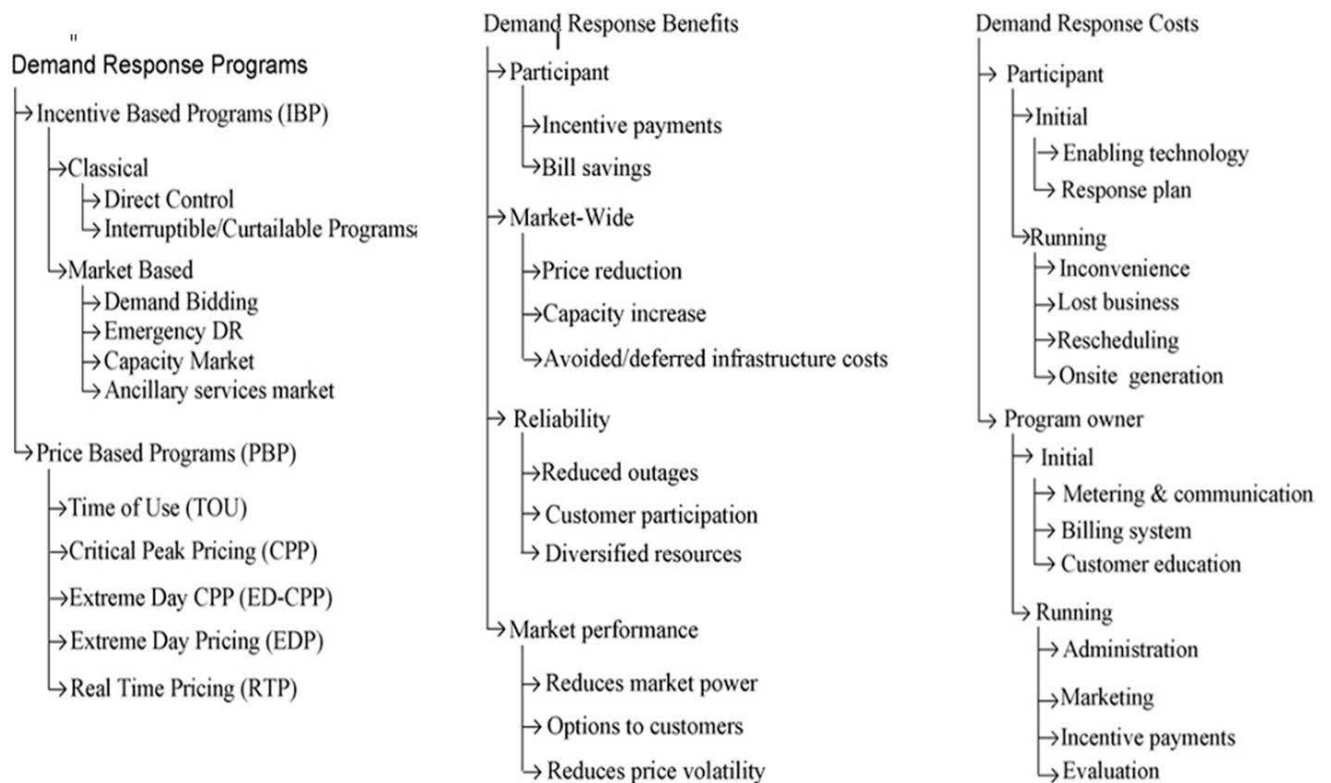
Source: (Albadi, El-Saadany 2008)

Fifthly and also evident in **Figure 3**, from the point of view of the electricity supply industry, demand response is treated as another 'resource' (Faruqui, Hledik 2007) in the hope, or assumption, that it will become another 'controllable entity' from an operational point of view. However, the complexity of demand response, particularly in residential settings, means it is unlikely to be as

controllable as has been suggested by those pushing the associated technology, such as smart meters. In fact it is unclear that customers, who are treated here as passive consumers and just one part of a complex technical system, will perform and conform as expected. Overall then, this figure serves to illustrate the wider point that the emphasis tends to be on the technology rather than on people and this is a significant omission. As will be seen in the pages that follow, people cannot be treated as a controllable part of a system that appears to bring them little benefit. The next section will show how the current tools, while useful in some contexts, may actually limit the options available to demand response. The aim in doing this is to point out the gap that this thesis will start to address.

1.4   Demand response's limited approach

Demand response faces more than technical issues. There are significant challenges in terms of getting people to accept, participate in and respond to the various schemes. Getting the schemes up and running is the first challenge as it is not clear the technology will be accepted. In the Netherlands, for example, despite a history of strong environmental action and energy efficiency savings (Boshell, Velosa 2008) customers protested against the government's mandatory rollout of smart meters on the grounds of privacy concerns and the installations were made voluntary.

Even where the technology is not resisted outright, getting people to sign up to DSM is difficult. Time-of-use pricing (TOU) is not popular, particularly with the higher end users, or those who use the most energy, whom it would probably be most helpful to have on these tariffs. Despite appeals to customers to sign up to a 'fairer' system where people pay for what they use when they use it (Faruqui, Hledik 2007), even in the US which has been offering TOU tariffs for years, voluntary uptake is still only 6% in Maryland and similar in other parts of the country (Alexander 2010). Even in recent trials, response to 'opt in' systems can be as low as 1%, such as was the case in the CoopRoriz project in Portugal (Mourik, Rotmann, 2013), though when the system was changed to an 'opt out' arrangement, participation went up to 31%. In a privatised and competitive electricity supply industry like the UK, it could prove even more difficult to get customer acceptance as different providers might provide different incentives, encouraging customers to shift suppliers (Shaw et al. 2009).

The main challenge, however, is getting people to respond to demand response requests when they are made. The next two subsections will review the two main sets of tools on offer: automation, smartness and control and price, information and feedback. While these have achieved a certain

success in the commercial and industrial sectors, it is felt unlikely that they will result in the level of demand response required by a significant proportion of renewables on the grid, particularly in the context of domestic demand.

1.4.1 Automation, smartness and control

The tools in this category aim for a world in which either people are excluded altogether and the system is managed invisibly or behaviour is a predictable part of a managed system. However, there are two significant challenges. Firstly, it is not clear how much shiftable load exists in a domestic setting, particularly in the UK. Many of the techniques in this category are used with commercial customers, where automation has had a positive impact on load curtailment potential but residential customers are a much more diffuse group, each of whom individually will not shift a significant amount of energy. Goldman et al. (2002), for example, found that commercial customers in California and New York were most likely to target air conditioning and lighting to provide quick load reductions. Other shiftable loads were plug loads, process loads, refrigeration, motors and elevators. Most of these options are not available to residential customers in the UK and the ones that are (lighting and plug loads) may constitute essential, unshiftable practices in a residential setting.

In their study Lutzenhiser et al. (2010) claim that the 'usual shifting suspects' were worth focusing on from an energy point of view, namely air conditioning, clothes drying and pool pump timing. Once again, however, in a UK context these opportunities are limited as the number of residential air conditioners, pool pumps and even tumble driers is limited and even in the US would presumably be restricted to higher socio-economic groups who might not sign up to TOU. In a cool country like the UK load shifting opportunities are more likely to present themselves in relation to heating, as electric heat pumps become more widespread. However, there is already evidence that people do not like heat pumps (Hinton 2010), suggesting this shifting opportunity may be further off than hoped. Electric cars, another shifting opportunity for the future, have also been slow to penetrate the market, though are expected to perform more strongly in future. The first question that arises, therefore, is a technical one about whether the available technology can access enough residential demand response to make it worthwhile in energy terms. Accordingly, Lutzenhiser et al. (2010) suggest that "small-time behaviours that take lots of customer effort but have miniscule effect on energy use, should not be promoted." (Lutzenhiser et al. 2010: 14). Nevertheless, as 'smart' technology improves, so the personal effort required to manage demand will be lessened as some of

them become automated. This may also improve the appeal of technologies like heat pumps and electric vehicles, which will in turn improve the usefulness of DSM.

Secondly, it is relevant to consider how people respond to systems of control and automation. To find out, residential DSM trials (Isaacson et al. 2006, Hammerstrom 2007, Star 2006) have started to consider the residential energy user's experience. One of the two main approaches taken in these trials was to automate the response. This approach required that users cede control of some of their appliances so that participation could be invisible and simple and would not require any form of behaviour change. However, there were issues around user acceptance, technology breakdown and how the technology was used (McKenna et al. 2011). The second approach, which is discussed in more detail in the next section, was to elicit a response through price, either through automation or otherwise.

Taking control away from the user, however, may not work. Cole (2008), in his discussion of agency in relation to comfort and buildings, suggests that a key element of being comfortable is the ability to control one's environment. This is despite the fact that people are not very good at managing their thermal comfort levels in comparison with an automated system and are therefore actually likely to be less 'comfortable', as technically defined. Cole argues that even something as palpable as thermal comfort can be participatory and involve users in managing their own comfort. He also claims that comfort is social, or collectively understood, and so includes features unrelated to traditional definitions of comfort, such as views of nature or opportunities for interaction. There are two significant points to take from this. Firstly, whereas comfort has been defined by engineers in purely physiological terms and is considered to be deliverable by technological means alone, there is a large literature on comfort that contests this view such as Hinton's review (2010), showing that technical solutions do not always work in social settings. Secondly, it shows that people do not necessarily embrace automation and control, preferring to participate even when this may negatively impact on comfort levels.

Fundamentally, the tools in this category are most problematic perhaps because of the way the user is positioned in relation to the system. In most cases the user is either removed entirely or seen as an element of the system, to be manipulated and controlled as part of that system. This makes sense from an engineering point of view but it is likely to be resented by users and does not take account the deep-rooted nature of energy-use practices.

1.4.2 Price, information and feedback

Whereas the tools in the previous section aim for a world where the customer is largely uninvolved or at least responding as part of an automated system, the tools in this category include customer participation at various levels. Sometimes used separately but generally agreed to strengthen each other (Darby 2006) these are perhaps the most familiar market-based and/ or psychological strategies used to try and change behaviour. However, while some studies claim they have realised their aims, just as many recognise the complexity of the relationship between these tools and behaviour change. They work on a number of assumptions, often interlinked, such as the idea that making energy visible through some sort of feedback like metering, pricing or thermal imaging will provide information to the user such that their awareness will increase and they will change their attitudes and therefore their behaviour. This approach takes the philosophical perspective that the user is a rational, utility maximising individual whose behaviour is therefore predictable. There are presumed to be direct relationships between these variables so that an increase in price or information will lead to a concomitant change in attitude and behaviour. However, there are problems with this approach.

Price is hailed as being an effective tool to change energy behaviour. However, there are few alternatives to using energy, energy-use practices are deeply rooted and the financial reward for participation in existing schemes is minimal. Even where price signals are understood and visible, depending on price elasticity, they may be weak. This is particularly true where alternatives do not exist in the short term, such as when the only option is to use electricity from the grid, no matter what the cost. In this case the signal would have to be made very strong by means of substantial price increases and this may lead to social disadvantage and sometimes even social unrest. In a weak economy, high energy prices are particularly unpopular. Also, while Goldman et al. (2002) found that saving money and access to economic incentives were amongst the strongest motivations for participation in load curtailment programmes for commercial customers, this may be less true in a residential setting where practices may be rooted in more complicated meanings which could be harder to shift. Even where considerable efforts are made to attain benefits from participating in energy saving schemes, the amounts of money involved are usually relatively small and volunteers are often disappointed in how little money they manage to save (Lutzenhiser et al. 2010).

Even assuming price did work as is often assumed, as most programmes testing variable pricing have found, there is a problem in attracting higher end energy users in a liberal energy market to take up pricing tariffs such as time of use (TOU) as it involves them in higher payments. However, as they are

more likely to have high shiftable loads (Lutzenhiser et al. 2010, Faruqui, Hledik 2007) it is of fundamental importance that they participate if pricing is to work. Also, even advocates of TOU suspect that the effectiveness of pricing may 'wear off' over time, particularly when several peak days follow each other (Alexander 2010, Lutzenhiser et al. 2010). On the other hand, it might be true that households learn to cope with managing different pricing bands over time, or find ways of altering their practices. The still open question here is whether familiarity breeds competence or contempt.

This is not to say that these tools are entirely ineffective. Although price may not produce action it does motivate the attainment of higher levels of knowledge. These are associated with higher commitment, which has been linked to behaviour change (Heberlein 1983). Price may therefore have a useful role to play in producing change. However, as is clearly demonstrated by residential electrical demand response projects, though users did respond to price, it was sometimes in counter-intuitive ways and overall their responses were not well understood (McKenna et al. 2011). In addition, price responsiveness lessened over time, suggesting that the level of demand responsiveness required for renewable generation could probably not be fully accessed by this method (Ibid.). Relying entirely on price as a mechanism to change behaviour, therefore, is a weak strategy.

Even for those who advocate this approach admit it is not straightforward. Darby (2009) despite asserting the efficacy of a combination of price, information and feedback to produce some change in customer behaviour, raises more additional issues around information and feedback such as the question of which types of feedback are best; displays, billing or something else. She also highlights the problems around data protection and ownership, the changing relationship between suppliers and customers and the fact that much of the technology being advocated for use in DSM is pushed by suppliers rather than being pulled by customers.

Information appears to be even weaker than price. Lutzenhiser et al. (2010), using what they term their 3Cs framework (customer concerns, capacities and conditions) tried to evaluate changes in actual energy usage as well as behavioural changes. They showed that while pricing had a small effect, information seemed to have no impact on actual energy use. This is partly because it is difficult to attribute causality when looking at the impact of particular interventions on quantitative, individual energy readings as these can be affected by so many factors. Other explanations provided by the paper were that the control group might have accessed the same information and so have

been influenced by it or that the volunteers were self-selecting and may therefore have made all the behavioural changes possible prior to the study, but these are fairly unconvincing. It is rather more likely that providing information did little to change behaviour. Although Strengers (2010) found that information only signals reduce peak demands, she posited that this was because people felt involved in the programme, rather than that the information itself was instrumental in influencing demand.

The information on energy that is generally available is contradictory, lacks visibility and is often confusing. While there is information about energy reduction available, people are simultaneously being bombarded by other signals that encourage energy consumption and so it continues to rise steadily (Loveday 2008). The signals, like price may also be invisible, such as when the appliance is used by one person but has been purchased by someone else (Warde 2010), in which case the user may have no idea of how much energy the appliance uses, or where the energy use of a product is not made clear by the manufacturer. Price signals can even be obscured by the very instruments meant to illuminate them, such as when metering and billing make it too complex to understand how much energy is being used for what and how much it costs. Not only is the message confused, therefore, but the means of conveying it is frequently inadequate.

Some key questions arise in these studies. To start with it seems that the information provided often does not answer the questions people have. Customers in Lutzenhizer's study (2010), for example, wanted to see the results of their actions in the bills they received but these were not apparent. There is a danger that participants notice how little money they are spending on energy, relatively speaking, and how much effort it takes to change things and just decide that it is not worth it. Hargreaves' participants (2010) also had technical questions such as whether it was better to have a high wattage kettle boiling for a short time or a low wattage one boiling for a long time. These questions relate very fundamentally to the relationship between people's everyday practices and their energy impacts.

In their introduction to *The Habits of Consumption*, Warde and Southerton (2012) list five reasons why normal consumption models (on which pricing programmes are based) are limited. Firstly these models equate consumption exclusively with purchase (and a particular moment in time when a decision might be made) rather than use (where consumption is an integral, habitual part of everyday life). Secondly, they point out that purchase 'decisions' are not merely personal or based on individual financial resources but that people conform to social norms and will vary their

requirements accordingly. Thirdly, choices are not independent of each other but rather their sequential and cumulative nature precludes some options and favours others. Fourthly, some items are acquired repeatedly because they are used up and are subject to the "logic of replacement" (Ibid: 6). Fifthly, the role of deliberation is easily over-emphasised and a great number of ordinary items of consumption like electricity and water are both acquired and consumed without thought, "invisible, unremarkable and unrecorded at the point of purchase or use" (Ibid: 6). As has been shown by the field of behavioural economics, people do not make rational calculations on the basis of perfect knowledge in the light of "fixed intransitive preferences" (Ibid: 15).

Finally, there are some more ethical issues which come up in more qualitative studies around energy usage. Briefly, these include the fact that price signals can be seen as unfair, promoting a particular social order and inculcating a certain moral view: why should 'green' products cost more, rich people be allowed to do as they like or women be expected to manage shifting the energy intensive household chores, for example? The particular economic, class and social structures within which energy is used, are generally seen as unimportant by the electricity supply industry, but are in fact a fundamental part of energy-use practices.

As has been seen, demand response has an important role to play in offsetting the problem of renewables' intermittency and thereby reducing carbon emissions. However, the current tools for motivating demand response are limited in scope. Despite the fact that these tools are supposed to change behaviour, Uitdenbogerd et al. (2007) in their literature review of energy related intervention success factors point out that they can find no intervention strategy based on an analysis of behavioural determinants. They surmise that this is because many policy implementers focus on the instrument of change rather than on the change itself. One could add that these instruments are often used without a specific theory of change or a clear understanding of the status quo. This introduction has shown that demand response is in danger of making these errors. The point of doing so, however, is less to denigrate the current system than to highlight the opportunity to broaden the range of demand response options available by investigating alternative approaches.

One of the tasks necessary to do this is to better understand current demand. Richardson (2010) took a significant step forward in this respect in modelling domestic appliance use. However, the question as to how and why appliances were being used remained unanswered. This study will continue this work by remaining focused on domestic demand and will start by stepping back and trying to establish how energy is used. It will then ask what impact shifting energy use has on

energy-use practices and will consider what lessons might be learned by policy makers and energy supply companies. This thesis will use a practice theory approach to see if it is possible to widen the range of demand response options beyond that offered by pricing and automation. With this in mind, it is possible to present the aims and objectives of this work.

1.5   Aims and objectives

The overall aim of this work is to investigate the possibility of increasing domestic demand response by better understanding energy related practices in the home. Within this, the objectives are to:

- Examine current domestic energy-use practices

- Test the flexibility of energy-use practices

- Investigate the consequences of flexibility on practices

- Assess the implications of these findings in the context of demand response

- Contribute towards the development of data collection processes in the context of a practice theory approach

- Simultaneously represent quantitative energy data and qualitative practice data

The thesis will now present a literature review, the aim of which is to locate a theoretical approach capable of informing the methodological approach, data collection and data analysis.

2   Literature review: Locating a theoretical approach

Having ended the last chapter understanding that current demand response measures fail to take people into account, it becomes necessary to address this issue. This chapter identifies a theoretical approach appropriate for the study of energy consumption and how this might be shifted. The aim was to choose a theoretical position which could encompass the individual, social and technical aspects of energy. This chapter justifies the selection of practice theory both as a means to describe the status quo and to think about change. As the location of agency determines where the capacity to change anything lies and is therefore central to selecting such a theoretical approach, the chapter starts with a definition. It then goes on to examine alternative approaches to understanding energy behaviour before explaining why practice theory was chosen. As practice theory is complex, considerable attention is given to explaining it and discussing its main features. Finally, the chapter outlines what it is about practice theory that makes it so suitable for this study.

2.1   Understanding behaviour

Despite the increasing weight of evidence of the link between increasing consumption and impacts on the environment, most attention has been focused on efficiency gains (Warde, Southerton 2012) rather than on questioning what underpins that consumption. To start with it is necessary to recognise that there are many possible approaches to understanding energy use (Jackson 2005) and therefore also to thinking about how to change it. Some of these will be described after a definition of agency.

2.1.1   Defining agency

The dictionary definition of agency (Concise Oxford Dictionary 1999) is that it is "the state of being in action or of exerting power; operation: i.e. that someone/ something is able to take action (which means they/ it must be an actor) or can exert power on someone/ something". It is also "a means of exerting power or influence; instrumentality: i.e. that someone/ something is able to change/ alter something because they have power over it, are able to influence it in some way or are an instrumental part of it". If something has agency, therefore, it has the power to change things.

There are several parts of this definition that are of interest. To start with, agency is the state of being in action or exerting power or instrumentality. In other words, agency lies with the agent and denotes an active rather than a passive state. This suggests that wherever agency lies, there too lies

the power to leverage change. Even in a system that appears not to be changing, therefore, one should be able to identify leverage points.

Next, the definition suggests that agency lies with things as well as people; that is, that either things or people can be 'actors'. This corresponds with Actor-Network Theory (ANT) (Latour 2005) which claims that 'actors' (or agents) can be living and non-living. 'Things' in this context denotes more than just single objects. It could also refer to collective or structural 'things' like society or infrastructure respectively. This greatly increases the possibilities for leveraging change. Also, if agency is located in living and non-living things, the implication is that it can be located anywhere

Finally, it suggests that instrumentality can be located within or outside of what is being changed, though whether it is possible to stand outside the system and change it is a matter of dispute (Shove, Walker 2007). All of this suggests that theories of change suggesting singular causal relationships are likely to be limited at best. Agency is not, in itself, a theory of change, however. It does not explain how or why change happens. This means it is necessary to select a way of thinking about change.

2.1.2 Three major approaches to investigating energy behaviour

There have been three dominant approaches to investigating domestic energy (Hargreaves 2008). First, there is the technological approach to changing the world favoured by engineers. This approach defines the problem to be solved (comfortable interior temperatures, for example, would be defined in physiological terms (Cole 2008, Hinton 2010, Gram-Hanssen 2010a, Wilhite 2009, Shove 2008) and then works out how to solve it using technology. In this approach users are expected to conform to particular parameters or are seen as 'problems' that disrupt the smooth operation of the technology or technological system. Tools for change in a domestic energy context would include automation, efficiency, design, information, price and feedback. Although it is not always recognised by the implementers of this approach, agency lies with the technology, though users typically wrest control back from the system in various ways (Cole 2008).

Next there is the social but individualised approach centred on the agent or individual as either an economically rational being (Shaw et al. 2009, Rad 2008) with access to all the necessary information to make the 'right' decision, or a psychologically coherent being (Devine-Wright 2005, Devine-Wright 2007, Devine-Wright 2009, Macey, Brown 1983, Nisbet 2008, Abrahamse 2005) with an identifiable and stable (though alterable) set of values and attitudes who, again, will behave consistently by applying these to their decisions which, again, are based on fully accessible (and accessed)

information (Desmedt 2009). The problems of consumption are unformulated in this approach; ways of life are inert and consumption static and pro-environmental consumption is a matter of voluntarily making less environmentally damaging choices (Warde, Southerton 2012). Wider societal or systemic change according to these models results from the accumulated choices of individual consumers acting on the basis of behaviour change 'tools' like information, awareness raising and pricing. Some of the impacts of these have already been discussed in relation to DSM tools.

Finally, the third typical approach to analysing domestic energy use is also a social approach but locates agency in culture or society rather than the individual. It is variously known as the cultural (Gram-Hanssen 2010b), contextual (Hargreaves 2008) or structural (Shove 2010a) approach. These approaches typically focus on the collective structures of consumer behaviour, examining how identity, status and feelings of association are created and sustained through this behaviour. Individuals are relatively powerless in these models where the society one lives in has more deterministic agency than individual choices. Tools for change tend to focus on the macro level, for example: legislation, policy making, international agreements, and design standards and on the broader social level, for example: social/ segmented marketing (DEFRA & DTI 2003, DEFRA 2008); or community-based, peer group or social networking approaches (Payne, Williams 2008, Devine-Wright 2009b, Middlemiss 2006, Georg 1999, Wall 2007). This approach has been critiqued for focusing too much attention on 'conspicuous' consumption at the expense of the generally more 'inconspicuous' consumption usually indicated by energy usage (Gronow, Warde 2001).

2.1.3   A socio-technical approach to energy use

Each of the above approaches has particular strengths and it is not the contention of this work that they are invalid, merely that they are limited. More recently, some writers on energy (Shove 2008, Wilhite et al. 2000, Gram-Hanssen 2007, Keirstead 2006) have started to adopt a socio-technical approach to understanding energy usage, one that combines aspects of all three of the approaches looked at so far and recognises that agency is located in multiple places (Wilhite et al. 2000, Jelsma 2003, Shove 2003). They argue that the energy system is a socio-technical one and that both the living and non-living agents within it have agency and co-evolve over time.

An example may help to demonstrate the point. Consider the location of agency involved when a person watches television to relax. Normally the person would be considered to have agency and so would choose what to watch or whether to watch at all. However, considering this practice within a broader socio-technical context it can be seen that what is watched, and when, is moderated by

society, so that society can be attributed some agency. Similarly, the television itself has agency as it may limit or facilitate access to multiple channels. Even the remote control influences what is watched, who watches it, when and how long it is watched for, what other functions may be available on the television, how many televisions there are in the house and so on. What is illustrated by this example is that both living and non-living things, that is, people, technology and their surroundings, are active and therefore they share agency and so it makes sense that the system as a whole is socio-technical. As agency is shared across this socio-technical system, it is possible to see how, over time, the various components of this system might develop sympathetically in a way that is mutually reinforcing. In this way the elements of the system co-evolve and may seem to stabilise the status quo. On the other hand, as there is a spectrum of agency, interventions are possible at multiple points (in this example, they could involve changes to the person, society or technology). Depending on what new elements are introduced into such a socio-technical system and how this is done, so the system may evolve just slightly or change more radically.

The approaches discussed here so far are summarised in **Figure 4**, the axes of which are agency (low to high, insofar as individuals are concerned) and structure (ranging from individualistic to structural, so corresponding to this distinction as it was made in **2.1.2**). In the bottom left hand corner are technical approaches which tend to be individualistic but want to locate agency in the technology (so that users are fairly passive). Solutions are all technically driven and focus on optimisation and efficiency. The role of structure is not generally recognised. Where users are recognised they are generally seen as 'scripted' by the technology (Hinton 2010) or treated according to the economic or psychological approaches already discussed and which, in turn, appear in the bottom right hand corner. Here the agency is high and is firmly attributed to individuals, who are seen as rational, utility maximising consumers who have the power to change the system through their individual actions. They act based on information which raises their awareness and leads to classifiable values. These are stable across different contexts but could be changed should the right incentives or penalties be administered.

Figure 4: Spectrums of Agency and Structure in four Approaches to Understanding Energy Use
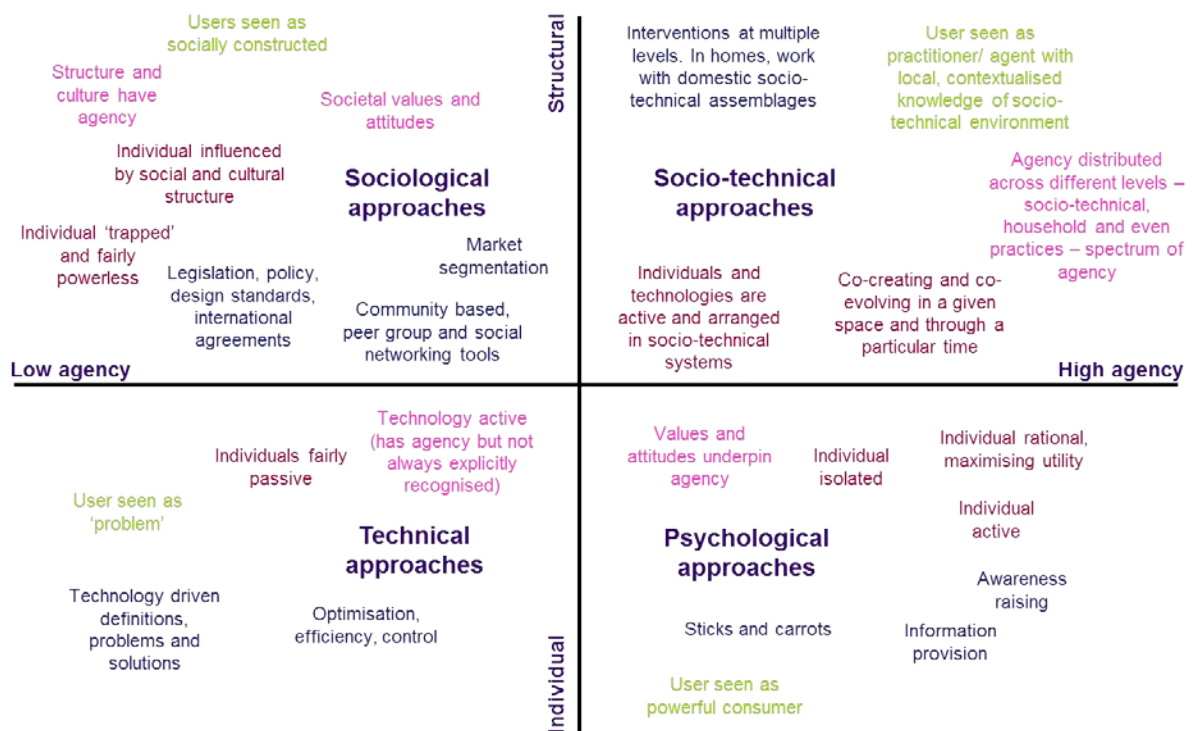
Source: Inspired by a summary table (Hinton 2010: 40)

On the top left of the figure are structural approaches where agency is located in society and individuals are seen as relatively powerless, socially constructed or behaving in line with societal norms, which will be changed by macro approaches such as those listed and discussed above. Finally, on the top right are the socio-technical approaches in which agency is recognised as being widely distributed between all three of the areas discussed so far, so that agency is spread across individual knowledge, institutional knowledge, societal norms and technological systems. Practitioners are seen as skilled and knowledgeable about their local contexts and tools for change need to recognise that individuals, societies and technologies are located in mutually interdependent and co-evolving systems.

Having reached this point in the review of the literature covering energy use behaviour, it was decided a socio-technical approach should be adopted. Within this it was felt that practice theory offered the most comprehensive theoretical account of energy-use practices and so it is the approach used to inform this thesis. In order to explain this choice, the next section offers an in-depth review of practice theory.

2.2 Practice theory

The following pages present a largely theoretical review of some of practice theory's most important features. This review covers the subject in considerable depth for three main reasons: practice theory is complicated and needs to be clearly distinguished from other approaches, it is still under development (like many theories) so its application in to this empirical research allows fresh insights into energy use, and it is the cornerstone of this work, informing the methodology, collection and analysis of data and discussion of results and so warrants some attention. The point of this section is to explain practice theory to an audience that is not familiar with it, nor with many social science theories. This is necessary because it is utilised in the rest of the thesis, particularly in **Chapter 5**, where the findings of this work are discussed from a practice theory point of view. This section is not only theoretical, however, and ends with an explanation of how practice theory is applied in this particular research.

2.2.1 Defining practices

Practice theory has emerged from an interest in the 'everyday' and 'life-world' and arose out of the work of Anthony Giddens and Pierre Bourdieu (Reckwitz 2002). In practical terms, practice theory shifts the focus of analysis. Unlike the previous three approaches discussed, it does not focus the individual's values, actions or behaviour; or the various contextual, societal or structural barriers to change; or the appliance, technology or material infrastructure. Instead, it is recognised that consumption is embedded within and occurs as part of social practices and so these become the focus of the analysis; the place where agency is understood to lie.

Reckwitz defines a practice as:

> "A routinized type of behaviour which consists of several elements, interconnected to one another: 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. A practice – a way of cooking, of consuming, of working, of investigating, of taking care of oneself or of others, etc. – forms so to speak a 'block' whose existence necessarily depends on the existence and specific interconnectedness of these elements, and which cannot be reduced to any one of these single elements." (Reckwitz 2002)

In other words, practices are recognisable and routinized behaviours which consist of *interconnected and interacting* elements. These elements involve the body and things and structures in the world

(and their uses). They also involve the mind and different forms of knowledge. Put simply, Shove et al. (2012: 7) define them as a "recognisable conjunction of elements which form an entity".

2.2.2 The elements of practice

The idea that practices are comprised of elements has been widely adopted. Different writers have highlighted different key elements in practices which (Gram-Hanssen 2010b) has summarised. **Table 4** summarises Gram-Hanssen's table but adds an additional column to include her summary of the relevant elements.

Table 4: Key elements in the understanding of practices

Schatzki (2002)	Reckwitz (2002b)	Warde (2005)	Shove, Pantzar (2005)	Gram-Hanssen (2010)
Practical understanding	Body	Understandings	Competences (skill)	Know-how and embodied habits
	Mind			
	The agent			
	Structure/ process			
Rules	Knowledge Discourse/ language	Procedures		Institutional knowledge
Teloaffective structures		Engagement	Meanings/ conventions (image)	Engagements
	Things	Items of consumption	Products/ material artefacts (stuff)	Technologies

Source: Adapted from (Gram-Hanssen 2010b)

Table 4 highlights the lack of agreement between authors on the exact elements of practices, though there is some correspondence between the terms listed across the rows of the table. It is not necessary to discuss these different approaches in detail. The most frequently cited is the Shove-Pantzar three element model comprising material artefacts, conventions and competences (sometimes called 'stuff', 'image' and 'skill') Shove (2008: 9). Here 'stuff' "includes technologies, artefacts, spaces, bodies, structures, formats, compositions and ingredients. 'Image' represents the social and personal meaning attempted or achieved through practices, including emotion, aspiration, belief, identity and aesthetics. 'Skill' includes understanding, taste, competence, know-how or 'procedures' for accomplishment of a practice as learned socially and through performance" (Scott 2012: 4).

In this work, however, Gram-Hanssen's (2010b) model is adopted. She proposes that practice comprises four elements: know-how/ embodied habits, institutional knowledge, engagements and technologies. These elements provide a key focus in this work theoretically, methodologically and

analytically and so this terminology is important. Know-how is much like local knowledge ('how we do things around here') or embodied knowledge (non-verbal knowledge or habits). Institutional knowledge is officially sanctioned knowledge deriving from society's institutions and may include theoretical knowledge, instructions, laws and policies. It might be thought of as the way things are 'supposed' to be done and is more 'top down' in attitude. Engagements are the meanings brought to a practice, both culturally and individually determined, and encompass the social and cultural conventions that surround a practice. Finally, technology encompasses more than is usually understood by this term and includes the material 'stuff' of the surrounding world (the physical components, products, infrastructures and so on).

Taking laundry as an example might help to elucidate Gram-Hanssen's four elements further. Know-how might require in one home that laundry is done when the wash basket is full or on Saturday mornings, for example. Institutional knowledge might specify that washing is done at a certain temperature because that is what the clothing label stipulates or is how the washing machine instruction manual requires the machine should be used. Meanwhile engagements might necessitate that laundry be washed after every wear to be considered adequately clean in Western work cultures. Finally, the technology involved in laundry is most obviously a washing machine (in a Western context) but would also include detergent, softener and the fact the house has piped water and grid electricity. How each of these elements interacts with one another can then be seen to have implications for energy-use practices.

While Shove's model has the attraction of being simple, Gram-Hanssen's has been adopted because of her distinction between different types of knowledge. These types of knowledge: know-how and institutional knowledge equate closely with Warde's 'understandings' and 'procedures' or Schatzki's 'practical understanding' and 'rules' respectively. However, these were not selected because Schatzki's 'teloaffective structures' are difficult to explain to an interdisciplinary audience, he does not acknowledge the constitutive role of things in everyday life and he explicitly sees practice theory as a way of describing the status quo rather than as a theory of change. Reckwitz's model is quite complex and did not include the concept of 'engagements'. Finally, although Warde's model is very similar to Gram-Hanssen's in many ways, his work is much more embedded in the consumption literature and his 'items of consumption' did not lend itself as seamlessly as her 'technologies' to a socio-technical study such as did this one.

Practices are about more than their elements, as Reckwitz's definition makes clear. It is through the interconnection and interaction of elements that practices exist. The interplay of these elements can be seen when practices are performed.

2.2.3 Practices in performance

It is important to understand that practices are performed because this drives everyday life and, therefore, energy use. Practices exist as entities but they are inherently dynamic (Warde 2005) and so must be performed. This is an important distinction between "practices-as-entities (idealised and abstract forms that are historically and collectively formed) and practices-as-performances (the grounded enactment of practices conducted as and amid everyday contingencies)" (Hargreaves et al. 2011: 7). While the analysis of practices-as-entities focuses on the elements and the ways they are linked, the analysis of practices-as-performances is interested in the moments of integration that occur when practices are in action (Røpke 2009). In other words, it is possible to recognise that there is such a thing as the laundry (the practice as entity) but unless it is performed, the practice does not live. This distinct analytical difference allows an examination of how combinations of elements are enacted and reproduced (Shove et al. 2012).

Performances of different practices intersect with, influence and challenge one another (McMeekin, Southerton 2007; Shove et al. 2008; Reckwitz 2002; Warde 2005). According to (Shove, Pantzar 2005) practices can be both stabilised or changed through their performances, depending on the context. It is in the performance of practices that consumption occurs and that practices themselves come to life. Each performance is different as the elements are always brought together slightly differently. This means that practices are sustained, changed or destroyed as the links between them are created, maintained or broken. In other words, as the relationships between know-how, institutional knowledge, engagements and technology are made or broken through repeated performances, so the practice thrives or is 'fossilised', a process whereby they die away (Shove, Pantzar 2006). Practices are therefore enduring and recursive entities reproduced through recurrent performance. Relatively stable practices and complexes of practice do exist but only because they are consistently and faithfully reproduced, rather than because they have achieved closure or a final state (Hinton 2010).

On the one hand, practices are inherently social in nature, which allows standards or norms to emerge and means they can be learned (Scott 2012). Practices are therefore capable of reproducing themselves and may seem to persist through routine performance, apparently stabilising the status

quo. On the other hand, their iterative performance over time means that practices and the connections between them are dynamic and changing, so that even apparently implacable practices can become unstable and decay (Scott 2012: 4). Old practices can be 'fossilized' (Shove 2008: 11, 145) or die. Alternatively, when existing links in practices break or elements become unstable, innovations may occur and practices or elements may be reinvented. **Figure 5** shows how diffuse elements are initially drawn together as links form between them and they become recognisable as a practice but these can later be broken as the practice fossilises. Shove et al. (2012) take a whole chapter of their recent book to discuss this 'Making and Breaking of Links' and it will be further discussed in the subsections below. Attention will be paid to this process of change throughout this thesis.

Figure 5: Proto-practices, practices and ex-practices
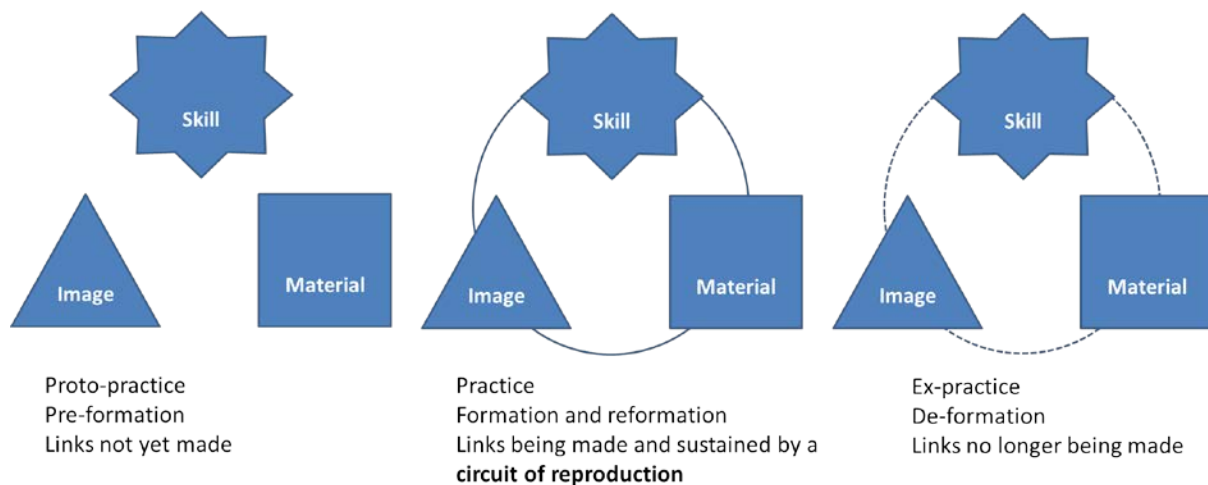
Source: Reproduced from Shove, Pantzar 2006: 7

Over repeated performances, different practices can become linked through their elements, as shown in **Figure 6**. So, for example, a practice carrier may carry an engagement between two practices, such as the concept of hygiene, which might be shared between laundry and food preparation. In a similar way, practices that are co-located in space or linked by their material elements might come to be more strongly connected to each other such as practices that take place in the kitchen and depend on plumbing. Finally, practices that depend on similar knowledge or skills might become linked together so that reading might link work and leisure, for example.

Figure 6: Elements between practices
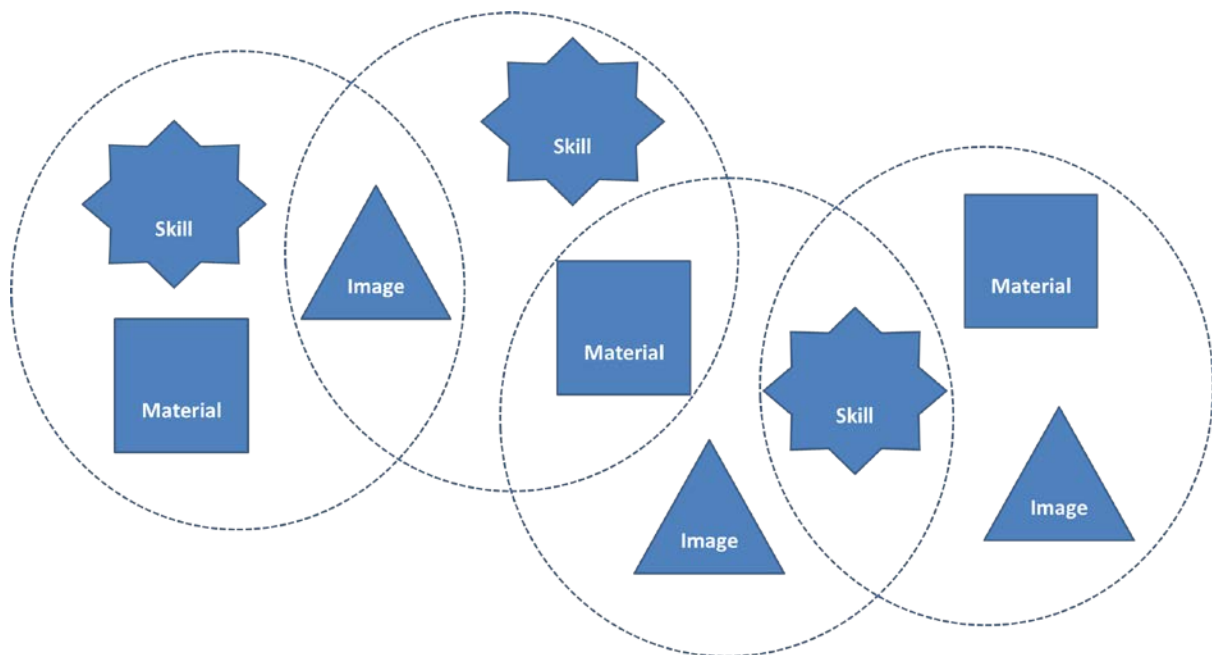
Source: Adapted from (Shove et al. 2012: 37)

2.2.4 Practices, carriers and recruitment processes

The human role in practice theory is considered to be that of a practitioner or a 'carrier' of practices. The implication of this is that practices remain the focus of the analysis, not the human individuals or groups that carry them. So, for example, the embodied habits and engagements brought to the performance of a practice are not the attributes of the practitioner, but rather of the practice. Understanding how humans are recruited to be practice-carriers and what their relationship is with practices is therefore an essential part of understanding the difference between practice theory and other approaches.

Although they are 'merely' carriers of practice and are positioned in time and space and in relation to other carriers and practices, all of which constrains their activities and choices, practitioners are also skilful agents, able to engage creatively in the performances of practices as well as to resist, debate and sometimes even change them. Thus, while they do not have complete agency, neither are they trapped or powerless. As Sefang puts it, individuals are "knowledgeable and skilled 'carriers' of practice who at once follow the rules, norms and regulations that hold practice together, but also, through their active and always localised performance of practices, improvise and creatively reproduce and transform them" (Sefang 2010: 8 in Wilhite 2012). Humans are therefore not automatons in this process: the elements need to be *actively* integrated and not all humans reproduce their practices 'faithfully' and the creative process described by Sefang gradually

transforms the practice over time. Also, a more subtle point: because there is no world outside of the unlimited possibilities of practices and they must be enacted to exist, practices make some human agency possible (Shove et al. 2012). As such, individuals are the "unique crossing point of practices, of bodily-mental routines" (Reckwitz 2002: 256).

It is therefore possible to speak about a carrier's 'career' with a practice. People are recruited into a practice and then gradually, by faithfully performing that practice, become skilled practitioners over time. The process of enrolment begins with domestic practices at infancy and as the individual follows his/her life path they will increasingly deepen their relationship with some practices, resist others, defect from yet others and become engaged with new practices, through formal associations and social or recreational activities (Warde 2010). In their recent book, Shove et al. (2012) examine the recruitment process in detail. In order to do this it is necessary to think about practices as if they were stable, practice-as-entities. They start by noticing that, much in the same way as happens in the natural world, practices evolve through competing with each other. The practices in existence today have emerged from an "unbroken lineage" (Ibid: 64) from practices that existed in the past but that they also compete with each other on a day-to-day basis to capture the human resources that are available.

How the process of recruitment works is still being understood but one way in which practices enrol people is through social networks. Shove describes how, as practices spread and become the social norm or become embedded in material structures and networks (like bathrooms or transport systems), so their chances of recruiting people increase significantly. It would therefore seem possible to transmit practices through networks, norms and material artefacts but when it comes to practical consciousness the transfer mechanism is more challenging to uncover as, by definition, practical consciousness is not fully available to the discursive consciousness. Shove postulates that apprentice-like mimetic processes allow procedural knowledge to be absorbed whilst also inculcating practitioners into the use of the material artefacts involved. She discusses how people get involved and the hierarchies of involvement and how these determine who gets to shape the practices of the future.

Once a practitioner is recruited, the practice and practitioner become mutually transforming as their careers intertwine. Starting out as novices, practitioners get caught up in the practice. As their competence improves so their status may change and, as each level of proficiency allows still greater progress, they may even become what they do (as in the case of a doctor, for example). In the

meantime, the practices are similarly transformed by the practitioners. Newcomers may perform the practices differently, so producing mutations. High levels of expertise may also allow practices to develop and evolve as the limits and edges of the practice are explored. In some cases, conventions within the practice are contested and practitioners may seek to overthrow the original system, so potentially revolutionising a practice. More banal, perhaps, but related, is the fact that practices are differently performed because conventions and aspirations are differently distributed (Warde 2010). Some practitioners will strive towards best practice, in other words, whilst others will be content with adequate performances and so practices become internally differentiated. Those who are 'in the know' will be able to tell the difference between the ordinary and the excellent.

This section has traced some of the means by which practices-as-entities expand, contract and change as they recruit or lose carriers. This depends on how their elements are distributed, how they relate to other practices and what social networks they percolate. From the practitioner's point of view, their encounter with practices happens in the course of their daily life paths (Pred 1981). All practices are not equal and particular practices will capture significant parts of the day. These governing practices will exert a disciplining influence that pushes their life paths in certain directions (Foucault in Hargreaves 2012). This process, taken over the life paths of society, has the effect of changing practice more widely and, perhaps, irrevocably. As Pred (1981) points out, powerful institutions take time-allocating and scheduling precedence over the projects of other institutions such that they force those projects aside and may also obliterate the skills and knowledge necessary to their performance. As elements (here, Gram-Hanssen's 'institutional knowledge') are destroyed, so the practices of which they were a part may disappear forever. Of course, this process works just as effectively in reverse. Though innovation in practices may also entail the extinction of elements (Shove et al. 2012), the overall effect is the same; widespread societal change over time. This links nicely to the discussion in the next section on stability and change.

2.2.5 Stability and change

Understanding the process of change is an important part of a thesis looking at shifting energy-use practices and is one of the reasons so much attention was paid to the definition of agency earlier. This theoretical grounding will be relevant in later stages of the thesis, particularly during **Chapters 5 and 6**. Inevitably there is an overlap between how practices recruit people and how they are stabilised and changed. The fact that practices are recognisable entities implies that they must be reasonably stable (Røpke 2009). Of course this suggests that it is easy to distinguish between practices but in fact their boundaries tend to be hazy and, as there is little guidance in what

separates one practice from another, definitions that 'make sense' are typically used. What allows one to say that many non-identical performances of a practice are nevertheless part of the same practice may ultimately need to be better articulated (Warde 2010), but it does work intuitively and even when viewed from different angles, the basic outlines of a practice can be agreed upon. Røpke (2009) cites the game of baseball which, even though it is viewed very differently in different national contexts, can nevertheless be played by opposing national teams even though they are, in a sense, playing different games.

It has already been established that practices and their elements co-evolve and this tends towards their stability. This sense of durability is even stronger when whole practices start to cohere into *bundles* (loose-knit patterns of practices based on things like co-location) and *complexes* (dependent relationships between practices based on things like "sequence, synchronisation, proximity or necessary co-existence") (Shove et al. 2012: 87). In addition, practices are socially constructed and so collective learning is an important part of becoming a competent practitioner (Warde 2010). This means that routines and conventions are important and therefore that practices have substantial inertia. Interestingly, one function of this inertia is for practices to partly insulate practitioners from the effects of consumption – they are not subject to every new innovation, design or promotion. As Warde puts it, "the effect of production on consumption is mediated through the nexus of practices" (Warde 2010: 141). The inertia of practices explains why initiatives to change behaviour often fail. However, it has led to practice theory being criticised for describing the status quo but not being able to explain change. Nevertheless, the theory does in fact account for both reproduction and innovation in practices and recent academic attention has been increasingly focused on how to alter undesirable practices, though this is not an easy task. There are three options: killing off old practices, transforming current practices or introducing new practices, which are each discussed in turn.

Dealing with killing off practices first, (Schatzki 2012) suggests three ways in which practices might be encouraged to fossilise or die: physical events, external challenges and internal challenges. A physical event might change a practice by killing or altering the carriers of that practice in some way, such as an earthquake for example. Internal challenges require elements within that particular practice to change. The example he uses is the abandonment of particular agricultural practices consequent on the depletion of soil nutrients. External challenges such as the collapse of a market or the launching of a new product that renders another one obsolete might also cause the practices involved to be abandoned. Of these, Schatzki suggests that external challenges are the most

common and easiest to fashion. However, there is a note of caution for practices may mutate in unpredictable ways.

Knowing whether a practice has died or merely been transformed is based on the size and type of the change it has undergone. This requires first that the practice be defined and this is problematic as the boundaries of practices are not strictly delimited. Related to this, Warde talks about the 'paradox of recognition' (Warde 2010: 145) which suggests this problem is worsened as the number of practices grows and many of them become more varied internally because they may be more difficult to recognise, particularly with regards to their symbolic significance, by means of which they communicate things like status, identity and competence to others.

Schatzki (2002) suggests that multiple mutations are possible as long as some components live on but where changes are vast or a practice's projects and tasks cease to be carried out, that practice can be understood to have collapsed. This can be the result of mass defection, mass transformation or both. Shove et al. (2012) list three major reasons for defection. First, where the internal rewards and the scope to innovate and progress along a practice career path are limited, practices retain their carriers less well. Second, if symbolic or normative anchoring fails to take place, defection is easier. Third, where practices fail to connect with other practices and try to stand alone, they will soon die. There are exceptions to this, however. In some cases deeply embedded practices die because of a wholesale challenge such as was faced by cycling with the introduction of the car. In other cases, the apparent competitive success of one practice over another disguises what is actually a more subtle transformation in that practice. The increasing amount of time spent on the Internet, for example, might on the face of it seem to have replaced time spent with friends and family but actually has been analysed to be in the process of transforming how interactions with friends and family occur.

The next strategy for change, transforming current practices, is perhaps even more capricious. However, the basic principle is that practices change when new elements are introduced or existing elements arranged in different ways. Here it is important to remember that practices are enacted through performances, each one of which is potentially different (Røpke 2009). Four possible means of changing practices are suggested here, each relating to an element of practices. First, Schatzki (2012) suggests that it would be possible to create contexts that would support particular types of practices or at least would encourage the dissolution (or evolution) of particular bundles of practices, so suggesting transforming the material context of the practice. Second, according to (Scott 2012),

practices provide internal rewards, such as emotional or physical enjoyment. These are based on the competent performance of the practice which deliver satisfaction and self-esteem (Warde 2010), thus suggesting that the secret to change lies in manipulating embodied knowledge or know-how. Third, external or extrinsic rewards come from opportunities to increase social, economic and cultural capital by means of, for example, identity and status (Warde, 2005: 148). This focuses more on altering the socially situated engagement of practices. Forth, one of the most common approaches to try and change environmental practices is to provide information based on evidence, which would be to try produce change by focusing on the forth element, institutional knowledge.

Rather than transforming whole practices, it may also be possible to influence the circulation of their elements. Earlier it was stated that elements can be part of several practices at once. One of the implications of this is that elements may be said to exist somewhat independently of practices (Shove et al. 2012) and they may therefore travel between practices. This process is represented in **Figure 7**, which shows elements transferring from one practice to another.

Figure 7: Elements of Practice Change over Time
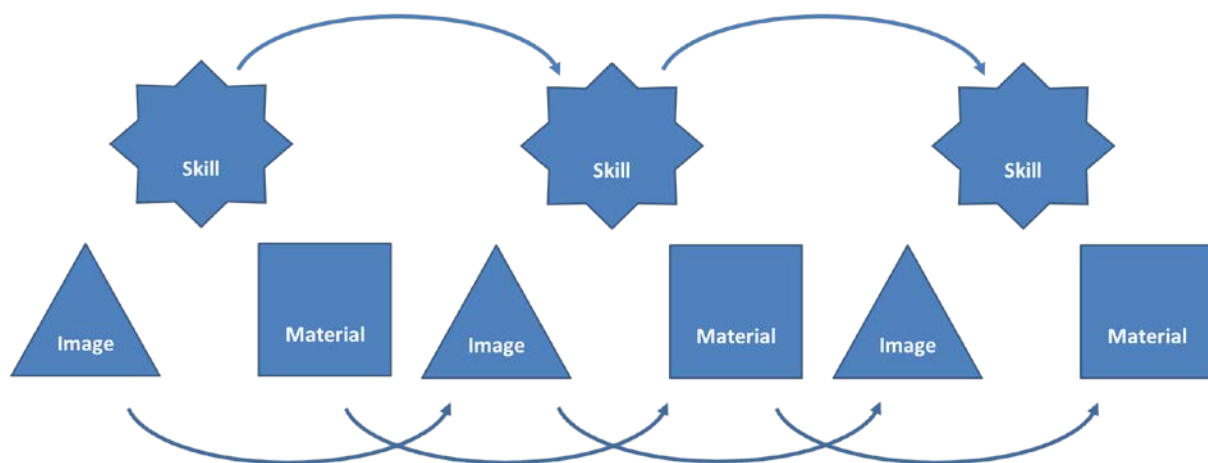
Source: Adapted from (Shove et al. 2012: 33)

Over time, an element of a particular practice may either create a bridge between two practices or may evolve and change but the practice itself survives as a whole. So, for example, a meaning like cleanliness might travel between bathing and laundry, implying the increased intensity or frequency of those practices. On the other hand, a meaning such as cleanliness might evolve in relation to laundry, so that cleanliness is no longer about hygiene but about whiteness, meaning that boiling the laundry is no longer necessary. Whereas much of the current practice literature discusses how the dispersion of an element like cleanliness, for example, leads to less environmentally sustainable practices overall, by implication and by contrast, novel elements might also be introduced by means

of which more sustainable configurations of elements might be generated (Hargreaves 2012), so making possible the designing of more environmentally-friendly practices.

The third and final strategy for change is developing new practices. Whilst it is possible to dissolve or change bundles of practices, Schatzki suggests, establishing entirely new practices is much harder and has unpredictable outcomes because they "assume lives of their own and unfold in unforeseen ways" (Schatzki 2012): 10. However, if the attempt is to be made, it needs to consider all aspects of practices rather than just one element as is usually the case. In other words, rather than thinking about designing policies, awareness campaigns, pricing signals, smart appliances or whatever, it is necessary to think about designing practices. The tools listed might still be used but they would be recognised as part of the attempt to establish or modify the entire practice. (Scott 2012) proposes that creative effort can be brought to bear on necessarily social process of engaging people in new practices or, in other words, "enabling a form of social innovation to occur, where communities of practitioners challenge existing norms to create new ways of living and doing" (Scott 2012:6).

What has been written here mostly applies to the elements of practices. However, there are two further points that contextualise this discussion. Firstly, entire practices have an influence on the practices around them so that change is not only about replacing or transforming elements. Secondly, and related to the first point, practices normally exist as part of an interdependent web of co-existing or even co-dependent practices (Shove et al. 2012) and they may come to influence the change process through more subtle processes like "partial colonisation, hybridisation and cross-referencing" (Ibid: 124). Sometimes these relationships lead to convergence or synchronicity and these may set new developments going. However, the "traces of the past are inscribed in the patterns or the present" (Ibid: 125) so that the future will always be a function of the past.

Leading from this and before leaving the subject of change for the time being, it is necessary to visit the difference between the competition between and the complementarity of practices. While practices have generally been seen to compete for space in the household and time in the schedule, in fact, there are as many instances where complementary relationships strengthen practices. Shove uses the freezer as an example, suggesting that it would be easy enough to show how different forms of food preservation competence like pickling and curing fell away as freezing user practices took hold and that as the freezer became embedded in society, so food provisioning changed (Shove, Southerton, 2000). However, she argues that this may not provide the whole story. Citing research (Hand and Shove, 2007) that looked at freezing *practices* rather than *technologies*, she posits that

freezing in fact strengthens the connections between different forms of food preservation, preparation and provisioning in that it helps with planning (as well as, conversely, helping to avoid the need to plan) and supports "self-service catering and individual snacking" (Shove et al. 2012: 93). She points out too that as the distrust in ready-made frozen foods has grown over time, so the freezer's role in daily life has changed again. Freezers, she points out "act as a kind of relay device, condensing and materialising the otherwise abstract concepts of care, health and convenience as these flow through associated practices of cooking, parenting and managing the home" (Ibid).

One of these interpretations suggests that freezers have become dominant at the expense of other possibilities but the other proposes that rather than superseding previous arrangements, it has become co-dependent with them. Looking at practices in this way suggests that practices come to dominate not just because of their ability to compete but also because of the spatial and temporal links and connections between them and other co-dependent practices, which are constantly being reproduced as practices are re-enacted.

2.2.6 Time, space and practice theory

By implication, if practices are performed, this performance must have a time and place and this is another important feature of practices. Schatzki's defines practices as "co-ordinated entities that are temporarily unfolded and constitute spatially dispersed nexus of doings and sayings" (Schatzki 1966: 89 in Gram-Hanssen 2010a: 154) so highlighting the temporal-spatial aspect of practices. Both time and space can be seen from three distinct points of view under a Practice approach (Shove et al. 2012). First they can be seen as resources, in which case they are the subject of competition between practices. Next they can be seen as coordinates by means of which practices might be located or contextualised. Finally, they can be seen as Schatzki describes them, as 'timespace'(Schatzki 2010), within which time and space come together through action and so are treated as constitutive dimensions of action.

Although it is not possible to separate time and space, it is necessary to do so in talking about them and so time will be dealt with first. Practices are dispersed across time, both historically and because they are temporally located within the bounds of daily life. From a practice perspective, as has been discussed, historical time gives rise to practices and, therefore, also in some sense to carriers. As carriers move along their path, participating in particular practices, so 'sediments' (Røpke 2009: 2493) accumulate in their minds and bodies which support participation in certain practices at the expense of others. This relates to Shove's concept of 'projects' which are used to make sense of the

temporal flow and to coordinate complexes of practices and which build up experience, so allowing participation in ever more complex projects. Historical time also allows practices to develop along trajectories; as each is conditional upon the time, space and social context in which they exist (Warde 2010) so they are moulded and shaped. From the point of view of quotidian practices, time is used as a resource to manage the puzzle of everyday life as different practices are fitted together as has been discussed above.

Shove et al. (2012) consider four ways in which practices relate to time. The first two consider practices-as-performances. Seen as a resource, first of all, practices relate to clock-time in that it is only possible to do one practice (or a limited number) at any one time. The patterns of time and space are reproduced in daily life through participation in these practices (Shove et al. 2010). The amount of time they take and the timing of practices is important and time is seen as finite, which means that the dominant practices are defined as those which consume most time and so their survival depends on how practitioners' life paths are spent.

Second, Shove says, seen from the point of view of the practitioner rather than the practice, enacting practices properly implies cooperating with their existing rhythms and temporal injunctions. An individual's experience of time results from his/ her performance in practices because time is constituted by practices. Although, therefore, everyone has access to the same amount of time in theory, in fact for some people their time is not their own as they become subject to pressures like work or family life practices. Warde (2010) points out that 'simultaneous and sequential' involvement across different practices (particularly when these span diverse social networks) may lead to the widely recognised experience of 'fragmentation of the self'. However, as he points out, this is neither a postmodern identity crisis, nor a psychological adaptation to a postmodern world but rather is a consequence of the social organisation of practices. As such, a description of fragmentary lifestyles should be based on recognition of "multiple social engagements and differential locations in a plurality of practices" (Ibid: 144).

The third way in which practices relate to time according to Shove, involves practices-as-entities and how they endure over time. As seen earlier, practices require recurrent performance but, as these are not continuous, the implication is that the elements must be 'lying around' waiting to be integrated so that they are able to bridge performance moments. In this way they both connect performances in objective time and arrange the way in which time is organised and structured.

Shove's forth framing proposes that practices actually *make* time (see also Røpke 2009), first by means of the fact that they necessarily take time to accomplish properly and so time arises out of them. This applies particularly to practices that have a strong sequential aspect or which demand complex synchronisation. Time is an integral part of practice, in other words: it takes a certain amount of time to carry out a practice in terms of duration but competence might also be assessed through sequencing, coordination and timing. Second, she suggests that time is known by means of the practices which fill it. They determine how time is spent and so they shape it: note, for instance, the difference between weekends and weekday, which is really a function of the practices that fill them. This implies that larger societal rhythms and temporal infrastructures are structured by and around practices.

The implications of these relationships are profound and start to show how daily practices link to the broader organisation of society in two important ways. Firstly, (Shove et al. 2012) show how the repeated performance of practices transforms the terms by which competition and/or collaboration between them is framed. Instead of being a merely competitive relationship, it becomes complementary, at least for a while, possibly in an attempt to out-compete other practices. Using the example of prime time television which they describe as a "collective and dynamic 'negotiation' between television programmers and millions of different households" (Ibid: 90), they show how evening domestic scheduling coalesces around prime time (which would, in turn, influence when the infrastructures that support these practices are used). Practices are not therefore just consumers of time and space but time and space are also the outcomes of the relations between practices: consumption is part of the making of time rather than a drain or a sink (Shove et al. 2010). Even more significantly, by encouraging the circulation and distribution of certain elements over others, they shape terms and conditions according to which other practices are determined so that certain linkages become more likely.

Secondly, as Pred sees it (Røpke 2009), projects recruit people, other living organisms and objects and they link together to perform practices by coupling or uncoupling as necessary to achieve the tasks of that project. These tasks are defined in terms of individual or institutional contexts. Practices are able to relate to the wider institutions and structures of society by means of the social reproduction of dominant projects (which are the collective goals of individual life paths), thus ultimately producing class and power systems (Shove et al. 2012). This implies again that opportunity and access are unevenly and unequally distributed. In addition, those who can engage in socially esteemed practices get to shape the future trajectory of that practice. By working together

to accomplish some particular project, not only might these powerful actors change a particular practice but the way power is exercised may be transformed. By bringing actors and/ or networks into association, the future structures may be forever altered.

Before moving off the subject of time, it is worth considering one more issue. Of course if time influences practices in their entirety, it is logical to expect that it works on their elements too. As an example, paying attention to the relationship between a particular element, such as material objects, and time provides interesting insights. From the point of view of historical time, (Shove et al. 2010) notice how objects move from novelty to obsolescence. Where an object is on this continuum may well influence how this element is incorporated into a particular practice. Objects may also signify a time, a memory or an emotion and these all have temporal associations, all of which may affect how they are used. Considered in the context of time, therefore, material objects are both stabilising and communicating devices which can provide, reproduce or challenge temporal identities.

As practices are "the spatially-temporally extended manifolds of actions" (Gram-Hanssen 2007), it is also necessary to tackle the issue of space in practice theory. (Shove et al. 2012) also see space in three ways: as a resource, as a geographical location and as an outcome of practices, all similar to her analysis of time. The difference, however, is that new issues of inequality come to the fore in the distribution and circulation of elements. For example, the earth is not evenly populated and not all spaces lend themselves to all practices. She notes that though a densely populated area offers more carriers to a practice, it means the range of practices available might be limited due to lack of space. This may not limit everybody, however, as some practitioners have access to additional resources that allow them to escape these space constraints. Determining absolutely the spatial boundaries or needs of particular practices is therefore not possible.

Further complicating factors to understanding the relationship between space and practices are: that the space may not have the requisite features for a particular practice to be carried out (it may need to be level or quiet, for example); that the concept of space itself might be transformed by the practice (flying, for example, both 'shrinks' and takes up space, as travel over distance becomes easier but the paraphernalia and infrastructures associated with flying spreads out); and that spaces may overlap (so that a car park might also be a playground – rather than competing, these practices may co-exist in the same space). Understanding a practice in one space may therefore provide only limited insight into how it is performed in a different space.

Wilhite (2012) addresses this in his investigation into the relationship between material objects, bodies and habit (or technology and know-how, in Gram-Hanssen's terms), claiming that the size of the material space in which a habit is performed is important. Smaller spaces suggest tighter scripts (Harvey 2000 in Wilhite 2012) and stronger habits. This accounts for the fact that a practice like showering, which takes place in a very small, uniform space with few objects involved and is repeated frequently and without much need to refer to technical knowledge, becomes a strongly embedded habit over time. Habits are likely to be weaker when they happen in larger areas with more diverse materials and contexts and where social mediation is likely to be required.

Having dealt with the relationship between space and practices, Shove et al. (2012) then move on to consider the distribution of practices-as-entities, a particularly important consideration in the light of how unsustainable practices like air-conditioning seem to be spreading. They point out, in fact, that practices do not travel or diffuse; rather they are re-enacted in different sites. Their elements, however, can and do travel (though they are sometimes changed by their journeys). They then look at four relationships between space and the circulation of practices. Firstly, elements cannot go just anywhere because they may be constrained by: physical limits (size or lack of infrastructure, for example), social structures (cultural conditions, for example) and existing competence (specialist knowledge cannot go where no underlying knowledge exists, for example). If an element cannot move for whatever reason, the practice will have to adapt either by borrowing an element, using that element in some altered form, or by changing entirely.

Secondly, because space and practices are co-constituted, if the initial stages of this process have not happened, the practice may not work in that space. So, for example, Wilhite (2012) cites the example of introducing refrigeration practices into Southern India where the storing of prepared food is associated with laziness and stupidity. This meant that those who bought the first fridges were more interested in their space saving properties (because storage rooms were no longer required for fresh produce) than in their ability to store cooked food that could be reheated later. Over time, as know-how and institutional knowledge are transformed, this has started to change, though generational differences persist.

Thirdly, communities of practice share "practice-space" (Shove et al. 2012: 133) even where they might be widely dispersed (using the Internet to play a game, therefore, is not about overcoming space but about creating a new space). Presumably practice-spaces are not specific to the internet

(communities might just as well share a yoga studio or football pitch) and the size of these sorts of spaces would again be relevant to the specificity of how practices were scripted.

Fourthly, the consequences of enactments of practices live on in the temporal spatial structure of society; flying and driving today thereby help to embed the future inevitability of flying and driving if tomorrow's 'quality of life' is to be similar to today's. It is also clear to see how buildings are being transformed as comfort becomes a matter of interacting with air heating and cooling devices rather than engaging in a whole series of practices ranging from drinking hot drinks, staying in one room near a heat source, shutting windows and doors and wearing extra clothes to stay warm to sitting out on the porch, taking a swim, keeping the curtains closed on hot days and taking a siesta. As thermal comfort is increasingly expected to be delivered mechanically, so knowledge of some of these practices die out and the buildings which enable them change too so that it is no longer possible to shut doors in an open plan house or office or sit on the porch once houses are designed without them (Wilhite 2012). Increasingly, therefore, spaces and their practices influence each other so that eventually the one demands the other. It is not possible, for instance, to work in a glass high-rise office block without air conditioning even in mild climates. This same idea of being 'locked-in' to a particular technological infrastructure is part of what makes the energy system feel so intransigent. However, all is not lost. While skills may be lost from the everyday over time, they may be able to be recaptured in through historical records and reskilling projects that bring institutional knowledge to bear.

So far, this section on space has dealt with both the relationship between space and practices and the way elements diffuse through space, so enabling practices to be re-enacted in various locations. As should now be clear, place is more than a context or a setting for practices. Before closing it will spend a moment recognising how space impacts on practices in three more ways. Firstly, it can allow certain conjunctions and forms of association as has been discussed. Co-location can lead to changed and even new practices (Shove et al. 2012). Secondly, moving a practice from one space to another causes disruption and may therefore open up moments for change. Consider, for example, moving house. Some practices will be re-established there but others may not be possible because of the material lay-out of the new home (Wilhite 2012), just to take the example of one element that may influence a change. It is easy to see how a utility room or extra bedroom where there was not one before may have a big impact on how practices are performed. Thirdly, people are short of time, effort and money (Guy, Shove 2000) but also space. As was discussed above, the amount of space

available affects the strength of habits, which in turn impacts on practices. Also mentioned was the fact that access to more space (and other resources) allows more flexibility.

A final comment is necessary before closing this discussion on time and space. It is important to note that time and space are not the same as elements (Shove et al. 2012) they do not circulate and are not shared in the same way. However, like elements, they are both structured by and help to structure practices and as such facilitate an unequal pattern of access to practices going into the future.

2.2.7 How practice theory illuminates this work

The sections above have been very theoretical and so this section will highlight some of the particular features of practice theory to explain why this approach was selected. Most importantly of all, practice theory changes the focus of the analysis. Instead of suggesting energy use is the result of individual decisions, structural imperatives or technological constraints, practice theory recognises that there is a dynamic interplay between these which occurs as a function of practices (Scott 2012). Consumption is not a matter of purchasing decisions or appliance use but is part of using goods and services whilst engaged in the competent performance of collectively recognised and locally situated practices (Warde, Southerton 2012). "The analytic focus shifts from the insatiable wants of the human animal to the instituted conventions of collective culture, from personal expression to social competence, from mildly constrained choice to disciplined participation" (Warde 2010: 146). The practice, its elements and how these interact during performances therefore become the focus rather than how to change people's minds, the social structure or the energy system (though all of these remain relevant under a practice approach). The profound implication of this, as Warde puts it, is that: "Contrasting understandings, levels of practical competence, and degrees of involvement generate behavioural variation" (Warde 2010: 147), rather than things like socio-demographic factors or attitudinal differences.

Focusing on practices also means no longer concentrating on resources, however efficiently they are provided. The task is to better understand services and the expected standards; the practices and conditions of everyday life that underpin the more or less sustainable demands placed on systems of provision (Shove 2002). The requirement is to think more systematically about the relation between consumption, provision and practice. It is the shared understandings of 'normality', the "obligatory, non-negotiable conditions of everyday life" (Shove 2002b: 2) that need to be interrogated. This is what Giddens calls 'practical consciousness', Gram-Hannsen calls 'engagements, Shove calls

'meanings' or 'conventions' and Schatski calls 'teloaffective structures' and it is widely neglected by current approaches to policy making.

Leading from this, practice theory is interested in the performance of practices in everyday life and will therefore bring additional insight into the use of domestic appliances and the consequent use of energy. By focusing on the '*doings* and sayings' of social life (Gram-Hanssen 2010b), practice theory draws attention to the fact that practices must be repeatedly 'done' or performed to be sustained (Shove, Pantzar 2005). Interest is broadened from the cognitive (values, attitudes, decision-making, knowledge) to also consider 'doings' (Schatzki 2000) and these performances are crucial to understanding everyday life. This helps to address the oft-cited gap between values and action as well as the 'user' problem, whereby technology is used in unintended ways.

Practice theory is also relevant because it is a theory of consumption and energy is consumed in the pursuit of practices (Warde 2005) rather than for its own sake: energy consumption is one of the traces left behind by the performance of a practice. This recognises that energy use is invisible (Burgess 2008) and "an often mysterious feature of everyday life" (Guy, S. & Shove, E. 2000: 1) and so simply understanding how much energy is used will not provide any insight into how or why it is used. Knowing, for example, that the average three bedroom house in the UK uses 25,000kWh of gas and 5,500kWh[1] of electricity a year says nothing about what is going on in the house (quite aside from the fact that this average obscures vast differences in usage between similar households which remain unaccounted for). Taking this a little further, practice theory is able to account for both conspicuous and inconspicuous consumption, which moves the analysis beyond energy monitoring.

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[1] **Source:** http://home-save.co.uk/energy/why_switch_supplier/average_energy_usage/, 20 January 2013

Figure 8 shows the electricity demand for a single household on Christmas day in 2009. It provides some additional insight into energy use because it is possible to see some of the appliances that have been used. However, even then, the practices in which those appliances are embedded are obscured and so again why energy is used cannot be fully appreciated. Warde argues that it is "the fact of engagement in the practice, rather than any personal decision about a course of conduct, that explains the nature and process of consumption" (Warde 2005). However practice theory focuses consumption studies not only on the conspicuous consumption of goods but on the accomplishment of mundane everyday life.

Figure 8: Inconspicuous consumption – energy use as part of everyday practices
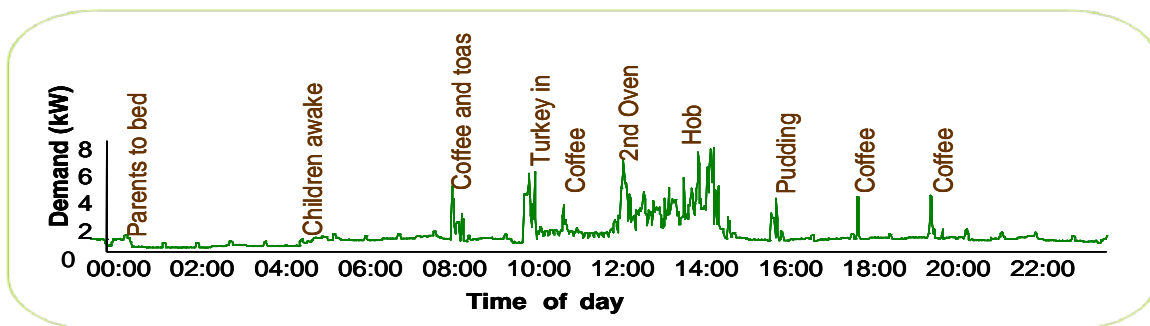
Practice theory also links the material and the social worlds together, so firmly moving the social sciences beyond the social, which is important in an account of energy consumption. By concentrating on "both body and *things*" (Gram-Hanssen 2010b) or the 'bodily activities' referred to by Reckwitz (2002) the material aspects of the world are recognised as just as important to how energy is used. Gram-Hanssen points out that practice theory draws attention to "how routines and technological structures contribute to the construction of energy-consumption practices while simultaneously highlighting how socially shared knowledge and attitudes hold practices together (Gram-Hanssen 2010a).

As has already been discussed, practice theory is a theory both of how things come to be the way they are and of how they might change: it provides an account of both the dynamic and stable nature of things. Although still under development, understanding the processes of co-evolution, recruitment, mutation, fossilisation and innovation all offer ways to think about how patterns of consumption could be moved towards greater sustainability. As a result of recognising that agency is variously distributed throughout practices, it is possible to account for the multiple resources being used as well as the different influences being brought to bear on how those resources are used.

Finally, practice theory recognises that practices are embedded in time and space and so are of particular significance to work that is interested in shifting the temporal (or spatial) nature of consumption, such as one interested in demand response.

These distinctions are summarised in **Table 5** from Wilhite et al. (2000) showing how different an approach informed by practice theory is from a traditional social sciences approach. It shows that practice theory can be expected to concern itself with context, consumption and conventions operating at multiple levels and to both recognise the co-evolution and interrogate creation of demand.

Table 5: Established and new agendas for a social science of energy demand

Traditional approach to energy –use 'behaviour'	'Construction of demand' approach to energy use
Choices are driven by economics	Economics is relative (changes through history) and contextual (embedded in other systems of decision and desire)
Separation of energy consumption from the analysis of other forms of consumption	Social scientific theories of consumption are relevant for understanding energy
Demand comes from consumers; hence the focus on consumer choice	Producers and consumers are implicated in the co-evolution of demand, and the choices of both are highly structured
Consumer choice is sovereign	All of the forces contribution to escalating demand for energy services may be studied for policy opportunities
Focus on classic end uses: lighting, heating, cooking, etc.	Focus on changing conventions of comfort, cleanliness and convenience
Demand side management viewed as a bounded technique for influencing behaviour	Recognition that demand is a societal, not an individual phenomenon; it could be managed at multiple levels
Invokes a distinction between needs and wants and assumes that the latter are subject to individual preferences	Rejects the relevance of needs-wants distinctions on the grounds that for all practical purposes both are socially constructed

Source: (Wilhite et al. 2000: 119)

These, then, are the reasons practice theory was selected to inform the theoretical, methodological and analytical approach to this work. Although practice theory cannot do everything, it does offer a more holistic overview and is therefore able to bring new insights which should help to open up additional options for demand response.

2.3 Conclusion

Chapters 1 and 2 have covered a lot of ground, summarised in **Figure 9**. **Chapter 1** started with the recognition that current demand response methods were unlikely to produce the change required because they were based on an inadequate understanding of people. **Chapter 2** therefore started by trying to understand more about agency: what it is and where it is located, as it makes sense to

leverage change at points where agency is present. It was recognised that there are multiple

approaches to changing behaviour and that they tend to be disciplinary specific, with particular

views of people, of what needs to change and what level and of how this should be achieved. Three

in particular were disregarded, namely the individualised approach that treats people as

economically rational or psychologically coherent beings, the structural approach that sees culture

and society as all powerful and the technological approach that believes design and technology will

produce the required change. It was concluded that, for a study of energy consumption, a socio-

technical approach was required.

Figure 9: The logical progression of chapters one and two
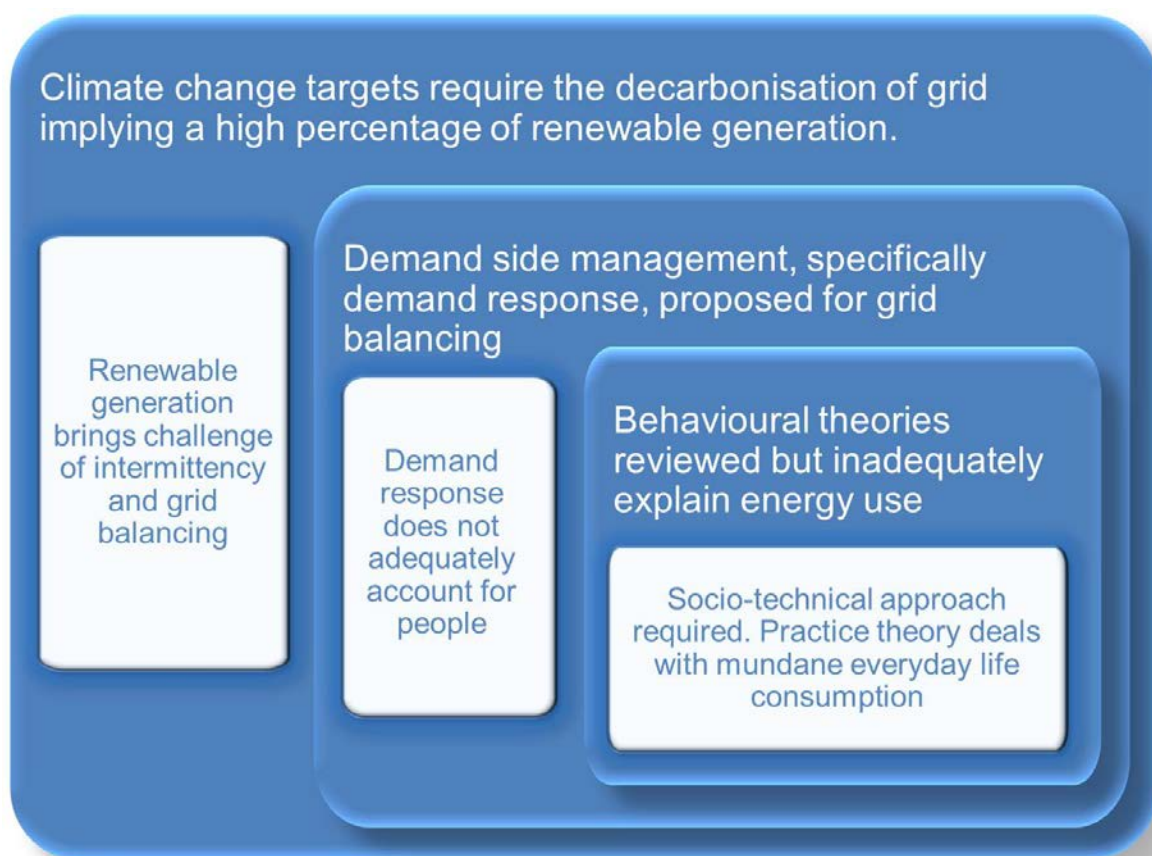
One such approach, practice theory, was considered appropriate to this study because it deals with

mundane (or everyday) consumption at the level of practices. Some care was taken to explain

practice theory, first defining it and then outlining some of its main distinctive features, such as the

fact that practices are made up of elements and must be performed. A more in-depth theoretical

discussion followed, starting with an explanation of how people carry practices and are engaged by

them through recruitment. This was followed by an inspection of how practice theory aids an

understanding of both stability and change and might usefully, therefore, be engaged by a study aimed at both understanding the status quo and trying to identify ways to change it. Next, time and space were identified as being important aspects of practices both from a conventional point of view, as resources, but also in more challenging ways, such as the fact that time and space are actually created by practices.

The section then identified several reasons why practice theory is considered, in the view of this researcher, the most comprehensive approach available at this time for looking at energy consumption, including the fact that: it changes the focus of analysis, emphasises performance (and therefore energy usage), is a theory of consumption, can tackle both conspicuous and inconspicuous forms of consumption, goes beyond energy monitoring and appliance use, links the social and material worlds, focuses on conventions rather than resources, is able to explain change and stability, and has lessons relating to time and space.

Reviewing the progress so far then, it has been established that neither a purely technical nor a purely social approach to understanding demand response will work. As a socio-technical approach and given all the other advantages covered above, practice theory offers the best hope of bridging the gaps. Given its socio-technical nature, a promising way to investigate energy from a practice theory perspective is likely to be a multidisciplinary approach using qualitative and quantitative data. The next chapter will therefore outline the methodological approach adopted in this work, starting with the ethical and philosophical issues raised, considering the methods used and describing how they were tested through pilots, how they were then used in the actual study and a few of the difficulties that were encountered.

3   Methodology

This thesis draws on insights from the disparate worlds of engineering and sociology in an attempt to understand energy-use practices. It has therefore taken an interdisciplinary approach which has resulted in the development of new methods and ways of displaying data. This chapter will outline the methodological implications of this interdisciplinarity, explain what was learned by piloting and then describe the empirical data collection phase, from recruiting volunteers through to collecting and coding the data. Empirical data was collected by observing 'practices-as-performances' in order to learn more about the more usually discussed theoretical world of 'practices-as-entities'. To do this research volunteers were observed for twenty-four hours and participated in three challenges. Data was collected by means of energy monitors, photographs, observations and interviews and was coded to discover the main themes relating to shifting energy-use practices. The theoretical relevance of the approaches used is explained as they are introduced.

3.1   Interdisciplinarity

3.1.1   Epistemological opposites – quantitative vs. qualitative ontologies

Although there are increasing examples of interdisciplinary and cross-disciplinary work, engineering and social sciences such as sociology come from two distinct and usually contrasting phenomenological points of view. Engineers generally locate themselves within a positivistic philosophy wherein people can agree on a common reality, quantifiable by means of objective experiments, mostly undertaken in controlled environments. Sociologists posit that reality is a social construct, implying multiple realities and subjective interpretations. These are more open to experience than experiment and the naturalistic context in which they occur is key to understanding them (Newman, Benz 1998). There is a long history of differences between these opposing epistemological stances which take sometimes quite different interpretations of reality, as humorously portrayed in **Figure 10**.

On the one hand, quantitative research tends to start with theories and test for the confirmation or otherwise of the hypothesis (also known as deductive research) and it falls under the category of empirical or statistical studies, the approaches more usually taken by psychology and the behavioural sciences, although there are exceptions of course as these can also take a qualitative approach. Designs include experimental studies, quasi-experimental studies, pre-test-post-test designs, and so on. Attempts to control variables, randomisation, and valid and reliable measures

are required and the aim is to generalise from the sample to the population. Data is coded according to a priori operational and standardised definitions (Newman, Benz 1998).

Figure 10: Epistemologically opposed views elicit different versions of reality
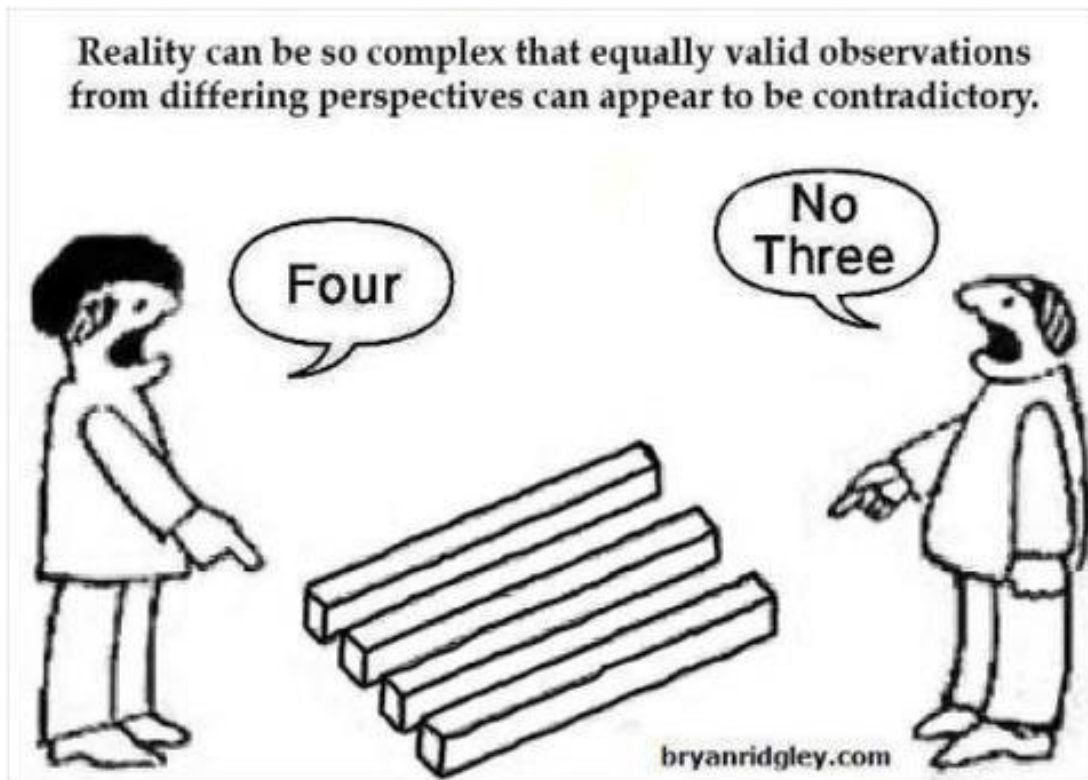
Qualitative research, on the other hand, tends to start with observation and develop theories (inductive research). Its methods include ethnography, case studies, field studies, grounded theory, document studies, naturalistic inquiry, observational studies, interview studies and descriptive studies. It stems from traditions in anthropology and sociology where the philosophy emphasised the phenomenological basis of a study. Qualitative research may only involve one case studied over time and data is coded a posteriori based on the interpretation of the researcher. It may include personal experience, introspectives, life stories, historical, interactions, and visual texts, amongst others (Newman, Benz 1998). Defined by Patton as "detailed descriptions of situations, events, people, interactions, observed behaviours, direct quotations from people about their experiences, attitudes, beliefs, and thoughts and excerpts or entire passages from documents, correspondence, records and case histories" (Patton 1990:p.22), "the cardinal principle of qualitative analysis is that causal relationships and theoretical statements be clearly emergent from and grounded in the phenomena studied. The theory emerges from the data; it is not imposed on the data" (Ibid: 278).

The search for knowledge (or truth) is the purpose of research. It therefore needs to incorporate whatever forms of knowing are useful to it in order to gain insight into the specific research question. While a scientific way of knowing might be based on phenomena that can be physically sensed, observed and counted, there are other ways of knowing are also claimed, from intuition and faith, through experience and authority, to reasoning and sensory perception (Patton 1990). Taking these together, one might discern the elements of a practice approach. In order to apprehend practices it is therefore arguably necessary to adopt a range of approaches to try and uncover the tacit knowledge implicit in habits, intuition and faith; the institutional knowledge involved in reasoning about the physical world; the embodied knowledge through which things are experientially understood; the engagements and cultural understandings through which authority is lent to practices; and the technology and 'stuff, which may either facilitate, or be the subject of, knowledge.

This characterisation of the different approaches may be a little stark, in order to highlight the headline features of each point of view. Methods from each tradition have long been borrowed by the other and interdisciplinary work has been strongly supported by UK research councils in recent years. This thesis is philosophically rooted in the sociological view that a socially constructed reality is necessarily only available to subjective interpretation. However, it is also committed to making this interpretation available to the positivist world of engineering. Accordingly, although the methodological approach and analysis are mainly qualitative, some quantitative data has been collected. More importantly, a predominantly engineering audience is assumed for this work and it is primarily in this sense that this work is interdisciplinary. This work takes a sociological approach to a problem initially articulated in the engineering world (that of managing electricity demand) and is trying to advise the electricity supply industry. It uses new combinations of techniques, has involved many interdisciplinary conversations exploring the different languages and concepts on either side and trying to develop a mutual understanding. This is no easy task as it is difficult for one discipline not to view another through its own sets of assumptions. The first task is to become more aware of one's own disciplinary culture, which is one reason why the theoretical approach in this work has been so carefully outlined. The next section will explain in more detail how practice theory influenced the research design and decision to take a mixed methods approach.

3.1.2   The methodological implications of a practice approach

Practice theory has been critiqued for not engaging enough in empirical work and not much has been written about the methodological implications of using a practice approach, either in terms of research design or data coding and analysis (Halkier, Jensen 2011). This thesis hopes to address both

these issues. This section deals with how using a practice approach influenced the methodology and the next with will describe how the empirical work was carried out.

The task of this section is to explore the practical implications of how using a practice approach differs from an ordinary approach in developing a methodological strategy (so the methodological design is not laid out here). One of the first considerations in designing an empirical study is the collection of data. As Halkier and Jensen (2011) point out, practice theory foregrounds the performative nature of practices and privileges this analytically, making the theoretical assumption that the activities of social life have to be carried out, as discussed in **2.2.3**. Accordingly, it was felt essential that this study's design should allow an insight into practice performances in their everyday contexts. As a result it seemed inadequate to merely interview people and was felt preferable to observe practices directly if possible. Of course, direct observation does not provide unique access to the action. Observational data is just as entangled in social interpretations as any other form of data collection (Halkier, Jensen 2011) and so understanding the meaning of and reasons for what is going on can be difficult. In addition, because practices are socially constructed and performed differently every time and because context and the way the elements and practices intersect are so important, observing one performance does not necessarily allow one to say anything about other performances. It was also true that some practices were not observed or were only partially completed during the observation. Additional data collection strategies were therefore necessary.

As a result, interviews also formed a large component of the data collection. Although practice theory is complex to explain and use, both methodologically and as an analytic tool, the idea of practices is a fairly common sense one. Asking people about practices, therefore, seemed more likely to be successful than asking them about how they consume energy in the home (Hinton, 2010) and so interviews were included in the methodology. Hitchings (2012) argues it is possible for people to talk about their practices and interviews were a substantial part of the research design. He suggests that although much of what people do is subsumed under Bourdieu's notion of 'habitus', the act of interviewing can be a 'sensitising device' through which people can stop and consider their everyday lives. Halkier and Jensen (2011) also argue that the interaction and communication that occur during interviews are in fact expressions of the action they describe. This corresponds with the idea that methods of data production co-constitute the knowledge they produce suggesting, in fact, that observation (or, indeed, any kind of data collection) could equally well be accounted for as a practitioner performance (Halkier, Jensen 2011). Both authors suggest, therefore, that interviews allow as much access to understanding the performance of practices as direct observation. Be that

as it may, this study combined the two and it was hoped that the two techniques: observation to better understand the 'doings' of practice and interviews to gain insight into the 'sayings', in addition to the energy monitoring to see how these doings and sayings were implicated in consumption, would allow a reasonable insight into how practices were conducted in each domestic setting.

Observation and interviews were not the only data collection tools used, however. This work also collected data on energy in a number of different ways. Most obviously, perhaps, households had energy monitors fitted before the observation and these were left in the house for the duration of the study. The observation phase was also particularly focused on when energy was used and the interviews, whilst not always discussing energy explicitly, were concerned with energy-use practices so that energy formed a backdrop to discussions. Two additional data collection tools, the photographs and the use of time-shifting challenges helped to locate this energy use within time and space and so have allowed a much deeper understanding of energy-use practices.

There are different ways to go about understanding energy behaviour in the household. Jensen (2008) lists three as outlined in **Table 6**. This table identifies three approaches to studying lifestyles and consumption.

Table 6: Three approaches to studying lifestyles and consumption

	Consumption as green lifestyle	**Consumption by indicators**	**Consumption as culture**
Lifestyle concepts	Empirical, constructed periodically	Expressed by indicators such as socio-economy, demography, ethnicity, etc.	Cultural and sociological
Methodology	Primarily qualitative	Primarily quantitative	Qualitative and quantitative
Rationale	Normative. Green behaviour controlled by values and attitudes	Demonstrative. Consumption as a function of measurable and quantitative relations	Explanatory. Consumption as culturally and socially conditioned
Strength	Focus on barriers to a green lifestyle	Objective measures, based on quantitative data	Understanding different rationales for consumption
Weakness	Selective understanding. Focusing on green practices and overlooking everyday consumption	Lack of understanding behind consumption. Limited by available data.	Overlooks the individual differences, limited focus on possibilities for change.

Source: Copied from (Jensen 2008: 355)

The first (listed under the 'consumption as green lifestyle' column) focuses on certain behaviours. This individualised but normative approach undertakes occasional empirical, qualitative research

and is good at highlighting the barriers to change but neglects the everyday and focuses on values. The second (listed under the 'consumption by indicators' column) measures lifestyle against socio-economic and demographic indicators suggesting that consumption in these categories is fixed and unchanging as it is the result of measurable factors, objectively and quantitatively derived. In fact, however, this technological approach sees lifestyles as comprised of activities and typically has a limited theoretical basis and consequently little explanatory power. The third (listed under the 'consumption as culture column) focuses on everyday life and the consumption that results. This is more in line with a practice approach and sees consumption as embedded in the associated cultural, social and technological dynamics as discussed above and therefore collects multiple sources of data. This approach recognises that consumption arises as an "unintentional consequence of people's social positioning in other fields" (Ibid: 355) and so has greater explanatory power than the other two. The weakness of this approach is that it neglects individual differences and it has been criticised for suggesting that opportunities for change are limited. The first of these has been overcome by doing both observations and interviews to give insight into the particular individual households. It is also believed that practice theory as an approach has moved on in the last five years enabling this thesis to have already have discussed theoretical positioning of individuals in practices as well as providing a theoretical explanation of change (**3.2.2.2**) and suggesting that this critique is not as valid as it once might have been. It is hoped that the work in this thesis will further contribute to an understanding of this change process through the empirical work that has been undertaken.

Apart from its methodological significance, a practice turn alters the importance of the types of questions to be asked in an empirical study. Instead of looking at people or technology, the attention shifts to practices; what practices are available, which ones are dominant, how are carriers positioned in relation to practices, how evenly spread is their participation across them and how committed are they to performing practices appropriately (Warde 2010)? While empirical studies using practice theory have tended to follow the development of individual practices over time, in this work it was felt necessary to try and understand the relationship between practices because shifting one practice implies displacing another. Shove et al. (2010) agree that understanding the rhythmic richness of everyday life requires moving from single practices to focus on the dynamic interactions between them, suggesting that practices with different rhythms might amplify, enable or cancel each other out. This means the relationships both between elements within practices and between entire practices are of interest, as well as how elements and practices are located in time and space. These issues will be drawn out in the analysis and it is hoped this provides some insight into the interwoven fabric of daily life.

As a result, three practices were selected for study: food preparation, laundry and work and relaxation. This was ambitious because each of these practices could legitimately occupy a study on its own. Of necessity, therefore, the focus here will be on understanding how they interrelate rather than understanding every detail of each of the practices. In addition, it is important to note that the aim was to try and disrupt these practices to see what could be learned about their flexibility. Again, Shove et. al (2010) suggest that if disruptions are unique moments of stress that reveal the underlying, interlacing rhythmic structures that normally hold everyday life together, then deliberate disruption may be justified as a kind of research. Each of the three practices, therefore, was the focus of a challenge that involved time-shifting that practice and reflecting, through interviews, on what happened.

So much for data collection and practice theory, but what can be said of the analysis? The data coding process started the analytic process and is described in 3.4. Halkier and Jensen (2011) write about the analytical implications of practice theory and propose that there are two ways in which it facilitates the analysis of consumption. Firstly, practice theory highlights the importance of the social reproduction and social organisation that underpins consumption whereas normal research preferences individual consumer choices. It recognises, in other words, that consumption is a social and socially constructed process. This means it is possible to stop blaming or placing all the responsibility onto the individual and recognise the social constructedness of practices. The individual consumer should not be privileged as an actor either theoretically or methodologically. Rather the consumer is the intersection point for practices which are in a dynamic relationship with each other in the social organisation of space and time. This explains the fact people seem not to behave rationally. In fact as they carry different practices, each with their own elements, so their knowledge, values and behaviour may seem to change inexplicably when in fact they are just following the edicts of the practice or performing it appropriately to the context in which they find themselves.

Secondly a practice theory analysis means that consumption is recognised as a continuous "relational accomplishment" (Ibid: 117) within the intersecting practices of everyday life. Put simply, how practices are carried out is the result of the context in which they are carried out: normative conventions govern what is considered to be an acceptable practice in a particular context. This allows the context to be better highlighted and releases the analysis from an over-emphasis on stabilised categories such as fixed lifestyle types or segments. It sees practices as in dialogue with

one another and having the ability to transform each other (Halkier, Jensen 2011). This explains why people behave differently in different situations, rather than either having a consistent set of principles or values that guide everything they do or behaving in accordance with a socio-economic, demographically determined category. In summary, both methodological individualism and cognitive approaches assume that changing habits requires self-reflexivity but a practice approach demonstrates why this does not work on its own.

However, there were methodological challenges with using a practice theory approach. Firstly, the temporal and spatial aspects of practices make it important to look beyond the single moments of integration that a particular performance highlights towards how practices are constituted and how they might change over time and through space. Both energy and time can be considered 'trails' of practice and an account of the 'temporal texture' of daily life would be incomplete without considering how practices intersect in time and space (Shove 2010b). Ideally, therefore, a longitudinal study might have been conducted rather than just one twenty-four hour observation. Although in this study, there were four interventions in each home each with an accompanying interview, meaning that some insights over time were possible, only observing a single performance of many practices is a limitation of the study. However, even had a longitudinal study been conducted, multiple observations of a practice do not necessarily allow one to predict how that practice will be performed in the future.

This leads onto the second problem: that of writing and reporting about practices. If practices are best understood through their performances then writing about them can only provide the merest insight into them. How can multiple performances be described without overwhelming complexity? How is it possible to adequately describe the tone of voice or bodily movements that signify passion or expertise? How can the context be described adequately enough for someone who comes from a different set of engagements? How does the interaction between different practices and between people (Halkier, Jensen 2011) influence what is written about each? Even more than this, although a philosophical point, is it even possible to describe practical consciousness by means of discursive writing or are they such different forms of knowledge as not to have full access to one another?

The third problem is one that has been hinted at throughout this work and is related to the first, namely the fact that the social nature of practice means performances differ between individuals and groups, so making it difficult to classify empirical observations. The social nature of practices also means that the researcher's presence, whatever form this takes, must impact on the practice

and so make the original form of the practice unknowable by an outsider. This philosophical point relates to a more tangible and practical one; that of the relationship between the researcher and the practitioner. Halkier and Jensen (2011) write of this when they relate a moment of frustration in an interview resulting from the mutual positionings of the researchers and practitioners caused by their different gender, class and ethnicity. Such tensions can be revealing if handled reflexively but the point is made: that it is both difficult to classify observations and impossible to separate the researcher from the action.

All of this points to the fact that understandings of practices are fleeting, emergent and contingent, all of which is challenging in the context of making recommendations. The dilemma of how to generalise from qualitative data is one of the main critiques of such methods and is not exclusive to a practice approach. In a practice based study, however, claims will be made on the basis of the patterns in the enacted social process rather than the individual person or the so-called determining structures. Analytical generalisations are theorised assertions about the categories and dynamics of the data (Halkier, Jensen 2011) and the sample fits into these categories according to the theoretical relevance of the sample. The important point is that the inferences and conclusions of a practice based study reveal consumption practices as intersecting processes that are continuously socially performed and so escape from methodological individualism and essentialism (Halkier, Jensen 2011).

Although it is operationally difficult for all the reasons discussed, it is important to generalise the specific to some degree if research is to have a wider significance. Having established categories, however, the opposite problem arises in that the stability of the generalisations is over-emphasised (Halkier, Jensen 2011) because it is difficult to keep reminding the reader of how provisional everything is without appearing to undermine the value of the research. Imagine, for example, a practitioner is coded as having participated in a particular practice but did so in a contested space (such as delaying food preparation but experiencing a lot of complaints from the family for doing so). The chances of a shift being permanent in this context are unlikely and so the researcher coding this needs to take account of the insecurity of this categorisation and find a way to represent it. As suggested above, this suggests also that placing practitioners into segmented consumer markets is likely to be a mistake (although the idea of segmenting practices (Powells, G. et al. 2014) would be an interesting one to explore).

Overall then, practice theory brings theoretical illumination to the understanding of energy consumption but is not methodologically straightforward to use. Nonetheless, it has been used to

justify the particular methodological design employed here, the details of which will occupy the next section.

3.2 Preparing to collect data

Before the empirical research could begin, three important pieces of work needed to be done: getting ethical approval for the research, piloting the methodology and recruiting volunteers. This section will discuss each in turn.

3.2.1 Ethics

Though ethical considerations run through the life of any study, influencing the writing up process as much as the data collection process, it is necessary to get clearance at the start and so this was the first priority. Loughborough University has a special committee to ensure appropriate ethical standards are maintained. Their comment on reading the application from this researcher was: "The Sub-Committee also wished to inform the Investigators that they were extremely impressed with the depth and considerations taken with this proposal and felt that the Investigators should be commended for their efforts."

Although this study was not particularly ethically sensitive, it did involve human participants, some of whom were considered vulnerable; specifically, adults over sixty five and children under eighteen. To ensure these volunteers were dealt with appropriately and to make sure all the volunteers know what to expect, they were all given information sheets (**Appendix One**) which explained the process, told them their rights and provided contact details should they require further information or wish to make a complaint. Every volunteer (including children) signed a consent form (see **Appendix Two**) saying they were happy to take part in the research and giving permission for data about them to be used in this thesis and in relevant publications.

The researcher's involvement in the research was also ethically significant because it had implications for her own safety and for the university's insurance and so various health and safety protocols had to be developed. The collection, storage and use of data were also dealt with in detail in the ethical submission (see **Appendix Three**). Once the ethical framework was set, it was possible to pilot the methodology. This happened in a number of stages as different aspects of the methodology were tested.

3.2.2 Pilots

Piloting in research involving case studies is difficult to do for fear of tainting that case for study. Nevertheless, it is possible to test parts of the methodology, both in terms of the process to be followed and the data that may result (Robson 2002). This section will describe the piloting that took place on this project and explain how these influenced the final study design.

There were three main pilots. To start with, the researcher worked with a group of students on campus and asked them to shift their energy usage to find out what impact this would have. She also undertook three observation studies with family and friends whilst on a trip in South Africa and one at home in the UK with her housemates to test the concept of the twenty-four hour observation as this methodology was developed specifically for this study. Finally, she carried out a study into people's laundry practices with her housemates and a colleague's family, using a questionnaire and a plug in energy meter to test whether these would provide the required data on practices and energy consumption.

3.2.2.1 *Eating a banana in the dark: Testing the energy shifting challenge concept*

In March 2010, as part of her PhD data collection, another researcher ran a participatory project with a group of students living on campus to find out whether engaging the students in sustainability might also enhance their well-being (Escobar-Tello, M.C et al. 2013). She set up a number of evening events and on-going challenges through which students could win points and prizes. She also set up a website to track the students' thoughts as they progressed through the experience. She invited this researcher to run an evening workshop and set an energy challenge as part of her programme of events. This was used as a pilot to test whether it would be possible to ask people to shift their energy use. The challenge was for the students not to use any electricity in their halls between 18h00 and 21h00 on a particular Wednesday evening and to record their experience on the website (see **Appendix Four** for their web-based discussion).

There were three main responses to the challenge. One volunteer and his partner planned ahead. They ate food that did not require cooking, engaged in a joint energy use activity (the cinema) and switched everything off when they went out. The second volunteer brought his electricity use forward, cooking two portions of his meal the previous night. On the evening of the challenge he ate his dinner cold and went to sleep very early, suggesting significant flexibility. The third volunteer did no planning. He read until it became dark and then, noticing he was hungry decided to eat

something. Arriving in the kitchen he realised that cooking required energy and so he ate a banana in the dark. Dissatisfied, he went out and worked in the library.

The aims of this pilot were to see if the concepts could be successfully conveyed to a lay audience, whether they would participate in a challenge to shift their energy usage and how well they would be able to reflect on their experiences. It was clear from the discussion that the students had understood the problem of demand side management and the fact that some of them undertook the challenge showed that it was possible to ask people to manage without access to electricity for a limited period. Based on this pilot, therefore, the idea of challenges and asking people to shift their energy use was further refined and incorporated as part of the methodology.

Specific changes to the method were also developed through conversation with an expert from the energy industry. In particular, it was decided to give a day ahead warning for each challenge, to focus challenges around particular practices, to carry out the same challenges in each house and, where possible, to focus challenges around peak energy use times. **Table 2** in **Chapter 1** captures this conversation about likely time-shifting scenarios from the energy industry point of view, what these might be worth and how they might be implemented. Based on the pilot and this conversation, three challenges were developed, each of which tried to test the flexibility of a different energy relevant practice and which would all be undertaken by every household in the study. These are described in more detail later on.

3.2.2.2 Invading private spaces: Testing the observation phase

The first pilot made it clear that it was important to better understand normal domestic energy-use practices before trying to shift them so as to provide an insight into whether the household was just naturally flexible. For all the reasons discussed in the last section (**2.2.3**) to do with practices and their performances, and given that energy is invisible (Burgess 2008) and ubiquitous, it was decided that the best way to understand a practice was to observe its performance in situ (Burgess et al. 2003). The problem was how to observe domestic energy-use practices. Various methods were considered and rejected: remote videoing, self-reporting through methods like diaries and auto photography (Halkier, Jensen 2011) and video tours (Pink 2001). Remote videoing was considered too invasive of privacy and would have been extremely time consuming to analyse, there was a concern about the accuracy of self-reporting and whether it would be carried out by participants and the video tours were too technically difficult given the researcher's resources at the time.

The preferred method was one of ethnographic observation but in a domestic setting getting agreement to conduct full-time observations for an extensive period in numerous homes was considered impossible. A shorter time frame seemed a reasonable compromise and so a twenty-four hour observation was tested in three family and friends' houses in South Africa and the researcher's own home in the UK (the latter with an energy meter installed).

The aim of the pilots was to test: how intrusive the methodology would feel, how much the researcher's presence would disrupt what was going on, whether useful data might emerge, how data might be reported and what gaps might exist in the method. Pictures were taken of every appliance in the household so they could be listed and their energy use calculated. Four pilots were done to check for consistency.

A number of decisions were made based on the lessons learned, namely: to study people known to the researcher, to standardise data capture, to capture energy data (so install meters rather than calculating potential energy use based on appliances) and to take pictures of practices rather than appliances.

3.2.2.3 Washing dirty laundry in public: Testing energy monitoring

The final part of the methodology to be tested was that of energy monitoring and asking people about their energy-use practices. This study was undertaken by the researcher and a colleague, each of whom fitted a plug-in electricity meter to their washing machines and took readings before and after each time they used the machine. This meter monitors and measures the energy/ power consumption of connected electrical appliances.

They also developed a questionnaire to be filled in each time an appliance was used (the Appliance Use Diary can be seen in **Appendix Five**). The questionnaire attempted to fulfil a number of functions; facilitating an understanding of how and why people were interacting with their appliances, the energy implications of these choices, the impacts of shifting and, ultimately, how practices were driving activity and energy use. The energy monitoring was supposed to be a straightforward way of quantifying this last aim by measuring the amount of energy used in each washing load.

There were a number of problems, several of them predictable. Firstly, doing paperwork interfered with the normal flow of the practice and was both too time-consuming and had limited usefulness as

a tool to capture discursive knowledge. Questionnaires tended to be damaged or lost and were not filled out if the person was in a rush even though they were quite short. In the light of this, it seemed unlikely that people would be prepared to shift their energy practices and also fill in multiple forms, especially if they were required to do so more than once. In addition, it was difficult to develop a standard form that would capture a wide range of appliances and it was not clear that the answers on the forms would enhance an understanding of energy-use practices anyway. The energy monitoring also turned out to be variable and somewhat misleading.

Overall then, getting volunteers to record their own energy use and energy practice data was abandoned in favour of observation, remote energy monitoring, setting up specific challenges and conducting additional interviews. How these techniques were combined and how they worked is explained as it becomes relevant in the following section, where the data collection process is described.

3.2.3 Recruitment and selection of volunteers

The context of this study is domestic electricity use in the UK but so as long as households used energy of some kind there were no exclusion criteria per se. Volunteers were initially selected to give a good range of 'active occupancy' profiles (Richardson 2008) which refers, quite simply, to when people are at home and awake. Somewhat unsurprisingly, Richardson found that active occupancy was a key driver in appliance use in the home. As active occupancy correlates with domestic electricity demand it is of interest in investigating energy-use practices, which in turn relate loosely to Richardson's 'activity profiles'.

All of the volunteers were known to the researcher to some degree, though in one household she had not met two of the occupants before the study started. Despite some obvious disadvantages such as the potential to influence what was going on, the chance of researcher bias and the fact that the sample was not representative (Robson 2002), there were two significant advantages to this strategy. Firstly, the researcher's safety was better ensured. Secondly, it was thought that people known to the researcher would be more relaxed and may therefore behave more naturally and give more honest feedback than if she had been a stranger in the house. Of course the chief determining factor in the selection process was that they agree to be part of the study. When determining the representivity of a sample this should always be considered as, by definition, by agreeing to be involved volunteers differentiate themselves from the rest of the population.

It was challenging to recruit people for the study as most were hesitant about the observation phase. One wrote: "I would be willing to consider it. However (my husband) is still in shock! at the thought of someone observing him for 24 hours.....he has pictures of you sitting at the bottom of the bed whilst we sleep!!!" Of the thirty approached, the twelve households who agreed to be involved were formally written to so that the purpose of the research and their involvement in it was clear to them. A volunteer information sheet was developed for this purpose; one for adults and a different one for children (**Appendix One**). Finally, twelve suitable households agreed to participate and the researcher decided to investigate her own house as well. Consent forms were signed by all volunteers, including children, at the time of the observation phase of the empirical data collection. No incentives were offered to participate in the study, though the researcher either purchased a small gift or contributed to the food of the house in every case. These 'gifts' were usually around £10.

Five of the initial observations either had to be abandoned or redone. On one occasion this was because people moved on before the challenges could be completed, on another because it was not possible to observe the volunteers properly (though this household did participate fully in the challenge phase) and on three occasions the energy monitoring equipment did not work as it should have, due to the distance (or thickness of the walls) between the electricity meter and the modem. In one case this meant a household had to be disqualified and so there were twelve households in the observation phase but only eleven in the challenge phase. Only these eleven and their twenty nine occupants are described in **Table 7**, which outlines the basic demographic profiles of the volunteers and the types of houses they lived in. Perhaps most important for this study, however, is the column describing their employment status as this relates to their active occupancy and was therefore considered, at the beginning of this study at least, to be the thing most likely to impact on energy use flexibility.

Table 7: Partcipants in the study

ID	Occupants and their Relationship	Employment status and active occupancy	Age	Type of house
1	Single female	Employed full-time as lecturer but also regularly works at home.	36	Terrace, 2 bedroom
2	Family: married couple and 2 young daughters	Both adults self-employed, woman part-time. Man an architect, full-time, about a third of that time at home. Woman a trainer, part-time, mostly at home. Children at junior school with various afternoon activities	Male 41, female 39, female children 5 and 7	Detached house, 3 bedroom above flat which is rented and metered separately
3	Housemates (resident landlord). Single man with lodgers	Man self-employed as photographer, mostly at home. Lodger self-employed as writer and trainer, often away. Temporary lodger employed in office, normal hours.	Male 52, lodger 43, temporary lodger 46	Semi-detached, 2 bedroom
4	Family: Single female with teenage daughter	Adult employed full-time, normal office hours. Child at senior school with various after school activities.	Female 53, female teenager 16	Terrace, 4 bedroom, 3 floors
5	Family: married couple and 2 young daughters	Man employed full-time but two jobs. Away Tues to Thurs. Otherwise office hours. Woman self-employed as part-time gardener so mostly away from home in mornings. Children at junior school with various after school activities.	Man 39, woman 37, children 5 and 7	Semi-detached, 4 bedrooms
6	Housemates (all renting), 1 single man, 1 unmarried couple	Single man employed full-time in shift work in casino (afternoons and evenings). Other man self-employed doing part-time work, times and venues variable but often at home. Woman full-time student (mostly at home), also doing part-time work as estate agent so occasionally away from home.	Single man 26, other man 24, woman 23	Terrace, 2 bedroom
7	Married couple	Man self-employed as gardener mostly away from home for work. Woman employed full-time at university but home works two to three days a week.	Man 35, woman 31	Terrace, 2 bedroom with converted loft
8	Single man	Self-employed setting up solar farm. Mostly home work but meetings away from home required. Also rents out home so sometimes leaves house altogether and others live there.	54	Detached farmhouse, 6 bedrooms
9	Single woman	Retired/ voluntary work for family. Works from home but frequently away visiting family and friends. Active volunteering life (evenings).	80	Detached house, 5 bedrooms
10	Married couple	One employed full-time, one full-time student but work in office at regular times. Both also volunteer two nights a week.	Man 25, woman 24	Flat, 2 bedrooms
11	Housemates (resident landlady).Single woman with 3 lodgers, one male and two female	Woman full-time student working part-time, mostly at home. Female lodgers both full-time PhD students, one doing regular office hours and the other partly at home and partly at university. Man works full-time and also has own business – goes home at weekends. During week leaves house early, returns late.	Woman 41, female lodgers 24 and 23, male lodger 56	Semi-detached, 4 bedroom (4th room in loft)

3.3   Empirical data collection in the field

Having worked through the snags in the methodology and recruited volunteers, the empirical work could begin in earnest. The research was divided into two main stages. The first involved a twenty-four hour observation of each volunteer household, designed to address the question of how the performance of practices in the home relates to energy use. The second phase involved setting volunteers three challenges to time shift their energy practices. Each is outlined below.

3.3.1   Phase one: The observation

The aims of phase one of the research were threefold: to assess 'normal' energy-use practices in each household, to identify shiftable practices that could be tested in stage two during the challenges and to link measured energy data with observations of energy-use practices. In order to achieve this, a number of methods of data collection were used. First, there was the twenty-four hour observation in which the energy-use practices of all household occupants were monitored as closely as possible. These observations were captured in tabular form noting each practice, its duration, location and the people involved. Second, the researcher took photographs. Third there was a post-observation interview to get a better insight into what went on during the time in the house. Fourth, the researcher monitored whole house electricity usage at one minute time intervals. Each of these will be addressed in turn.

The primary method in this phase was the twenty-four hour observation. As the observation hoped to establish volunteers' typical domestic electricity related practices, volunteers had agreed to invite the researcher on a 'normal' day and so they were encouraged to get on with whatever they would normally do, ignoring the researcher's presence as much as possible. Robson (2002) points out that participant observation is generally a qualitative style of data gathering with anthropological roots. It is typically used by those taking an ethnographic approach and can either be used during an exploratory study on its own or as a supportive or supplementary method. Here both were relevant as this phase tried to familiarise the researcher with the particular context as well as being part of a larger set of tools used to collect data.

Participant observation is appropriate when working with small groups in which greater insight is desirable; for events that are frequent or take a limited time; for accessible activities when the prime motivation is to find out what is going on; and when the researcher is not short of time (Robson 2002). Although an appropriate methodology in some respects, therefore, there were shortcomings too, most notably, getting access and spending enough time to get a sense of the

'everydayness' of what was going on. Accessing volunteer households has already been discussed but the problem of accessing data was on-going. Once in the house there were delicate, often unspoken, negotiations about how much access the researcher was given by different participants and households. It was also impossible to simultaneously observe people in different rooms. The fact that energy-use practices were the object of the observation made things even more complex, as will be discussed later, because energy is not only invisible to those using it but sometimes also, as it turned out, to those watching them use it.

Although twenty-four hours may seem a long time compared with an interview, for example, the brevity of the observation period raised particular issues. As has been discussed, the decision to observe energy practices in situ was taken because it was felt it was important to try and observe the performance of practices. During the process it became clear that this was more complex than had been anticipated for various reasons including the fact that practices are temporarily spaced and so parts of them necessarily happened outside the 24 hour observation period; some practices did not happen at all while the observation was in progress; and anyway different performances of practices will always and necessarily be different even if performed by the same practitioner in similar circumstances.

This brevity also had practical implications. While it can also be difficult to understand what is going on when placed in a new context, for instance, when immersed in a situation for a longer period, patterns and structure may start to emerge. Observing everyday life is interesting in this respect in that it feels familiar but how and why others carry out practices in the way they do might very well be quite different. There are several issues here but three are particularly noteworthy: first that it can be difficult to recognise something as significant if it appears mundane, second, even if it is recognised, it can be difficult not to make assumptions about what is going on based on one's own experiences and third, and really the opposite problem, is that it can be difficult to understand what is happening if it is very different (and 'other') from one's own experiences.

Compared with interviews and questionnaires, however, observation has the advantage of allowing direct access to the action (Robson 2002). In terms of the observer's role, there are two ideal types, which carry different philosophical perspectives. The remote observer tends towards a fixed design and quantitative, structured methods and uses some sort of data collection instrument. The participant observer tends towards qualitative, unstructured and flexible designs and *is* the instrument. There are also disadvantages to taking on the observer role, the main one being the

influence of the observer's presence. There are two ways of trying to overcome this but both are problematic: detachment can seem anti-social but involvement can compromise the researcher's role. The researcher tried to take the role of an 'observer as participant', somewhere between these poles, who theoretically takes no part in the activity but is known to be a researcher. Being in this role was sometimes awkward as it was not clear how socially acceptable it was to take photos or to ask people where they were going or to change what they were doing.

As the researcher is the research instrument during an observation, great sensitivity and personal skills are required (Robson 2002) and there were lots of practical issues like eating, sleeping and where to sit that could be quite difficult in the context of this role. Being the first up and last to bed, staying constantly alert for twenty-four hours, setting up the research (the meter beforehand and the interview afterwards) and travelling sometimes long distances before and after the observation meant that the process was often exhausting. The time-consuming nature of observation was certainly one disadvantage of this method. Ethnographers might immerse themselves for years in a situation they are trying to understand but even relatively short observations like the ones undertaken in this study are much more time-intensive than interviews or questionnaires.

What was interesting too was how much more intimate the experience was from just visiting a friend, even before the interviewing process took place. The strength of trust required between the observer and volunteers was surprising. On the one hand, the fact that the researcher was observing friends meant this trust was relatively easy to establish which was important given the short duration of the observation. On the other, where confidences have been shared, this trust is a great responsibility, both from a research ethics point of view but also as a friend. There were several instances of relationships playing out differently in the context of the research. In an extremely interesting case, a participant described a dream she had dreamt on the night of the observation in which she was being watched in some sort of 'big brother' situation where the people in the house kept losing their handbags. Although she said the handbags turned up later, she suspected they had had their 'data' gone through. A fascinating glimpse of some of the dynamics that cannot be observed!

Moving from the role of the observer to the data captured. From the researcher's perspective watching the action unfold, there was simultaneously too much and so little going: it was both boring and surprisingly intense. The difficulty of noticing the mundane has already been mentioned but how to capture and characterise it was the question. In the end, as this was a flexible,

unstructured observation a narrative account was selected in preference to a coded schedule. **Table 8** is an excerpt from one of the spread sheets which were used to capture what was observed and tries to capture a range of information including the space, actors, activities, events, objects and time. Robson (2002) suggests that in addition to these the goals and feelings of those observed should be captured but this may not be possible through an observation alone, which is why interviews (discussed later) were also used.

Table 8: Excerpt from observation data spread sheet

Start	End	Who	Where	What	Comments/ questions
19.15	19.55	A, B, C	Kitchen	Preparing dinner	Hallway light on. Overhead light and two lamps in living room. Music playing in living room. Computer upstairs on standby. D's laptop and A's laptop on battery power. Raw food being prepared so spiraliser in use (hand powered). Dehydrator on. Periodic use of hand blender. Lights on in kitchen - overhead, under cupboard. Everyone discussing raw food.
19.15	19.56	A	Kitchen	Dehydrator	A also spiralised courgettes so they become like spaghetti and can have a sauce added
19.20	19.21	B	Kitchen	Hand blender	Sauces made with various raw ingredients
19.36	19.37	B	Kitchen	Hand blender	
19.54	19.55	B	Kitchen	Hand blender	
19.45	19.55	C	Kitchen	Scales	Weighing all food he is about to consume as part of particular set of dietary practices
19.56	20.00	D	'Junk' room and bathroom	Trying again to set up energy monitoring system	Turns light on in each for a couple of minutes each
19.55	20.00	C	Bathroom	Light on in bathroom	
20.00	21.00	A, B, C, D	Kitchen	Dinner	All sitting round kitchen table, chatting mostly about raw food

The second form of data collection that took place during the observation was taking photographs. This was negotiated with volunteers, each of whom agreed on their consent forms (see **Appendix Two**) for their photographs to be used once they had seen them. In some cases the whole house was made accessible but in other cases certain rooms appeared to be out of bounds. The purpose of taking photographs evolved through the study, as shown in **Figure 11**. At first, as already mentioned, they were used to catalogue appliances but this proved to be too intrusive and not very helpful. Actually, pictures that captured 'materialities' around both energy use and practices more generally were more interesting and seemed to point to certain arrangements of practices within the home. As the study progressed further it became clear that including volunteers performing certain practices in her photographs would better enrich the understanding of the practice and its context than lots of pictures of washing machines. However, as this had to be balanced with trying to be a discrete observer and there were issues of anonymity, the ability to include people was limited.

Figure 11: Evolution of the type of photographs taken through the study period

The third form of data collection in this phase was to conduct semi-structured, post-observation interview in each household in order to get the best possible insight into the day that had been observed. This interview took place either directly after the observation was finished, if there was

sufficient time and energy on the parts of the researcher and volunteers, or it was done later on Skype. It lasted fifteen to twenty-five minutes and had two main objectives. It explored volunteers' perceptions of how 'normal' the twenty-four hour observation period had been, as well as asking questions about particular practices of interest which had not been observed, namely: food preparation, laundry, work and relaxation, personal hygiene and DIY/ maintenance. Some of these became the subject of the challenges, which are discussed later. Interviews are discussed in more depth in **3.3.2** as phase two of the research involved several interviews. The Interview Schedules for all interviews appear in **Appendix Seven**.

The final data collection method in the observation phase was to monitor electricity usage using a meter. Typically engineering studies of domestic energy use would use all manner of gadgets to monitor energy usage whereas a social sciences approach would tend to assess behaviour or practices but might have no idea of the energy implications of those practices and so using a meter served the interdisciplinarity of the study. The meter consisted of two main parts. A whole house real time energy monitor clipped onto an electrical cable on the electricity meter and then communicated wirelessly with a hub attached to the home's modem (see **Figure 12**) transmitting data at one minute intervals. Measuring the data minutely means that it is possible to capture appliances being used for short periods like kettles and hair driers.

Figure 12: Energy Monitor

The data was accessible via a password protected online account so it could be remotely accessed. The meters were set up so that the researcher could see the energy data online but volunteers were not given access to it and did not receive any feedback until after the data collection was finished in case it influenced their energy usage but also for ethical reasons (due to events in the field it was necessary for the researcher to reuse some of the meters in other households which meant that data from different volunteer households was shared on one account which might have compromised data security). The researcher periodically checked the energy meters during the observation to ensure they were working but only captured all the energy data at the end of the process which meant that some data collection problems only became evident after the data collection phase was over.

It is fair to say that using the meters was challenging. As many volunteers lived some distance from the researcher, they had to be installed on the day of the observation which caused significant operational and logistic difficulties. There were also a number of problems in using the energy meters. Due to the nature of their business, individuals normally only have one account with the company that managed the data. The fact that it was necessary for all the accounts to be managed by the researcher in order for her to be able to access the energy data later on, meant she had to set up multiple devices and accounts, which required a lot of practical troubleshooting. The necessity, on a couple of occasions, of using one meter and account for multiple users meant keeping track of data required careful record keeping in order to disentangle the energy data later.

The meters themselves were also not particularly reliable. Around half of the houses monitored had at least one example of energy information being dropped temporarily, with a couple of households suffering significantly from gaps in their energy information and one house having to be disqualified because it was not possible to get any energy information for them. In this last case the distance between the meter and modem was the problem and thick walls also seemed to cause difficulties. It was also much more difficult than had been anticipated to match the observation data with the energy data though, in the end and having learned several lessons, it was more or less possible. The attempt to do this is described in **Chapter 4**.

Lessons for using energy monitors included: fitting and testing the monitor before the observation phase where possible, using a powerline ethernet adaptor[2] to 'boost' the wireless signal in houses with thick walls, monitoring the energy use data during the observation to make sure that times and observations match with energy consumption as closely as possible, correlating all the different forms of data as soon after collection as possible and discussing the data with the home owner where they are likely to understand their energy data. In some cases plug in monitors might also be helpful.

Overall, the observation phase provided insight into some of the elements of domestic energy practices, specifically the 'know how' and 'technology' in each household, and was therefore useful in understanding that particular household's particular practices in a more particular way. The observation phase was also crucial in setting up the challenge phase, both in terms of understanding what practices it would be interesting to shift and in creating the necessary rapport to be able to ask volunteers to shift those practices.

3.3.2 Phase two: The challenges

Whereas the first phase of the research was trying to establish what a normal day might be like, phase two's challenges were all about uncovering the impact of disrupting ordinary practices in the hope this would reveal the underlying, interlacing rhythmic structures that normally hold everyday life together (Shove et al. 2010). The challenges were designed based on reflections from phase one and discussions with an expert from an energy company. They were to have energy relevance but were not determined by this criterion. No distinction was made between different types of energy (electricity, gas or oil) when specifying the challenges. It was decided to carry out the same challenges in every household so as to offer some point of comparison and to be able to assess whether it was the households or the practices were flexible. In other words, there was an attempt to ascertain whether the difference in flexibility was attributable to the household or to the practice.

The challenges were set at times that 'made sense' in terms of peak energy usage (normally around 16h00-21h00) as well as in terms of normal domestic practices. Volunteers were given twenty-four hours notice. This was because discussions with an energy company suggested that this would be

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[2] Powerline ethernet adaptors extend the internet connection in the home to any other electrical outlet. See: http://www.pcworld.co.uk/gbuk/netgear-xavb5601-100uks-500-mbps-powerline-adapter-13212955-pdt.html for the one used in this study. Note that this one costs £99, however, which is more than the energy monitor.

the most helpful thing for the study to investigate: 'Next day response' and 'Shifting forwards/ Shifting backwards' as described in **Table 2**. They were then asked: first, to not use any energy to prepare food between 16h00 and 20h00, next, to bring forward or delay their laundry by twenty-four hours and, finally, to not use any energy for work or relaxation between 15h00 and 22h00. They did each challenge once, usually leaving about a week between each one. Afterwards volunteers were interviewed at home, either face-to-face where possible or on Skype, to find out what had happened and how this compared to what normally happened in the household. Interviewing on Skype caused some technical hitches around sound and recording quality but mostly worked reasonably well and had been perfected by the end. The challenge interviews aimed to find out what had happened during the challenge but also sought to uncover how that practice was normally performed in that household. As well as finding out what happened, interviews offer the ability to get inside the mind of the volunteer (Robson 2002) and so volunteers were interviewed as soon as possible after the observation and each challenge.

Having completed the observations and challenges, a couple of additional opportunities to collect data on shifting practices became available. In one case a volunteer from the first phase who had been on Economy 7 and using energy at night, had later fitted solar photovoltaic panels to benefit from the Feed-in-Tariff Scheme (FITS)[3] and reported significant shifting in his energy-use practices, particularly around laundry, to the daylight hours. In the second case someone who had not been a volunteer in the rest of the research but who had been involved in momentous shifting around energy became known to the researcher. She had bought a house without mains water or electricity and so had initially lived off a generator and had shifted all her energy use to 'the dark hours'. Recently, although she was still living off-grid, she had bought a solar photovoltaic panel and battery system which meant she had again shifted her energy use but this time to the daylight hours. Two

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[3] "The Feed-in Tariffs (FITs) scheme was introduced on 1 April 2010, under powers in the Energy Act 2008. Through the use of FITs, DECC hopes to encourage deployment of additional small-scale (less than 5MW) low-carbon electricity generation, particularly by organisations, businesses, communities and individuals that have not traditionally engaged in the electricity market. This will allow many people to invest in small-scale low-carbon electricity, in return for a guaranteed payment from an electricity supplier of their choice for the electricity they generate and use as well as a guaranteed payment for unused surplus electricity they export back to the grid. There are three financial benefits from FITs:
1. Generation tariff – the electricity supplier of your choice will pay you for each unit (kilowatt) of electricity you generate
2. Export tariff – if you generate electricity that you don't use yourself, you can export it back to the grid. You will be paid for exporting electricity as an additional payment (on top of the generation tariff)
3. Energy bill savings – you won't have to import as much electricity from your supplier because a proportion of what you use you will have generated yourself, you will see this impact on your electricity bill."
(DECC website, 7/11/2012
http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/feedin_tariff/feedin_tariff.aspx)

additional interviews were carried out with experts from the energy industry which were used to test some of the initial findings: one with a single person who helped the researcher plan and design the challenges, and the other with a team of people working on domestic shifting technologies.

All of the fifty two volunteer interviews were semi-structured to enable the line of enquiry to be modified as appropriate, following up interesting responses and asking about underlying motives (Robson 2002). There were few initial questions but a larger number of probes and prompts. Interviews were done face-to-face where possible but most of them were done on Skype. The semi-structured approach allowed the interviewer to be flexible and to delve more deeply into volunteers' responses in order to obtain a truer assessment of the respondent's beliefs (Robson 2002). In some cases it also opened up new lines of enquiry. The interviewer tried to follow the same sequence of questions but where a respondent started talking about a subject of interest the sequence of questions was sacrificed in favour of a flowing conversation. Most households did four interviews each (see **Appendix Six** for all four interview schedules) but this varied where there were multiple occupants as they sometimes had to be interviewed separately and on a couple of occasions interviews had to be redone due to poor sound quality. All interviews were recorded and transcribed by the researcher.

The length of the post-challenge interviews varied significantly, from about eight minutes to over an hour and a half depending on the number of people involved, the time available, their interest in the subject and, to some extent, their rapport with the researcher. The questions were informed by practice theory and so tried to uncover the different elements of practice in each situation, subject to the need for brevity. They also reflected the researcher's interest in the timing and sequencing of practices which is referred to throughout the thesis. Despite the fairly complex theoretical basis of this research, every attempt was made to avoid jargon and to keep the interview questions simple and open. Where Skype was used, this was mostly done the camera to enhance the quality and speed of the audio for the sake of recording clarity but this meant that non-verbal cues were lost in these interviews. As the researcher had already worked directly with all the volunteers and also knew all of them, this was less important than it might have been. However, given the practice approach, the embodied knowledge implicit in non-verbal cues is important and it was a pity to have missed this, though Halkier and Jensen (2011) talk about how difficult it is to represent this sort of knowledge in written reports.

Using interviews in conjunction with other forms of data collection in the context of a practice theory approach also provided some methodological insight, namely that just watching practices being performed was not necessarily enough to understand them fully because certain elements like institutional knowledge or engagements may not be visible. It may even be questioned whether practitioners themselves are fully aware of their practices, particularly where these arise out of engagements or habitual knowledge or 'tacit' knowledge (Pink, 2010). This speaks to the emerging debate (Hitchings 2012) about whether it is possible for people to talk about their practices (and therefore whether it is sufficient to interview people to reveal the performances in which they are engaged). Based on this research, it seems that observation and interviews are both desirable if it is at all possible to do both.

3.4   Coding the data

There is no common procedure for data analysis and interpretation in the social sciences, however (Crang 2001) explores the coding of interview data as an aid for conceptually organising materials. According to (Cope 2005), the purposes of coding are data reduction, organisation, exploration, analysis and theory building. (Bryman, Bell 2007) suggests that coding should be a continual process, where codes are made and remade as part of an iterative approach to data interpretation. Indeed coding encourages a thorough analysis of data and is intended to make analysis systematic, gradually building interpretation through a series of stages. (Bryman, Bell 2007) argues that there is no correct way of coding, rather, codes are 'creative' and rely on the researcher making sense of material and using knowledge acquired during the research process (Crang 2001). In this research, the data were initially coded according to themes (see **Table 9**). These were then used to report the results in what (Crang 2001): 230 describes as a "collage" or "dialogue", incorporating both the voices of participants, and their often differing positions, and the researcher's theoretical ideas and contextual readings. The researcher is in a powerful position when it comes to writing and representing participants (Linkogle 2000) and so the writing process is a fraught one.

Table 9: Original data codes

	Time	Practice	Active Occupancy	Change	Normal	Food	Laundry	Work and leisure
Sub-categories	Harried, disruption, shiftability, flexibility, routine, sequencing, shifting, scheduling, structuring, convenience, freedom, hard deadlines, coordination	Practice reflection, meaning, coevolution, instructions, official instructions, tacit knowledge, culture, technology, routines	Active occupancy, away, place, home	Preparation, planning, request, participation, motivation, absolute limits, money, environment, community, volunteering, family, health	Routine planning preparation convenience disruption sequencing shifting scheduling family practice reflection	Seasonal, preparation, sharing, connection, rhythm, hunger, shiftability	Reuse, smelliness, filling the machine, using the machine, visible dirt, weather, filling the basket or the machine, hygiene, dirt, work and recreation patterns, entertaining, domestic tasks, space to hang, ability to dry or iron	Work, relaxation, connecting and communicating

There is little guidance on how use a practice approach to analyse data, though perhaps advice on how to code is implicit in the theory (the elements of practices immediately suggest themselves as codes, for example). As a result, in the end, these themes were recognised as not providing a theoretical discussion compatible with a practice approach. This meant the codes had to be rearranged and the structure reorganised to reveal insights into practices and their flexibility. Halkier

and Jensen (2011) report similar difficulties with using the approach but for them, as with this study, categories were both imposed and allowed to emerge out of the data. Taking the imposed categories first, they have seven, all centred on food practices, namely: activities (doings and sayings), consumption moments, understandings, procedures, engagements, intersections between practices, and interactions about practices within social networks. In this work there are nine categories but there are overlaps as demonstrated in **Table 10**.

Table 10: Comparative table of coding categories

Group codes	Halkier's categories	Categories from this study
Practice	Activities (doings and sayings)	Practices (doings and sayings)
Elements of practice	Engagements	Engagements
	Procedures	Institutional knowledge
	Understandings	Tacit/ habitual knowledge
		Technology
Change and stability	Intersections between practices	Interactions between practices
	Interactions about practices in social network	Reflections on change, agency
		Disruption
Performance, time and space	Consumption moments	
		Time and space

No other way of coding data using a practice approach has been found and these categories were highly permeable. This highlights some of the main problems with the approach. Firstly, and significantly for coding, distinguishing between a practice's constitutive elements and the context of a practice or even delimiting particular practices from each is difficult. This manifests in a number of ways. Earlier it was seen how practices can share elements (for example, meanings like freshness might equally describe laundry or the body, or technologies like a table can be used for work or entertaining), which can make them hard to categorise. Besides this, as with all data coding, whether the data is classified as belonging in one elemental category or another is largely subjective (Halkier, Jensen 2011). Whether the whiteness of the laundry should be coded under engagements, tacit knowledge or even technology depends on context but also on how the researcher interprets what is said.

Complicating things still further, each performance also spreads over time and space, making it difficult to distinguish where they begin and end. Questions arise such as: do laundry practices include the wearing of clothes or not; are food preparation practices at home and at work part of the same practice or is food preparation at work part of working practices; where practices are co-dependent, is it possible to separate them or do they actually start to become one practice? Given the context of the research, this was even more difficult in the challenges. Understanding what is

inside or outside the definition of a particular practice is even more difficult when practices are disrupted. Do they thereby actually transform into another practice? Is eating out different from eating at home from a practice point of view, for example? Interpreting the importance of these differences is difficult. This messiness had to be resolved into the now fairly resolved narrative that is this thesis but it was not an easy process. Nevertheless, it has been one that has revealed new insights into both practices and shifting as shall be seen in the chapters that follow.

3.5   Conclusion

Part of the innovation of this PhD has been the way in which the data was collected as very little has been written on taking a practice approach to data collection. Few other examples of such extended observations of domestic practices have been discovered – the twenty four hour observations are believed to be unique to this study – and combining the collection of energy data with more qualitative methods, though not unheard of, is unusual, particularly in a demand response context. It is also believed that the setting of 'shifting challenges' has not been undertaken in energy demand shifting research before. The methods used meant ethics approval was needed, piloting had to be carefully done and compromises were necessary, in that the volunteers were known to the researcher. In the end, however, this led to greater insights into their practices, allowed more extensive access to the volunteers and resulted in better data collection opportunities than would otherwise have been the case. Taking a practice approach to data collection and coding has been difficult but this methodological robustness has been worthwhile. The following chapters will highlight the results, theoretical insights and practical implications of this process.

4 Results of empirical data collection

The previous chapter outlined how data were collected. This chapter will focus on the results of the two phases of research, the observation phase and the challenge phase. It starts with a definition of the three practices of interest as they were used in this study. It then goes on to present the data collected in phase one, the observation phase, and to outline the challenge of presenting the diverse data in a comprehensible form. After that it describes phase two of the research, first explaining what happened in each of the challenges and then how the challenge was managed and the relevant practice performed. Although extensive interviews were carried out in this phase they form the basis for the following chapters so are not analysed here. A house-by-house description of the challenges in comparison with what normally happened in the household is available in **Appendix Seven**. Finally, there is a brief section on the volunteers' feedback on being involved in time shifting their energy use.

4.1 Definition of practices in the study

Although it is obviously useful to define each of the practices used in this study it is not straightforward. According to (Røpke 2009), there is little guidance on where the boundaries of practices lie; they just 'makes sense'. Although practices must be performed (see **2.2** for a comprehensive discussion of this) and each one will be different, practices-as entities exist too. However, the boundaries between the elements are hard to determine and might be shared (competence, for example, is shared between practitioners, societies and materials). Making a definition even harder is the fact that even the same practice can look very different depending on how it is performed. Taking food preparation as an example, warming a ready meal is very different from the practice described in the previous chapter involving food growing and compost-making and might involve very different elements. Nevertheless, both are still recognisable as broadly part of the same overall practice. In addition, Røpke also points out, some practices involve carriers in roles so different that they might even be said to be part of different practices such as teachers and learners. However, given that the practice is meaningless without the participation of both teachers and learners, it makes sense to see this as one practice (Røpke 2009).

Bearing these reflections in mind, it was not clear in this study whether food preparation would include consumption (such as the teaching and learning example), or cooking or making compost. The guide, therefore, has been what 'made sense' in each household according to the data that was collected and the way the household itself defined that practice. This meant that compost-making,

like cooking, was sometimes a part of food preparation but that this practice was not seen as incomplete without it. Still, it is useful to define, more or less, how each practice was defined. Food preparation generally included everything from procuring and storing food to getting it ready for final consumption, usually eating it, and clearing up afterwards. It also included preparing, consuming and clearing up after beverages and snacks. Laundry is considered to start with wearing (or soiling) clothes and also includes collecting, sorting, washing, drying, maybe ironing and putting them away. Work (including homework) and leisure are vast categories and were generally left to participants to interpret. However, in broad terms, anything that used energy for these two practices was included, apart from lighting. Therefore, while reading a book was fine because it did not consume energy, reading a document on a computer or Kindle or a text message, was not. However, many participants interpreted the challenge as allowing them to operate their gadgets using batteries, as will be seen.

4.2   Phase one: Observing energy-use practices

The twenty-four hour observation phase of this research was developed specifically for this study and so represents one of the areas of novelty within this thesis. Four sources of data were collected during this phase; observations, energy, photographs and interviews. This section will focus mainly on the difficult task of bringing together these data in different ways in order to highlight different aspects of domestic energy consumption practices. The objective was to fulfil the interdisciplinary ambitions of the work by integrating and accessibly presenting as many types of data as possible so as to allow new insights into how practices might be shifted.

4.2.1   Making energy-use practices visible

Normally in engineering studies, the focus would be on the energy data, which is often absent from more sociological work but there are several problems with relying solely on such data. **Figure 13** shows the actual energy profiles for the households observed although, for the purposes of this graph, they all start and end at midnight, which does not correspond exactly with the observations which started and ended at different times to suit volunteers. Despite the apparent chaos in this graph, several interesting issues are revealed when the data are put in the broader context of the study. The household with one of the lowest energy footprints and possibly the most energy conscious practices also has one of the highest peaks (Household 7), caused by an electric shower, which nicely makes the point that technology can 'lock in' certain high energy-use practices despite the best of intentions of the carriers of those practices.

Also, although all of these houses were just getting on with their 'normal' days, their profiles look very different. This individualised household data can be modelled (Richardson 2010) but still does little to explain what is going on inside the 'black box' of the household (Burgess 2008). Linking the energy data with the observations and interviews helps this understanding somewhat. Three examples demonstrate the point in **Figure 13**. Firstly, the couple who live in Household 10 have a fully electrified flat and, though it is small and they are out most of the working day, they use a lot of electricity because the hob, shower and heating are all electric (the pale green spikes between 15h30 and 07h30). Secondly, the mum who uses the oven in the afternoon (Household 5) is baking cupcakes with her daughters because they are off from school and the next day is one of them has a birthday. She also puts dishwasher on a delayed start to make use of Economy 7 (the dark blue spikes between 00h30 and around 02h00). Thirdly, the man whose laundry seems endless has had a house full of twelve guests to stay (the purple spikes at 12h00 and again at 18h30 but he had already done four loads of washing the previous day). Although these spikes and the observations do not, as shall be seen, tell the whole story, they do start to get beneath these squiggly lines denoting energy consumption to reveal the everyday lives of people.

Figure 13: Actual energy profiles of households during observation period
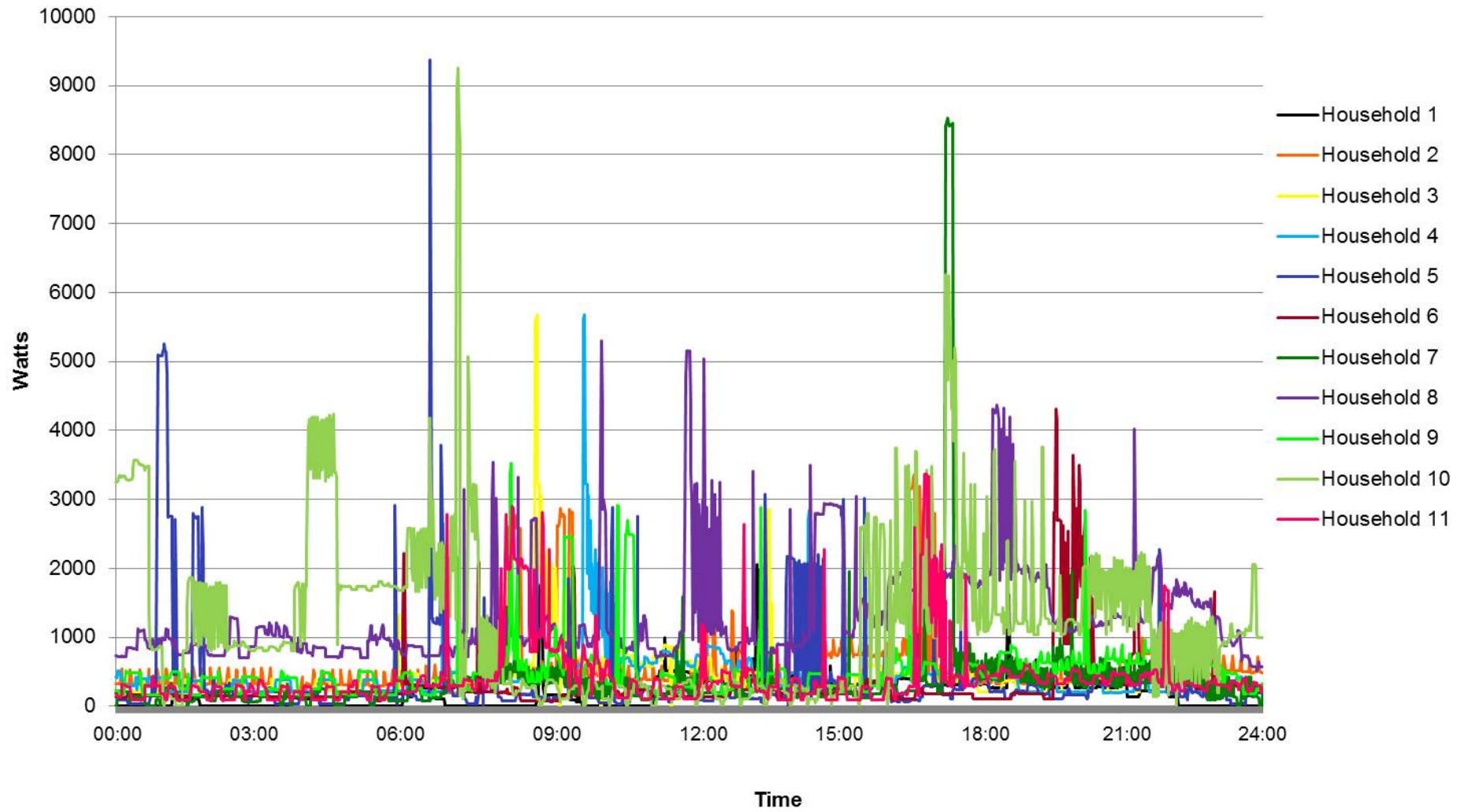
The consumption curves of individual households do not resemble the normal peaks and troughs of average, national consumption. Indeed, in some houses these 'normal' peaks seem not to exist at all. Aggregating all the data for the observation period as in **Figure 14** smooths out the graph somewhat and reveals a slight peak in the morning and evening but, for so few houses and for such a limited period, a normal consumption curve should not be expected. Instead, what is more interesting for the purposes of this study, is to zoom in on the data and see if it can reveal anything new about energy-use practices in the home.

Figure 14: Aggregated energy profile of all households on observation day
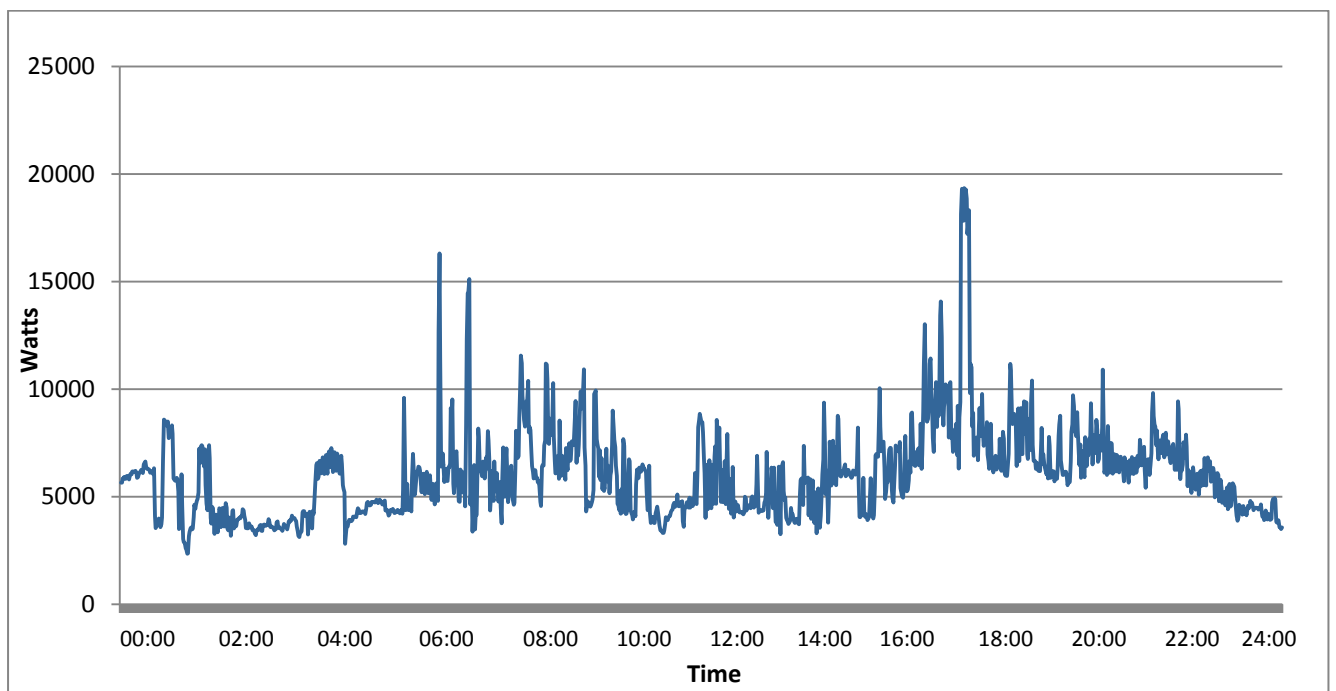
Accordingly, an attempt was made to match the logged energy consumption data with the observational data, though this was more complicated than anticipated. The energy data was stochastic and both types of data were unwieldy and difficult to collate. Looking back at **Table 8** from the previous chapter, for example, and comparing it with **Figure 15**, which shows the minutely electricity consumption data corresponding to this observation data, it is possible to show how difficult the matching task is. The first thing to notice about this, or any, energy graph is that it is the whole area under the line that is significant from an energy consumption point of view. This may seem an obvious point but the tendency is to focus on spikes and peaks. Although these may show an increase in the amount of energy being consumed, this is not necessarily significant unless it goes on for a long time or happens frequently.

Figure 15: Excerpt from energy data that corresponds to observation data in Table 8
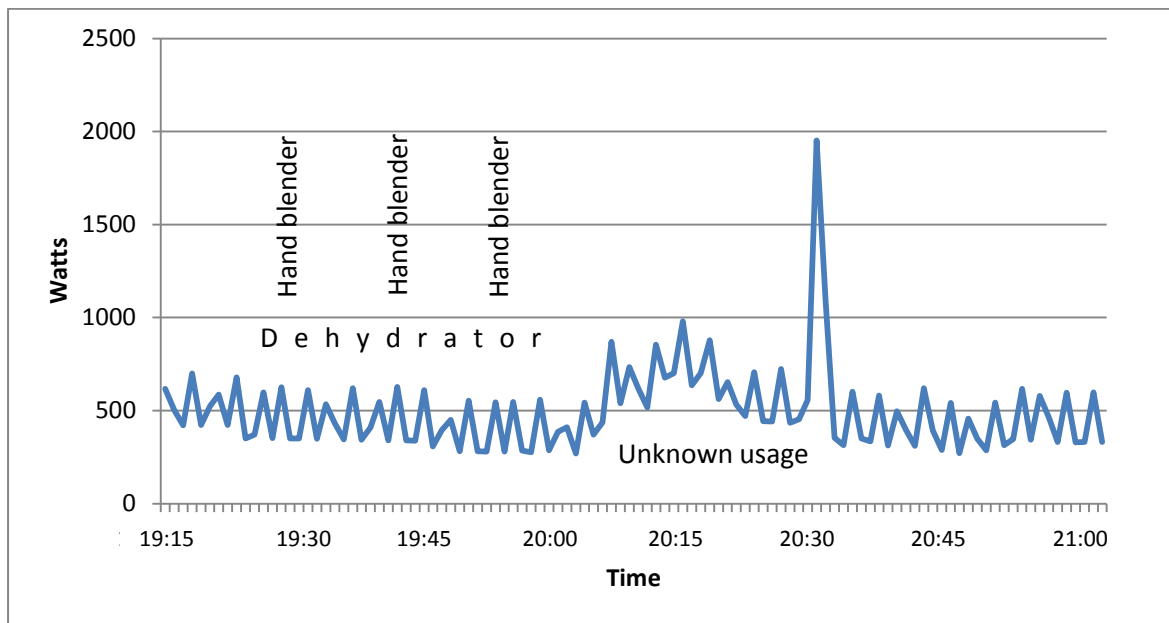
The second point is that the energy consumption represented by this graph is made up of multiple appliances. When measuring whole house electricity data it is impossible to differentiate between different appliances unless they have recognisable cycling patterns or use a lot of energy. Appliances such as kettles, white goods, electric showers, heaters and cookers tend to be visible and can sometimes be identified by means of their specific 'signature' but without plug in monitors, even these can be lost in the noise of the other appliances being used. This simultaneous use of appliances, and the fact that there is a 'base load' that runs continuously, means that electricity data is 'noisy' and that energy usage is not always attributable even to an appliance, never mind a practice.

This is what happens when zooming in to look at one household, time period or practice such as that covered by **Table 8**, for example, in which the observation data for a household is presented. Even though this represents less than two hours, one hundred and five energy data points were captured. The resulting graph (**Figure 15**), despite (or maybe because of) its high resolution is almost impossible to interpret and trying to match it to the observation of this period does not help. As can be seen by the annotations on this graph, the energy usage by the hand blender and dehydrator observed and noted in **Table 8** cannot be seen on the graph, whereas an almost 500W increase in consumption and a very noticeable spike cannot be accounted for by the observation. Although somewhat disappointing, this is not at all surprising. The consumption of hand blenders and dehydrators is very small and so is 'lost' in the noise of the data and it would be easy for someone to

slip out of the room and switch something on unobserved by the researcher, as must have happened at 20h05 in **Figure 15** while the researcher sat at the table eating dinner according to **Table 8**. Meanwhile the unusual pulsing on and off of an unidentified appliance made the graph unusually jagged. Upon seeing this consumption pattern, the researcher worked out that this was probably a thermal device using 200-300W every minute or so, such as an absorption fridge (which uses a heat sources to provide the energy needed to heat the cooling system). This was confirmed by the householder.

These difficulties all point to one main and important point. The invisibility of energy has often been discussed in relation to energy users but here even the researcher who was specifically looking for energy-use practices often missed them. This highlights an issue that will come up repeatedly throughout this chapter: namely, that there are different ways of viewing energy. The point has often been made that while for engineers energy might be about kilowatt hours, and for economists it is about pounds and pence, for energy users, it is about energy use services and what is possible as a result of using energy. The slightly more subtle point being made here is that the *perception* of what people are doing and the energy that associated with it are different from the energy that is actually getting used. In the domestic world it is often not at all obvious where all the energy is going.

Rather than invalidating the use of either the energy or observation data, however, this sort of triangulation is helpful. On the one hand, the observation allowed the preparation of a raw food dinner to be seen, a whole practice which would have been invisible had only the energy data been collected, and on the other, seeing the increase in consumption in the energy logging data could have allowed the researcher to interrogate the energy data with the householder, which might have revealed what caused the increase. While it would have been possible to identify particular appliances using plug-in meters, an in-depth energy analysis of households was not the aim of the study and so this data would most likely have represented a distraction rather than being illuminative. Besides, it would not have been possible to predict in advance what appliances might be associated with what practices, so making it difficult to know which appliances to monitor.

Although it was difficult to match the energy data and observations, this was eventually achieved much more closely in the researcher's own household. Accordingly, **Figure 16**, **Table 11** and **Figure 17** match up rather better than the previous example, partly because lessons had been learned from the difficulties of gathering data in other households and also, probably, because the researcher understood her own house better than the others she observed. **Figure 16** shows the energy data

collected during the observation day in Household 11, with the shading highlighting the area that is detailed in the observation, outlined in **Table 11** and **Figure 17**.

Figure 16: Energy data during 24 hour observation with shading showing detail in Figure 17
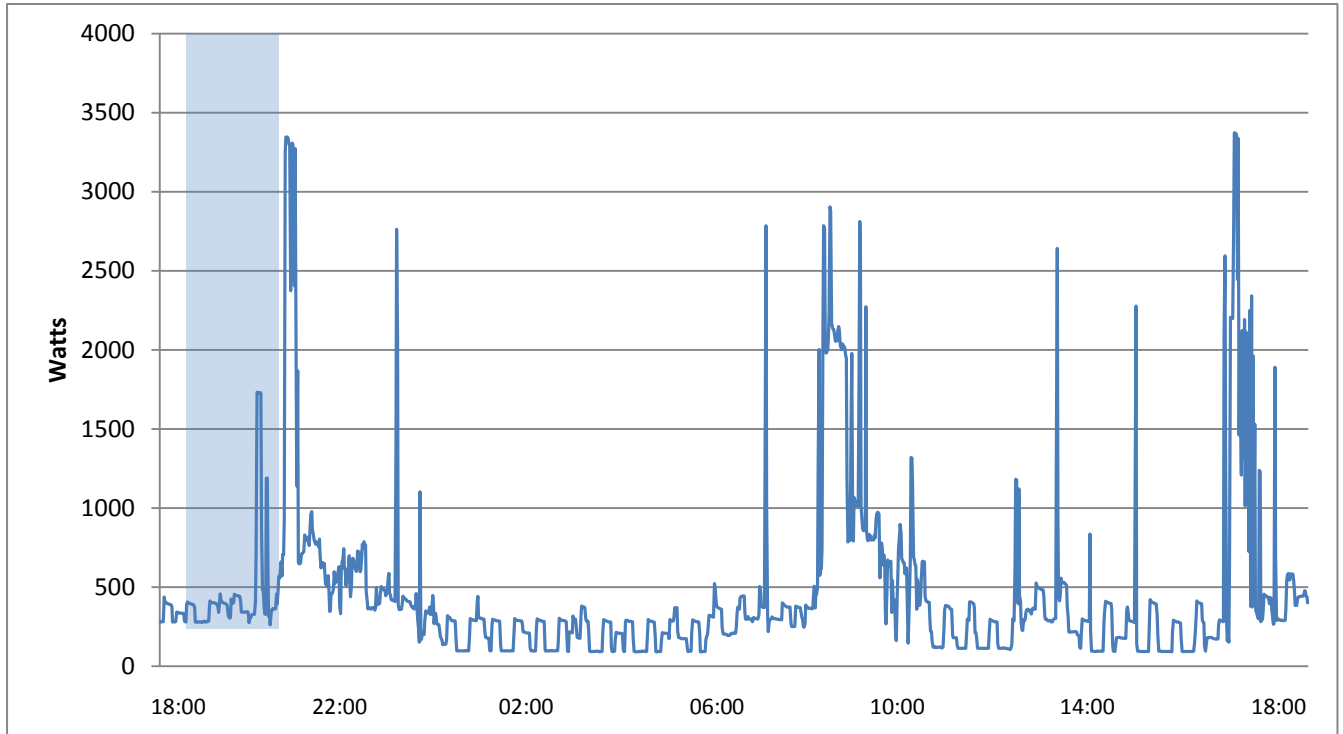
Table 11: Excerpt of observation data

Start	End	Who	Where	What	Comments/ questions
19.14	20.21	A	Hallway	Sitting on 'kitten chair' observing household and finishing off paper review. Computer on battery.	Old fridge freezer and under counter fridge and freezer. Lights switched off unless in use. Housemates encouraged not to leave appliances on standby but Virgin box is on all the time. House alarm cannot be turned off.
19.25	19.25	C	Hallway	Arrives home	
19.26	19.30	C	Kitchen	Puts shopping on table and gets food out of fridge. Then packs shopping away (fridge open quite a lot of the time)	A tells C that observation is being repeated. C says that she's going to be longer using the microwave because she forgot to take her dinner out of the freezer this morning
19.30	19.34	C	C's bedroom	Goes upstairs (no light on), Bedroom light on	A calls up to C that she has lots of parcels which were delivered to neighbours initially but are now here. Closes curtains (19.33)
19.34	20.00	C	Bathroom	Light on, fan on. Has a shower	Goes back into bedroom to get something at 19.41. Actual shower 19.42-19.53
20.00	20.37	C	C's bedroom	Light on	
20.01	20.01	C	Bathroom	Runs tap for a while. Not sure why	Light not on. Returns to bedroom where light was left on
20.04	20.10	C	C's bedroom	Hair drier on	
20.21	20.30	A	Kitchen	Gets dinner (salad out of fridge bought ready made in London today) and toast. Fridge open briefly	In between also doing timeline so takes longer than normal as has to also monitor what others are doing
20.15	20.18	A	Kitchen	Toaster	
20.18	20.21	D	Hallway	Puts on shoes to go to gym and chats to A	
20.21	20.21	D	Leaves house		
20.21	20.30	A	Kitchen	Light on	
20.23	20.27	C	Utility	Light on	Packs washing machine
20.27	20.59	C	Utility	Washing machine on	Goes back into bedroom to get something at 20.26. Puts powder into machine and sets it

20.28	20.28	C	Bathroom	Runs tap for a while? Not sure why	Light not on. Returns to bedroom where light was left on
20.32	21.30	A	Hallway	Overhead light on so can see dinner ingredients better	
20.36	20.55	C	Kitchen	Light on	Leaves light on while goes upstairs
20.36	20.38	C	Kitchen	Gets food out of freezer (open for about 2 minutes)	
20.39	20.45	C	Kitchen	Microwave on	
20.40	20.40	C	Kitchen	Gets stuff out of cupboard, puts rice into pot. Puts things back into cupboard. Puts water into pot	
20.41	21.11	C	Kitchen	Gas on to cook rice	
20.42	20.47	C	Kitchen	Makes sandwiches for following day and then puts things away again	
20.42	20.42	C	C's bedroom	Goes upstairs (no light on) to get something	
20.48	20.54	C	Kitchen	Microwave on	
20.49	23.00	C	C's bedroom	Goes upstairs. Light on	
20.53	20.53	C	Bathroom	Runs tap for a while. Not sure why as door closed	Back to bedroom
20.54	20.54	C	Kitchen	Gets food out of microwave and mixes around	Brings tea pot down but uses it for cold water. Pours out remaining water then rinses it out (fills and pours out whole pot). Takes pot and an apple upstairs 20.55
21.02	23.00	C	C's bedroom	Laptop on	Hear it turn on (cannot see as bedroom door is closed)

Figure 17: Exerpt of energy data corresponding to observations in Table 11
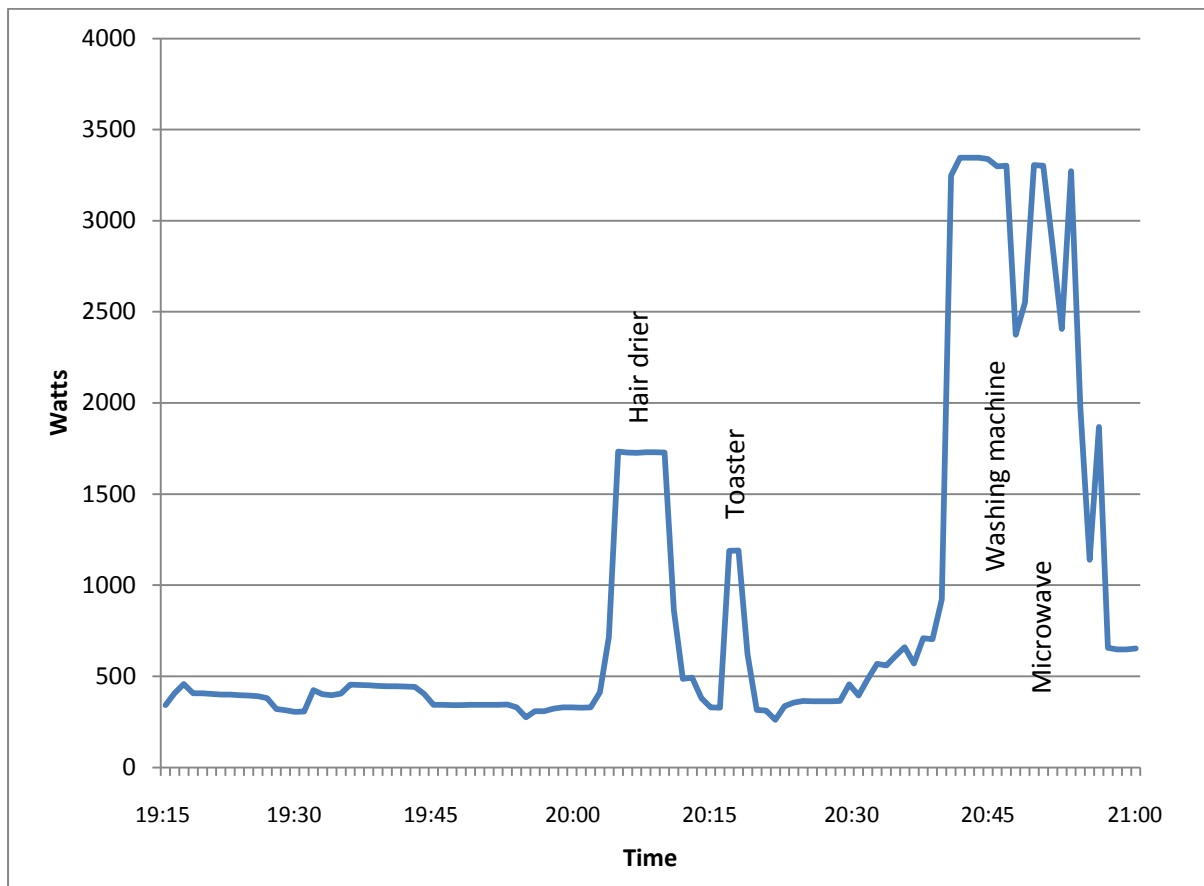
Examining the data in this detail and combining it with the observation data reveals a number of items of interest. Firstly it is clear that there is still a significant and largely unexplainable (in the context of this study at least) base load. In **Figure 16**, however, it is possible to see the cycling of the refrigerators and freezer which make up some of this load, something which is not visible in the more close-up view in **Figure 17**. Secondly, there are energy-use practices going on which are not actually using energy at the time, such as the computer being used on a battery. Practices using rechargeable appliances complicate matching energy-use practices with actual energy use because they may not coincide.

Thirdly, even though the consumption spikes are mostly visible, there are still invisible practices going on, such as the use of the microwave (the profile of which is hidden by the profile of the washing machine) and the shower (hidden by the fact there is a gas boiler to heat the water and the fan light does not use enough power to show up). At issue here again is the fact that metering alone cannot make practices visible. This is an interesting corollary of the earlier revelation that watching practices cannot reveal energy use on its own. Although a slightly philosophical point, it is *the way of*

looking that makes something visible or invisible. Related to this, there were some cases where energy use during the observations was not seen but was heard (the blender) or felt (the heating system), so emphasising the point that there are different ways to experience and observe energy use. Rather than suggesting energy is invisible, this suggests it is actually inextricably embedded in practices. This further justifies the use of an interdisciplinary approach that uses several different methods to understand energy-use practices.

Fourthly, it is evident that some practices remain invisible despite being subjected to observation and energy monitoring. Although practices in the communal spaces of the house were able to be observed in some detail, others went on behind closed doors. Here the interviews provided additional insight so that the researcher was able to know, for instance, that whereas other members of this household used their computers mostly for work, volunteer C in this excerpt seldom worked from home and used the computer to watch a favourite Chinese soap opera while she ate her dinner in her room and would later use it to talk to her boyfriend in London using Skype. The fact that this volunteer was also the researcher's housemate provided an especially privileged view of the household. Also, this house was formally observed three times due to problems with the energy data. Whereas permission for multiple observations would not be possible in most circumstances the researcher was able to convince her housemates to participate repeatedly.

Fifthly, the observation and the energy profile of this multiple occupancy household reveals that the period of active occupancy is quite long. Nevertheless, there are discernible peaks at from 19h45-23h45, 6h45-10h30, 12h30-13h30 and then from 17h00 onwards. This was similar to other households (where they are occupied during the day) and suggests that there is a 'normal' rhythm to energy-use practices, attested to by the significant peak time demand on the grid, and contradicts the assertion of several participants that there was no such thing as a normal day. This made it easier to set up the challenges in the second phase. Although measuring the energy data was not straightforward, therefore, and the insights revealed were more subtle than had originally been anticipated, it was a useful exercise.

4.2.2 Comparing the data between households

Having taken a close-up look at a couple of households' energy use, it is worth drawing back slightly to see what useful information can be gleaned about energy usage across households. On the face of it, an apparently simple analysis would be to compare the total energy used by each household on the day they were observed. However, this is problematic in a number of ways: the days are not

comparable as some fall in the summer and some the winter, the houses differed widely in construction, the number of occupants and occupancy patterns were different in different households and the numbers and types of appliances differed widely too. Looking just at the total energy consumption in these households, therefore, tells us very little. **Figure 18**, for example, shows there is a nearly seven times difference between the total amount of energy used in the household that used the least energy (household 1) on the observation day and the one that used the most (household 8), even though both house a single person living alone. This chimes with (Jensen 2008) finding that despite dwelling consumption (square meters per resident) being a decisive factor in overall consumption rates there are still huge unaccounted for differences in consumption rates of 6%-700% between similar households.

Figure 18: Total energy used by households on observation day
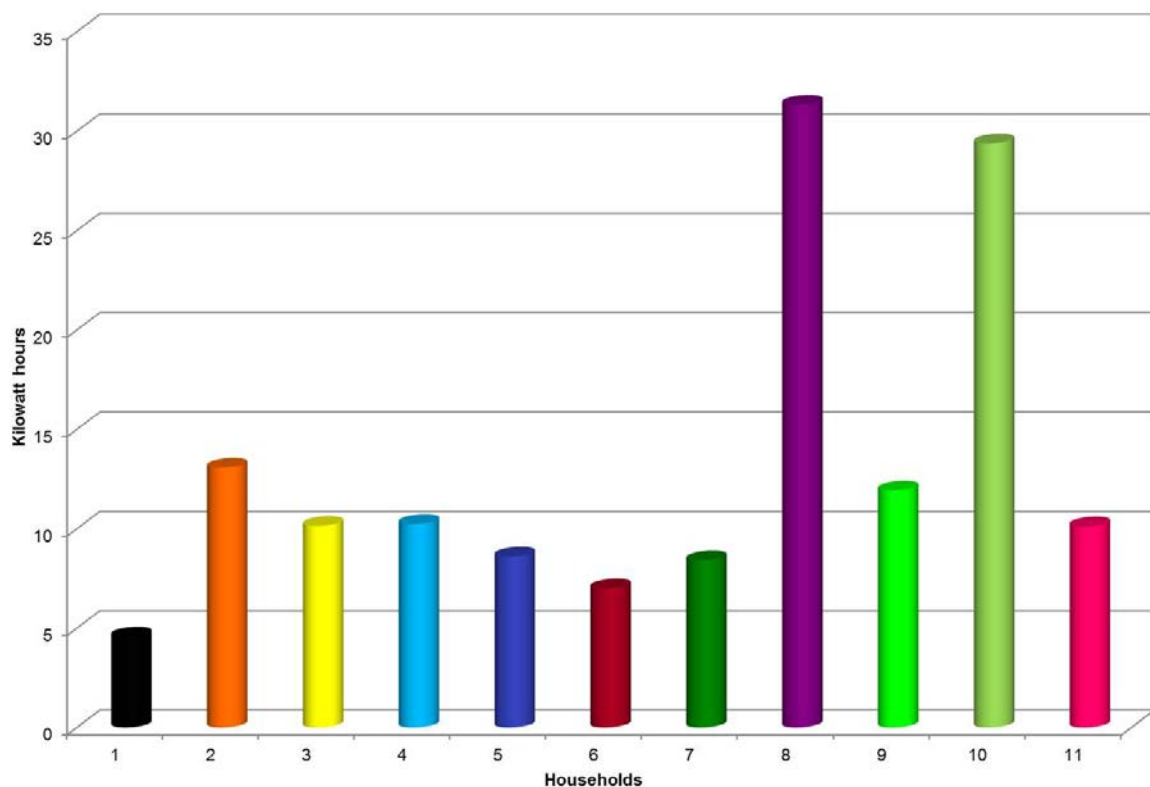
However, linking the energy data with inside information gleaned from the observations may reveal more as outlined in **Table 12**. Combining the observation data with the energy data in this study means, although questions do remain, some of the reasons for these differences in consumption become clearer.

Table 12: Comparing energy usage using the observation as a reference point*

Energy used	ID	Description of the household	What went on in the house on the observation day
4.57kWh	1	Single female, owner of 2 bedroom terraced house	She was aware of the fact that she was being observed and may have modified her behaviour. However, she lives on her own, turns things off, does not use her television except to watch films and has a gas oven. She did not use any large appliances on this day and the food was cooked in advance.
7.00kWh	6	Single male and unmarried couple renting 2 bedroom terraced house	Single man was out most of the time. When in, mostly in room using laptop. Woman and man of couple were each out for a few hours. Both members of couple spend most of their time in their room where they would have been listening vinyl records some of the time and working using 2 laptops. No TV, electronic gadgets or washing machine but there is an electric hob.
8.60kWh	5	Two adults and two children, owners of 3 bedroom detached house	Man out all day at work. Woman and children out for a few hours but in from late morning. Salad for lunch. Fairly regular cups of tea and making cupcakes uses oven in middle of day. Woman out in evening so dinner is a takeaway and chatting (no TV or music). DIY in late afternoon – not much energy (vacuum and drill). Children's food is cooked on gas hob and they're in bed early. Woman out in evening. Man gets takeaway and chats in evening. Dishwasher runs but no other major appliances on. Electric shower causes high peak (short duration) at 6h30.
8.41kWh	7	Married couple, owners of 2 bedroom terraced house with converted loft	Had a dinner party but prepared raw food so no large appliances used. Then watched film but on a laptop so low energy. Next day had someone for lunch but again raw food so no appliances. All went out for long walk with dogs. Guest then left and couple went out to fetch 20 boxes of vegetables so were out for a couple of hours. Electric shower causes high peak at 17h30.
10.14kWh	3	Single male owner and two single female renters, 3 bedroom semi-detached	Two people live separately in house. Weekend day so one out for most of day and late into evening. Summer (lunch eaten outside in garden). Laptop and large desktop computer and screen in use most of day. DIY going on (fitting loft ladder) but no energy. Business meeting late in day. Electric oven used for dinner. TV on in evening and some of the day.
10.24kWh	4	Single female and 16 year old daughter, owner of 4 bedroom terraced house	TV on both evenings, some ironing done. Gas fire on in living room in evening. Gas oven used for dinner on second evening. Kettle also on gas hob. Guest staying but at pub in evening. House empty during school hours and then just daughter between about 15h00 and 18h00. She has no heating in bedroom so uses electric heater. Plays music and studies after school.
10.12kWh	11	Single female owner, 3 single renters, 4 bedroom semi-detached house	Four people live separately in house. House occupied all day though only by one person using laptop, others out during day. In evening four laptops and people in separate rooms. Washing machine used twice. Oven used for dinner. Kettle and microwave used several times throughout day.
11.92kWh	9	Single female owner of 4 bedroom detached farmhouse	Large house. Owner spends most of the time in the winter in the kitchen- diner which is heated by the Aga (in summer she stays in the conservatory). Lots of gadgets which may be left on standby quite a lot. Large appliances like TV, fridge, etc. are quite old and so probably inefficient.

13.06kWh	2	Two adults and two children, owners of 4 bedroom detached house		Large and very busy house with lots of gadgets and quite high tech. Several things on standby. All mostly at home (lots of time playing board games) though mother and children out briefly on bikes and parents out in evening for a couple of hours. Children's dinner warmed in microwave, adults eat takeaway. Kettle warmed on gas hob. Dishwasher on in morning. Washing done but in downstairs flat as washing machine in house is broken. TV on for some time during the day and in the evening.
29.38kWh	10	Married couple owners of two bedroom flat with balcony		Electric heating, shower and hob accounts for high usage. No TV, only 1 laptop. No major appliances used. Man and woman out all day at work though heating comes on at around 15h30
31.33kWh	8	Single man owner of 6 bedroom detached farmhouse (frequently occupied by up to 12 people)		The largest house in the study with a high base load. The entertainment system and amplifier in particular are high energy and most of the lights are halogen. Lots of gadgets, USA-style fridge and two ovens, high tech house. Day spent out in garden and at shops in afternoon and working on computer in morning. Oven used for dinner and lunch, dishwasher was on twice. High load partly accounted for by six loads of washing, which were done as people had stayed the previous weekend.

* For a more detailed description of each household see **Appendix Seven** This outlines what happened during the challenges compared to what they normally did, as understood during the observation and through the interviews.

In thinking about shifting energy use, it is not necessarily the total energy use which is significant. **Figure 19** shows the maximum power used in each house on the day of the observation and highlights again that it is not necessarily the height of the spikes on a graph that determines how much energy is used in the household. In this graph households 5, 7 and 10 are all high because they have electric showers which draw a lot of power. However, households 5 and 7 actually have quite low total electricity consumption and 10's high consumption is explained by the fact the house runs entirely off electricity. Household 8, on the other hand, looks fairly average on this graph as, despite the amount of energy used on this day, the maximum amount of power used at one time was just over 5kW and even this was probably made up of the oven and washing machine running at the same time. This demonstrates again that there is no correlation between maximum power and total energy consumption. While power and energy consumption are both relevant to this work because they may focus the attention on places where shifting would be valuable, these fairly straightforward comparisons are not all that revealing and are not all that different from what has been done by many people many times before. What seemed more interesting was to try and present these diverse sources of data concurrently to see whether this revealed anything new, which is what the next section will discuss.
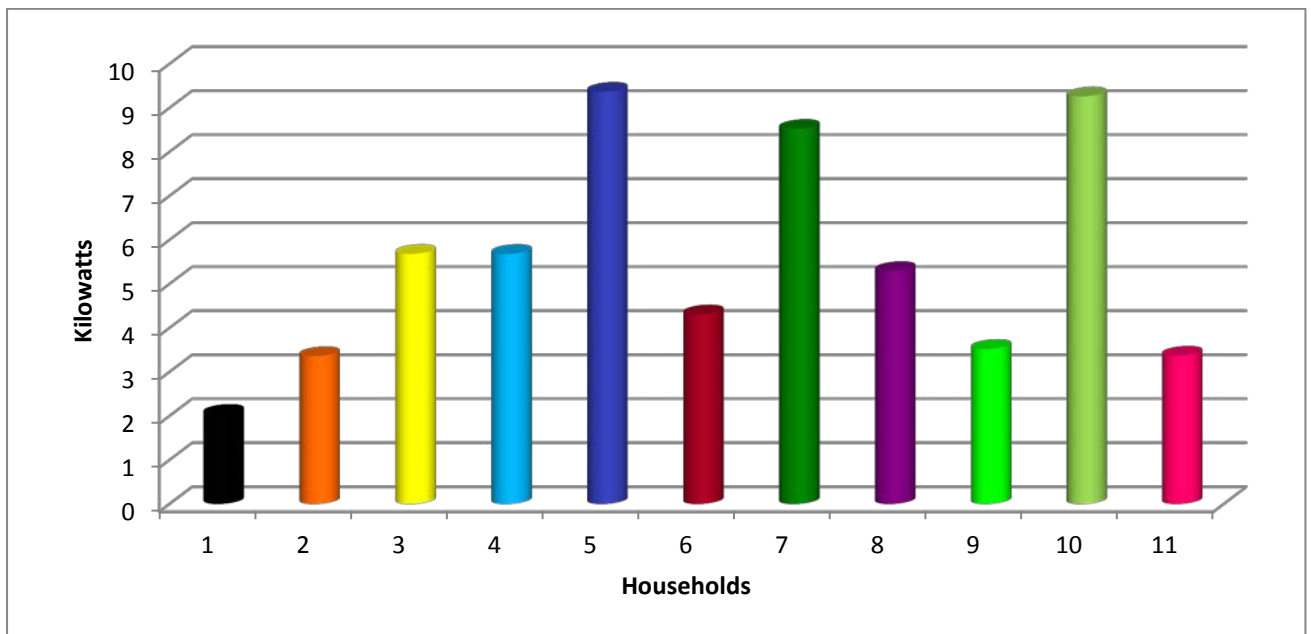
4.2.3 Presenting the data concurrently and comprehensibly

One of the ambitions of this work was to interpret and present diverse sources of data simultaneously on one page in a way that tells the reader something they might not have noticed initially when looking at each set of data in isolation. This section describes various new ways of presenting the energy data, observations and photographs concurrently and in the context of what was learned from the interviews.

Before presenting the data, it is worth briefly reflecting on the role of the interviews in this phase of the research. The initial ambition was to describe energy-use practices on a 'normal' day. While some volunteers claimed not to have such a thing as a normal day, discernible rhythms and patterns are evident when looking at the data. In what follows, the interviews may not seem to impact much on what is presented but it should be noted that it was the interviews as much as the observations that helped the researcher understand what was normal and so the interviews provided crucial contextual information both about what went on during the observations and about how to structure the second phase of the research. The interview data is analysed in detail in the chapters that follow.

Moving on to presenting diverse sources of data simultaneously: the first attempt to do this is the graph presented in **Figure 20**. At the top of this figure the time of day is highlighted in blue shading to highlight the fact that the X axis does not run from midnight to midnight as is normally the case:

this one is set to correspond with the observation period. Under this is the 'active occupancy' of the household, which corresponds quite closely with energy use in most cases, is highlighted in yellow. This also helps to show who is using energy at any particular time. At the bottom of the figure is the now familiar energy graph showing consumption over time. This has been annotated using photographs and text outlining what went on during the day so that the observation is linked directly to the energy data. Some practices have been pulled out and appear in purple blocks. This is understandably not an exact science because of the complexity of practices but it starts to link activities and energy together in a way that demonstrates, for instance, that laundry is about more than just the washing machine, tea about more than the kettle and preparing food about more than the oven.

One of the advantages of presenting the data in this particular way is that it provides a sense rhythm through a whole day in the household. It is easy to notice in this slide, for example, the regular rhythm of the kettle and meals. Highlighting the temporal aspect of practices and their energy use is a useful way of starting to notice how practices might be shifted.

Figure 20: Presenting multiple sources of data concurrently
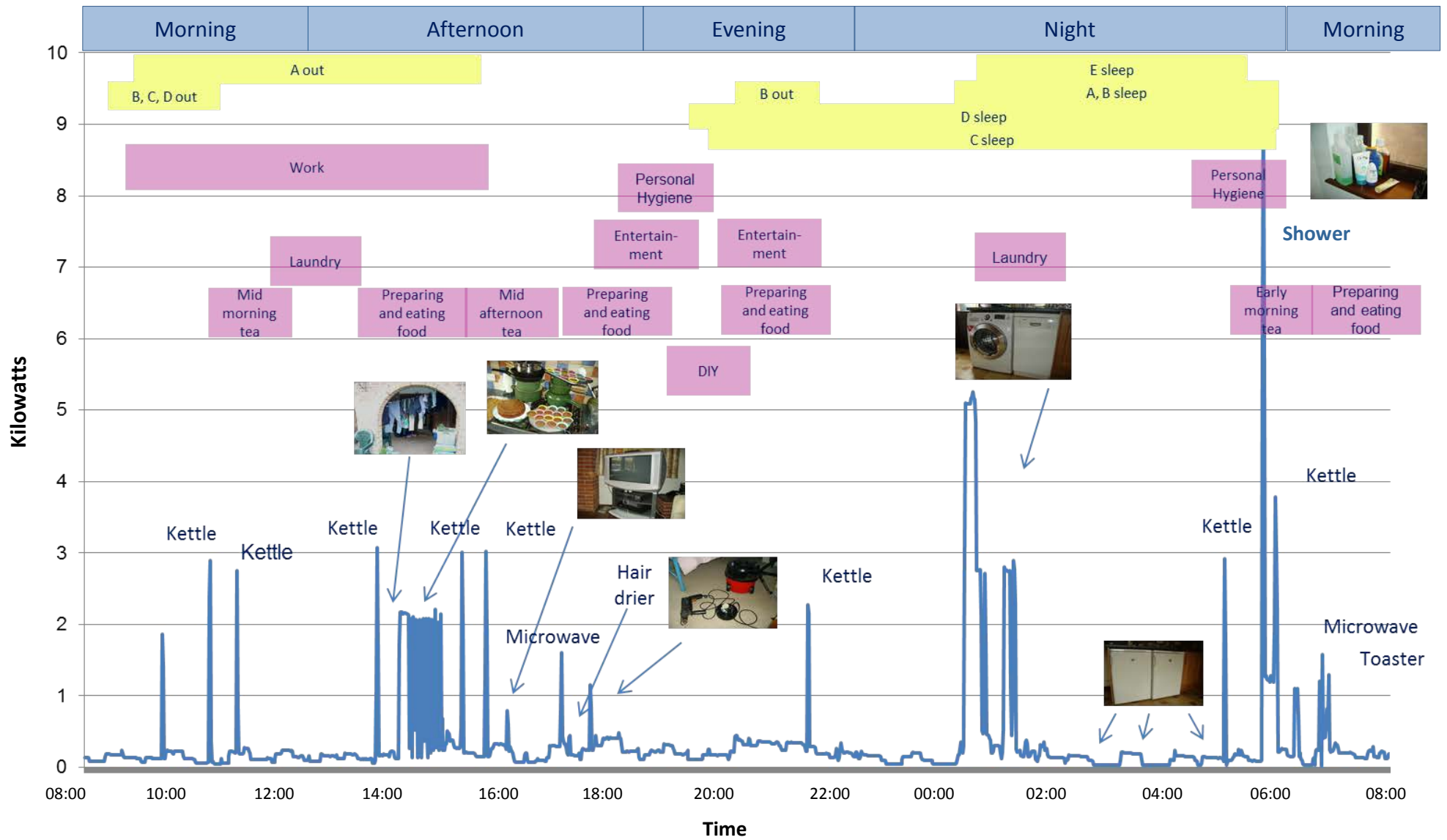
The second way of presenting the energy data concurrently with the observation was to link the two of them together in a spread sheet, an excerpt of which is shown in **Table 13**. The left hand columns of this table show the start, finish and duration of each activity. The duration links with the energy measurement data and is colour coded in Excel using conditional formatting. This varies the colours according to the extremes in the table and shades the ones between accordingly. There is a significant difference in how the energy data in this table is represented compared to previous representations in this work. An attempt is made to move away from the focus on spikes and troughs in the previous consumption graphs because of how misleading these can be. In **Table 13** the average power for each period is calculated from the logged data. The table therefore combines the level of consumption with its duration so that the darkest red colours represent significant electricity use over time. For example the washing machine turns on at 16.40 and suggests the average power during that hour and a bit was just over 2kW, making it just over 2kWh. The average power column indicates periods of high usage so that this one looks high and is a dark shade of pink but two lines below it looks even higher. However, because this only goes on for 13 minutes it does not use much energy overall. A better indicator, therefore, is the next column which recognises that average power over a period of time multiplied by that period of time equals the energy consumption. It is therefore the combination of high power for a long time which appears in the energy column and is significant. A good example of this is the consumption at 17.44 where the halogen lights are switched on and then left on for some five hours, with an energy consumption of over 10kWh.

Table 13: Presenting energy and observation data concurrently

Start	End	Inclusive Period (hh:mm)	Average power (W)	Energy (kWh)	Who	Where	Activities and practices
14:58	15:33	00:36	1291	0.775	A, B	Living room	Drinking tea
15:33	16:36	01:04	733	0.782	A, B	Garden	Wellies on. Planting and pulling things out in the garden (washing machine stopped in meantime)
16:36	16:36	00:01	957	0.016	A, B	Come inside	Unloads and reloads washing machine.
16:40	17:50	01:11	2027	2.399	A	Utility room	Washing machine on.
16:40	16:46	00:07	1173	0.137	A	Upstairs	Takes washing out to hang in airing cupboard upstairs
16:46	16:58	00:13	2560	0.555	A	Office	On the phone (halogen lights on)
16:36	16:39	00:04	1134	0.076	B	Dining room	Timeline. Lights on (halogen)
16:39	16:45	00:07	959	0.112	B	Spare room	Sorting things out. Lights on
16:45	17:44	01:00	2191	2.191	B	Dining room	Making phone calls. Timeline.
17:44	22:45	05:02	2037	10.258	B	Dining room	Turns on halogen lights
17:03	18:02	01:00	1918	1.918	A	Upstairs bathroom	Bath and meditation time. Lights and Jacuzzi bath. Radio on
17:44	18:02	00:19	1324	0.419	B	Goes outside	Makes phone call (washing machine on spin cycle and want to see moon). Washing machine finishes while out
18:07	18:15	00:09	2298	0.345	A	Utility room	Takes laundry out and takes it to hang in airing cupboard upstairs
18:07	18:15	00:09	2298	0.345	A, B	Outside	Go to fetch washing from outside
18:07	18:15	00:09	2298	0.345	A, B	Shed	Also fetch potatoes from shed
18:17	19:17	01:01	2493	2.535	A, B	Kitchen	Oven on. Making dinner. Gas hob on. Eating artichokes and walnuts

While it is a good idea to try and match observed activities and practices against what energy was consumed over that period of time, what this table really serves to do is to show how difficult that is. Firstly, the energy monitor was measuring total energy consumption and so the fact that appliances operate simultaneously still creates noise. For this sort of table to work properly, it would be better to use data from individual appliance monitoring, which has already been discussed. Secondly, activities would have had to be recorded more like they would be in a time use survey were they to be easily plugged into a table like this. However, individual accounting for how time was being spent would have moved the study away from the idea of observing practices. Thirdly, the table does not distinguish between people and machines doing things which is obviously relevant for energy use and has implications for shifting strategies. Fourthly, there are many instances where the energy consumption does not occur while the activity or practice is going on, such as filling the dishwasher or eating food.

Nevertheless, developing a way to present this data was still interesting and served to highlight appliances that use a lot of energy because they tend to be left on for a long time. As such, these appliances represent significant shifting opportunities. In the case of the example in **Table 13** the lighting consumes the highest amount of electricity. This accords with (Green, Ellegård 2007) who found that in large houses lighting accounts for the largest category of energy use, followed by cold appliances and then the combined category of information and entertainment (DVDs, audio, TV, computers, VCR, etc.). Although lighting may be difficult to shift, in this case halogen lights could be substituted over time for LEDs, so reducing the energy consumption and so contributing overall to demand side management even if not directly to demand response.

The right hand column of **Table 13** lists the practices being performed (at least those that were observed by the researcher), as well who was performing them and where. Again, this is difficult to represent in tabular form as it tends to reduce practices to activities. Nevertheless, the practices have been loosely colour coded so that pink is food preparation, yellow is laundry, green is leisure and blue is work. It is also worth noting that as practices are temporally spaced, are different each time they are performed and may involve different appliances, measuring the amount of energy used by them is probably impossible. Even in this household, where the laundry was performed six times during the observation, which may have been expected to give some indication of how laundry was normally done in this household, it was done slightly differently each time in that two loads were dried outside, two on the airing rack in the utility room and two in the airing cupboard upstairs. While this did not have actual energy implications, it does serve to make the point. The

interview also highlighted the fact that, although he frequently had a house full of people, these performances of laundry were considered to be unusual by the householder in that they did not represent his own laundry but that of guests.

The third way of trying to represent the different data uses the information gathered in **Table 13** but organises it differently to reveal different insights, as presented in **Table 14**. The aim here was to take the first steps in creating a map of practices in recognition of the spatial locatedness of practices and therefore, by implication, of energy consumption. Accordingly, each column represents a different room in the house (though only two are shown here). The technology (in the practice theory sense of the word) is approximately listed whether or not it uses energy (a full inventory of each room was not possible in this study as discussed in the methodology). Also noted are the people involved in particular activities and what times each room was used for a particular practice. Where those practices occurred in a different room, they were included there. So, for example, food preparation also went on outside the house – the vegetable garden was tended, shopping was done and potatoes were collected from the shed, but these did not take place in the kitchen and so are not listed here. The drying of laundry also happened in other places than the utility room. Conversely, where different practices took place within a particular room, they were included. An example here is that all meals were eaten in the kitchen which is arguably part of food consumption rather than food preparation but both practices are listed here. Times and energy related to food consumption are distinguished by being in parentheses.

Table 14: Moving towards a map of practices in the house

	Utility room	Kitchen
Person	A	A, B
Technology	Washing machine, drying rack, sink, cats' eating area, washing, cleaning products, vacuum cleaner, ironing board, storage cupboards	Fridge/ freezer; dishwasher, sink, oven, hob, microwave, toaster, TV, kettle, radio, storage cupboards, eating utensils, plates, food, drinking vessels, recycling boxes, compost box, waste bin, lights, breakfast bar with chairs
Activities	Sorting laundry, washing laundry in the machine, drying laundry on the rack, feeding cats	Preparing meals, putting away shopping, making tea, washing up, (eating) *chatting, watching TV, listening to radio*
Times	13:40-13:42; 14:49-15:56; 16:36-16:40; 16:40-17:50;	(13:15-13:40); 13:40-13:45; 13:42-13:44; 13:44-14:25 14:44-15:33; 14:46-14:48; 14:49-14:53; 14:54-14:54; 18:17-19:17; (19:35-20:00); 21:04-21:10; 21:36-21:42; 7:17-7:18; 7:45-7:56; (7:56-8:24); 8:25-8:25; 10:10-10:11; 11:55-12:24; 12:41-12:41; 12:41-12:54
Practices	Laundry	Food preparation (food consumption), *leisure*
Total time	07:10	04:55 (03.49 without eating)
Total energy	See text above for reasons why it was not possible to calculate this	

The most significant and useful feature of this representation apart from locating practices geographically is the attempt to summarise certain information so that the amount of time spent on a particular practice in a particular space is added up. This highlights which practices are dominant in terms of the amount of time they take up and helps to make the point that time-consuming practices are likely to be more difficult to shift than those of shorter duration because they are more difficult to slot in between other practices. Again, adding up the time taken by these practices is not completely straightforward because in some cases this implies the involvement of a person and in some cases machines are implicated. Also, it is not clear here which of the people involved is carrying which practice in which period. Finally, adding time up in this way would imply that there are more than twenty-four hours in the day as things may be going on concurrently, in parallel with one another. Obviously this sort of information about time is important in terms of developing time-shifting strategies and so this would need attention were this table to be developed further.

Another significant challenge which it was not possible to overcome in this study was working out how much energy each practice used. As will be seen in **Table 14**Table 14, this was not possible to calculate in the end because the energy logging was associated with the whole house and so was not possible to unravel in this way. It might have been possible to get a more accurate idea of this had

plug in monitors been used for this purpose but even this would have been difficult. If it were the ambition to get an idea of the energy use of practices, it would certainly be necessary to log both the energy and practices involved in far greater resolution than was possible in this study. This, however, was a failing of the technology, rather than the method. Also worth noting is that as data is increasingly summarised and simplified, so that subjective judgements are being made about what to include and what to highlight. In this table, for instance, the spatial aspect of practices has been highlighted by organising the data around the rooms in the house. The temporal nature of practices is also emphasised by the fact that the times of practices are listed and added up. The frequency, rhythm and duration as well as the total time are all therefore available for analysis.

The main disadvantage of this table is that it is difficult to understand the information at a glance, which is one of the main ideas in developing these ways of presenting data. Overall, this table works best when considered to be a summary of the information from the previous table in preparation for the following figure, **Figure 21**. Here practices are located in their spaces in the house while also noting something about the energy usage (denoted by the various shades of pink and red) and who is carrying those practices (volunteers A and B). An estimate of the amount of time spent in each room is also made and, though this has not been worked out for every practice, this could be done if it was considered important. This representation draws together the observations, energy information and photographs, together with some analysis of each data source but it allows an immediate insight into the household. The main strength of this representation is that the layout of the space and location of practices within this is quite clearly seen. Practices that involve energy use are highlighted because they have been colour coded though this is not based on actual numbers in the way it is in **Table 13**. The main weaknesses of this map are that it is difficult to know who is doing what in the room where more than one person is listed and that practices tend to be broken down into activities which would seem to reduce the analytical usefulness of this tool, at least from a practice perspective.

Figure 21: Practice map

Living room	**Dining room**	**Office**	**Kitchen**
Watch TV in evening, chat, drink tea	Researcher working – phone calls, laptop, transcribing, updating timeline, **lights on**	Volunteer working – phone calls, laptop, shredding documents	Storing food, preparing food, **cooking in oven,** eating meals & snacks, making tea, chatting,, dishwashing
3 hours	8 hours	6 hours	5 hours
Guest bedroom	**Conservatory**	**Garden**	**Utility room**
Researcher sleeping and reading	Entering and leaving house, researcher relaxing in morning	Tending vegetable patch, putting out compost, hanging out two loads of washing, fetch potatoes from hangar	**Washing six loads,** hanging out two loads of washing, feed cats
8 hours	1 hour	6 hours	7 hours
Volunteer's bedroom	**Volunteer's bathroom**	**Meditation room**	**Airing cupboard**
Sleep	Jacuzzi bath, radio, mediation		Hanging out two loads of washing
8 hours	1 hour	0 hours	18 hours
Bedroom 3	**Bedroom 4**	**Upstairs bathroom**	**Third floor bedrooms**
0 hours	0 hours	0 hours	0 hours

As practices are of central importance in this work, therefore, this concept was further developed and **Figure 22** highlights practices in particular, again attempting to extract as much data from different sources as possible. This figure traces food preparation practices during the observation period. The photographs illustrate the practices taking place (which are also noted in the text), the arrow represents time and the times of each practice performance are also noted. The location of the practice is noted, as well as who is involved and, loosely, how much energy is being used (by means of the shading). There are several advantages to this way of representing the data. The representation is simple and provides significant insight into the practice in that particular household despite communicating a fair amount of complexity and a lot of data. One of the distinct advantages of tracing this practice in this way is that it clearly demonstrates that food preparation does not only go on in the kitchen and that surprising appliances might be involved in food preparation, such as televisions and radios. It is also clear when things are happening, who is involved and (more or less) the energy implications of the practice so that shifting strategies can be tailored accordingly.

There are also disadvantages to this way of viewing the data. Information from **Table 14** about the duration of each part of the practice is weakly represented here. The way the energy colour coding is worked out, derived from **Table 13** is also not particularly transparent because it is not clear that the colour is a function of time and energy, nor that background noise from other appliances would influence the amount of energy being used. This means that the kettle consumption is coloured differently at different times of the day, which might be confusing, though this could be explained in accompanying text. Also, although in some ways it is helpful to isolate one practice in this way, this is also misleading for a number of reasons as it suggests that it might be possible to measure the total energy use of a practice, something already acknowledged as probably impossible, and it fails to highlight the interconnected nature of practices which is better represented in other figures and tables.

Figure 22: Tracing food preparation practices

Tracing food preparation practice

Time	Activity
13h15	
12h41	Kitchen. A & B. Eat lunch
11h55	Kitchen. A. Oven on. Prepare lunch
10h10	Kitchen. A. Kettle on. Make tea
08h25	Kitchen. A. Kettle on, make coffee
07h56	Kitchen. A & B. Eat breakfast, TV on
07h45	Kitchen. A. Radio on, make breakfast (kettle, toaster)
07h17	Kitchen. B. Kettle on. Make tea
21h40	Living room. A & B. Drink tea, watching TV
21h36	Kitchen. A. Kettle on. Make tea
21h04	Kitchen. A. Washing up, dishwasher on
19h35	Kitchen. A & B. Eat dinner
18h17	Kitchen. A & B. Lights on, oven on, prepare dinner, chatting and eating snacks
18h07	Shed. A Fetch potatoes
15h33	Vegetable garden. A & B. Weeding
14h58	Living room. A & B. Drink tea
14h44	Kitchen. A & B. Return home from shopping, unpack shopping into fridge and cupboards. Kettle on
13h45	Supermarket. A & B. Go to shops
13h40	Kitchen. A. Rinse plates, pack and switch on dishwasher, prepare for shopping
13h15	Kitchen. A & B. Lights on, eat lunch

Having represented practices over time, the following examines individual practices in more detail. Although practice theory minimises the analytic role of individuality, it does not preclude describing the consumption behaviour of one individual (Warde 2010) and so describing an individual household is a legitimate thing to do. **Figure 23**, for example, shows different facets of food preparation practices in what has been called a 'practice collage' (as opposed to the map of practices outlined above in **Figure 21**). In other words, an attempt is made to map the parts of the practice rather than provide a map of where the practices happen. As can be seen, food preparation is complex in this household as it involves making compost, growing quite a lot of the produce, food preservation (jams, chutneys, storing, drying, freezing and so on) and most meals are cooked from scratch.

Figure 23: Photographic 'collage' of food preparation and consumption in one household

The collage expands out the single practices shown in the earlier practice map (**Figure 21**) and makes even more explicit the possibility of different facets of a particular practice that started to emerge in **Figure 22**. It shows the various aspects of food preparation practice that were observed in this household during the twenty-four hour observation period and allows an immediate insight into how food practices are arranged and performed, both through the range and details of the categories included. This collage might easily be made more complex as each category could be expanded, which would have different energy consumption and shifting implications. For example, washing up could be done manually or in the dishwasher, food might be cooked in the oven,

microwave or on the hob and it could have been stored and preserved in a number of different ways and locations. Each of these might be considered a practice in its own right – where the borders of practices lie is not a precise science, as was mentioned earlier – but each is also recognisably a part of food preparation and might influence shifting.

Even so, despite this insight, it should be noted that the full complexity of food preparation in this house is not captured because it is frequently used for entertaining, in which case food preparation and cooking would take up a few hours and dining would happen more formally in the dining room, with relaxing before and after in the living room and conservatory. It is normal for ten or twelve people to attend such evenings and for many to stay overnight, with the laundry consequences already mentioned. There are several important points here: each performance of a practice is different; practices interlink with and influence each other; and different practices make different demands on each other. These points are further developed in the next chapter.

It may not seem obvious how each of the aspects of food preparation practice listed in **Figure 23** are relevant for shifting energy and so an example drawn from how food is stored might help. During the challenges (which are discussed in detail in the next chapter) one volunteer almost refused the food preparation challenge because she had defrosted some chicken and needed to eat it. Although, in the end, she managed to get around this and participate in the challenge, the way she stored or preserved her food had implications for her willingness to shift her practice. Links like these are unpredictable but the multiple sources of data allowed these rich insights to be gathered and so finding ways to represent them is important.

Also interesting, from a practice point of view, is to notice how the elements of practices (institutional knowledge, embodied habits/ know-how, engagements and technology) relate to the practice map. **Figure 24** attempts to do this, although it should be acknowledged that the different categories overlap with one another. However, it might be seen, for example, how watching a food programme improves institutional knowledge and growing food strengthens know-how, both of which allowed this participant to strengthen his existing engagements around food, which include eating fresh, organic, vegetarian food to promote optimum health and for ethical reasons. In order to perform food preparation practices in his household, therefore, a combination of technology and know-how was required so that he could grow, preserve and cook his own food in line with these engagements. As mentioned above, and represented in **Figure 24** through the relaxation over a cup of tea, engagements around food preparation were also highly sociable so that preparing good food

was a fundamental part of how this volunteer organised both his own day-to-day life and his social life. Finally, it is worth noticing the systems of provisions that underpin all of these practices: the electricity which is the focus of this work but also the gas, oil and water which service the household itself and the whole network of provision that allows food to be available in the shops.

Figure 24: Practice map organised into elements of practice

Before moving away from the presentation of data, there is one final point of interest to mention. Taking the elements of practices into consideration, the practice maps might also provide a tangible way to link and contrast practices both within and across households. **Figure 25**, for example, shows a number of kitchen and dining room tables taken from the study households. Bearing in mind that a table, in practice terms, is considered a technology, it is possible to look at how elements might link practices across different performances as shown much earlier in **Figure 6** during the discussion of the theoretical aspects of practice theory. On the one hand the tables might be contrasted: the two tables on the left are formal dining tables and may be distinguished from kitchen tables, even within the same household, as they offer different dining experiences which may arise out of quite distinct food preparation practices. On the other hand, the six pictures on the right of the figure are all

kitchen tables and so may serve to link practices across households. For instance, where kitchen tables were present the kitchen became a central part of the house and meals were usually eaten at them. This was not always the case with dining room tables, which were sometimes used but sometimes not (or might be completely absent). Where the kitchen table was central to meal times, coordinating the family schedule was generally the thing that determined when meals were eaten. As mealtimes were key moments for structuring the day kitchen tables were not just part of food practices but also part of the practice of connecting with one another, in much the same way as dining tables were both part of food and entertaining practices. As such, both types of table play a role in how practices in the household are arranged and may therefore be relevant to shifting those practices.

Figure 25: Linking practices across households

Where there was not a kitchen table and especially if the volunteer lived alone (or was not part of a family unit) the television often served as a central focus for meals, or at least would be in use while the meal was consumed, as shown in **Figure 26**. In these cases the scheduling of meals might be organised more around the television schedule, although with iPlayer, delay TV and various other options for recording programmes, this was not deterministic. Televisions were used for a multitude of purposes such as during domestic chores like ironing as a distraction, in the background whilst doing something else as a form of company, as part of the childcare regime (as a treat or at particular times of day when the children needed to relax after school or parents needed to get on with something) or, occasionally, for entertainment (where a particular programme might be watched or something previously recorded might be played back). In fact, sitting down in the

traditional way to watch the television at a set time so as to see a particular programme on the television schedule was not observed during the research.

Figure 26: Practices organising differently around different technologies

Focusing on a particular element, like technology, also helps to demonstrate how practices shift and change as also shown in **Figure 7** which looked at how practices change over time. The fact that practices and their elements co-evolve tends towards making them stable and maintaining the status quo. Over time, the elements within a dominant practice tend to merge ever more tightly together. This sense of permanence becomes even stronger when whole practices start to cohere into bundles (loose-knit patterns of practices based on things like co-location) and complexes (dependent relationships between practices based on things like "sequence, synchronisation, proximity or necessary co-existence") (Shove et al. 2012: 87).

At first this work seemed to confirm the idea that practices were difficult to change. The photographs taken during the observation phase highlighted the coevolution not only of practices and appliances but also of the spaces in which these practices take place. As Shove, Southerton (2000) have pointed out, appliances have become central to the spaces they occupy, such as the cookers in **Figure 27**. They demand that practices are organised around them so that even the raw vegan household in the study who did not cook had their food appliances arranged around the cooker. The fact is that virtually every kitchen has a cooker. They, and the other appliances around which practices are arranged, are seen as part of what is normal and necessary. This and the fact that practices are inherently social in nature means that standards or norms emerge and can be learned (Scott et al. 2012). Practices are therefore capable of reproducing themselves and may seem to persist through routine performance.

Figure 27: Elements of practice changing over time

However, all is not as uniform as it seems. The households in this study had cookers that were quite different from each other. To start with, there were cookers that used gas, LPG, oil and electricity. A practice perspective would note this technological difference, which might also be what an engineer would normally focus on. Less obvious to some engineers perhaps would be the fact that these cookers were being used for storage, heating, making tea and entertaining, implying that the engagements and 'meanings' of those practices or indeed of the appliances themselves are just as diverse as the 'technology'. Although the practices, spaces and appliances may appear to have coevolved into a stagnant state, paying more attention to the elements of practice in this way helps pull them apart again. Each performance of a practice pulls together the elements of that practice in a unique and slightly different manner so that they do not exist as static entities but are inherently dynamic (Warde 2005). Their iterative performance over time means that practices and the connections between the elements that comprise them change so that even seemingly implacable practices can become unstable and decay (Scott et al. 2012) or may innovate and so lead to change. This may happen in different ways, as discussed in **2.2.5**.

4.3 Phase two: Challenges to shift energy-use practices

The last section discussed the first phase in some detail. The second phase is discussed in less detail because the main information about the challenges was gleaned from the interviews, which are discussed in **Chapter 5**. The point of doing the challenges was to test the flexibility of particular practices: food preparation, laundry and work and relaxation, and to find out how moving these practices in time and/ or space impacted on them and on the practices around them. The aim of this section is to tell the story of what happened during the challenges and to present the main insights relevant to shifting energy-use practices. Each one is described and what happened is briefly outlined. The chapter is structured such that the challenges are presented separately. As the challenges correspond closely with the practices-as-entities under investigation, this angle has analytical integrity but it also seemed the most accessible way to present the data. For those interested in what happened in each participant household **Appendix Seven** has the details of how the challenges were conducted in each house in comparison to what normally happened. In this chapter and throughout the thesis, interviews are identified by two numbers separated by a decimal point. The first number refers to the participant and the second to the interview number for that participant.

4.3.1 Movable feasts

The fridge and freezer account for 26% of energy used by domestic appliances in the UK. Forty years ago only 3% of the UK population had a fridge but now 96% have one (Shove, Southerton 2000). This does not vary between social groups and is seen as normal. Cookers too are seen as a normal way of preparing food. **Figure 28** shows a typical breakfast table in the study. This section briefly describes the first challenge and outlines the results of the volunteers participating in it.

Figure 28: Food preparation and some of its assemblages

4.3.1.1 Description of the challenge

Participation in the first challenge required volunteers not to use any energy (gas or electric) in the preparation of food or drinks between the hours of 16h00 and 20h00, though no restriction was placed on participants eating during this period. They were not given any instructions about how to address the challenge though some did discuss it with the researcher. This challenge was selected because hunger is such a strong drive and might be expected to be relatively inflexible, especially where children or older people are concerned. The timing of this challenge was selected partly because this is when food is normally prepared and also because this corresponds with peak

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demand on the grid. As with all challenges, participants were given 24 hours notice. If volunteers considered themselves to have done the challenge, this was counted as successful completion, even if they had in fact cheated a little by using some energy. If, on the other hand, they felt they had not done it, this was counted as refusal, even if the infringement was minor.

4.3.1.2 Results of the challenge

Table 15 shows participants' reactions to carrying out the challenge. As in all the tables that follow, numbers across the top are the household IDs so correspond with **Table 7** which shows the participants in the study. Adding up the numbers down the columns provides the number of people in each household. Of the twenty seven who could have participated, the two in the unshaded boxes did not take part. One person was away for all the challenges and one considered herself to have refused the challenge even though she only warmed up a croissant for a few minutes in a gas oven. She said of the challenge: "It's very different asking someone to shift their eating habits than it is to shift their washing machine use habits for example. So the answer to the question is 'No, I'm not prepared to shift' (laughs)" (Interview 1.2). Of the rest, twenty one participated fully (four of them going out as their response and seventeen staying in), two participated once they remembered, and two did shift their practices though they cheated slightly. In the household that cheated, participation was complicated because they had actually shifted their food preparation forward to the previous day but then used energy to warm their food through before eating.

Table 15: How participants managed the food challenge

Managing the challenge	1	2	3	4	5	6	7	8	9	10	11
Away (avoided the challenge)			1								
Refused the challenge	1										
Out (but participated)			1			1					2
Participated at home		4	1		4	2		1	1	2	2
Forgot (but then participated)							2				
Cheated (but participated)				2							

As volunteers had to comply both with the rules of the challenge and the demands of the practice, they were subject to competing pressures and so how they managed the challenge differs somewhat from how they fed themselves during the challenge, which is captured by **Table 16**. The two participants in the unshaded boxes were discounted because they did not participate. The next two participants were the ones who temporarily forgot but did not use any energy because they ate raw

food (though this was in fact their normal way of eating and not done as a result of the challenge). The nine participants in the medium shaded boxes shifted their practices in space, eating while out or getting a takeaway and so shifting the energy consumption associated with food preparation away from the household. The other half of the volunteers (thirteen in total and the households in the darkest shaded boxes) shifted their food preparation practices in time by moving them forwards or backwards.

Table 16: How participants fed themselves during the food challenge

Getting fed	1	2	3	4	5	6	7	8	9	10	11
Away (did not eat)			1								
Refused (warmed up croissant)	1										
In (ate raw, no cooking)										2	
Out (ate while out)						1					
In (ate takeaway during challenge)			2		4	2					
In (ate main meal at lunch, snack after challenge)											1
In (cooked before but ate during challenge)		4						1			
In (cooked before and ate during challenge but then warmed up food - cheat)				2							
Out (cooked in advance but ate afterwards)											1
In (cooked and ate afterwards - snacks during challenge)							2		1		2

4.3.2 Load shifting the laundry load

Shove (2002) points out that laundry has undergone recent and radical transformation, as what is normal has moved in the last two hundred years from sewing children into their clothes for the winter, through boiling clothes once a month or sending them to the steam laundry to the current situation where ninety per cent of homes in the UK have a washing machine and laundry has become an individual practice involving much more than just the washing machine, **Figure 29**. What it means to wash well has evolved; on the one hand becoming more efficient as most washes are now done at lower temperatures but on the other becoming more resource intensive as washing is

done five times more frequently, partly accounting for the fact that demand for water has risen by seventy per cent in the last thirty years. Washing machines have helped to reclassify dirt. Cleanliness is now about whiteness and freshness rather than removing bacteria and what is considered clean is now whatever has come out of the machine. This section will explain the laundry challenge and its results.

Figure 29: Laundry practices are not just about washing machines

4.3.2.1 Description of the challenge

In most cases the second challenge people undertook was laundry. This meant in general that they shifted the use of the washing machine but this required shifting other parts of the laundry process as well. The washing machine is seen as having good shifting potential by advocates of smart grids (Strbac et al. 2010, DECC 2009) and so this was interesting to test out. The idea was to bring forward or put back the laundry by twenty-four hours, though a couple of volunteers came up with their own variations of this challenge. The fact that the catalyst for this practice varied more significantly than the previous one meant it was more difficult to give twenty-four hours notice on this challenge. However, a twenty-four hour shift was selected because while it might affect some of the indicators

that supposedly trigger laundry such as the weather, day of the week and fullness of the basket or load, it did not seem to be long enough to seriously disrupt the practice itself (or those around it).

4.3.2.2 Results of the challenge

In the case of laundry the management of the challenge and the management of the laundry were synonymous and so are presented as a single table. **Table 17** summarises what happened. Of the possible twenty seven participants, twenty three volunteers carried out the challenge. The unshaded boxes show the four people who did not take part. Of these, one person was away, one person forgot and one household (two people) refused to participate. The twenty three volunteers in the shaded boxes all shifted their laundry in some way. In one case the laundry was cancelled altogether, perhaps the ultimate shifting of energy use. In two households (three people) the laundry was put back for more than a week, in one case because of exams and in the other due to the simple fact that "the laundry was not needed" (Interview 8.3). Four households (eight people), brought their laundry forwards by twenty-four hours or more and the largest group, six households (eleven people), put it back by twenty-four hours.

Table 17: How volunteers managed the laundry challenge and carried out the laundry

Managing the challenge	1	2	3	4	5	6	7	8	9	10	11
NA (Away)			1								
Forgot the challenge											1
Refused to participate				2							
Cancelled laundry			1								
Put back up to a week						2		1			
Brought forwards		4	1							2	1
Put back 24 hours	1				4	1	2		1		2

4.3.3 All work and no play…

Work and leisure practices were chosen to be part of the same challenge because they might use many of the same appliances (**Figure 30**) and it is widely acknowledged both that the use and number of these appliances is on the increase and that they are becoming more energy intensive over time. Television usage increased by 13% between 1995 and 2005 and domestic computer ownership went from 0% in 1981 to 67% in 2005 and 81% of people had a mobile phone in 2006. Households, meanwhile, have reduced in size from 3 in 1961 to 2.3 in 2005, contributing to a 148%

increase in energy usage on domestic lighting and appliances between 1970 and 2005 (all figures taken from Loveday 2008).

Figure 30: Work and relaxation practices are intertwined

4.3.3.1 Description of the challenge

In the third challenge volunteers were given twenty-four hours notice and this time asked not to use any energy for work or leisure practices between 15h00 and 22h00. This time period was selected because it covered the peak energy use time from when children come home from school until bed time, more or less, and so included the time when children might do homework, part of the work day for those who worked from home and the main time when people relax and so may be expected to engage in leisure pursuits. These practices were chosen because it seemed as if they would be very difficult to shift and, indeed, this was probably the most difficult challenge because it meant some practices actually had to be put on hold. A number of volunteers interpreted the challenge as simply unplugging rechargeable devices.

This challenge was more difficult to define than the others and so there was generally some discussion with volunteers about this challenge in terms of what constituted work and entertainment and also about what was in and out of bounds in terms of appliance use. By the end it was more or less established that having the lights on was fine, as was using battery operated items, as long as this was acknowledged and discussed. It was fine for volunteers to prepare food or have a bath even if these were classified as 'relaxation' or to go out if they liked. The detail of what was meant by leisure (entertainment/ entertaining/ relaxation) in particular was left purposefully vague as it was as interesting to discover how people interpreted the challenge as how they experienced it.

However, the expectation had been that volunteers would engage in alternative (low energy) practices and this did not really happen for most volunteers. Although some people decided that electronic devices like iPads, Kindles and computers were disallowed, there were others who decided that if these had been 'charged up' beforehand and were operating off a battery, that was fine. Technically this is correct as it is possible to shift energy-use practices by using such devices as batteries and thermoses or to 'store' time using such devices as freezers (Shove 2010b) and DVD recorders so that particular practices can be carried out at a later date (so allowing them to shift). However, from the point of view of testing the impact of shifting practices, this challenge was perhaps somewhat limited or, at least, it served to highlight again the demanding nature of practices.

4.3.3.2 Results of the challenge

This challenge is the most complicated to report on, partly because there are two practices involved – work and leisure – but also because there were numerous responses to the challenge and so the results are presented in two tables. First of all, **Table 18** shows how volunteers managed the challenge itself. As volunteers demonstrated different responses at different times during the challenge it is impossible to summarise all of their activities in tables like this but their major responses have been captured.

Table 18: How volunteers managed the work and relaxation challenge

Managing the challenge	1	2	3	4	5	6	7	8	9	10	11
NA (Away)			1			1					
Forgot the challenge		4									
Refused the challenge						2					
Participated but the challenge made no difference			1	2							
Participated but did only part of the challenge							2				
Shifted practices in space (out as response)					4				½	2	1½
Shifted practices in time (moved back or forwards)									½		½
Carried out some alternative practices	1		1					1			2

Of the twenty seven possible volunteers, the eight in the unshaded boxes in **Table 18** did not complete the challenge: two (in separate households) were away, four (in one household) forgot about the challenge and two in a final household found that the simultaneous onset of a sudden and severe illness and the arrival of a guest created a context in which participation was deemed impossible. In fact, the household that forgot the challenge did manage to complete most of it but this cannot be counted as they were unaware they were doing it.

There were five volunteers who only partly completed the challenge and this is shaded in medium blue in **Table 18**. For three volunteers the challenge appeared to make no difference to what they normally would have done, one because he was going out anyway (not as a response to the challenge) and the other two because by the time they had arrived home late from work and cooked a late dinner, the challenge period was over anyway. The third household started the challenge three hours late at 18h00, effectively taking working practices out of the challenge because a pressing deadline meant they had to finish what they were doing. Although they then cooperated fully with the challenge they can only be counted as having partially completed it.

Of the remaining fourteen volunteers, seven people (including two entire households) went out in response to the challenge, effectively shifting their practices in space. Another two people are represented by fractions in the table because they were out for part of the time, so shifting their practices in space, but also at home some of the time, when they shifted their practices in time. Five people did something different to what they would normally have done at home, so shifting the actual practices they were engaged in as well as shifting their normal practices in time to make space for the alternative practices they carried out.

This does not capture the full complexity of what people did during the challenge and so the second table presenting the results of this challenge is **Table 19**, which summarises how volunteers adapted their practices. This table overlap where people were with what they were doing to allow more insight into their response to the challenge. Again there are the same eight volunteers cannot be included as completing the challenge. Next there is the household of two people who carried on with their normal practices until 18h00. They are represented by fractions because for part of the time they were on grid and for part of the time the used gadgets on battery power. Like the other four people who did this, they are considered to have shifted their energy use but their practices remained largely unaffected. It could be said that they followed the letter but probably not the spirit of the challenge as their energy use was shifted to some degree by using battery operated gadgets but their practices remained largely unaffected.

Table 19: How volunteers worked and relaxed during the challenge

Carrying out work/ relaxation	1	2	3	4	5	6	7	8	9	10	11
Did not participate		4	1			3					
Had gadgets on mains (normal energy and practices)							½+½				
Had gadgets on battery (normal practice, shifted energy)			1	2			½+½		1		
Had gadgets on battery part of the time (shifted practice somewhat, shifted energy)	1										3
Switched gadgets off and went out (shifted energy and practices)					4					2	1
Had gadgets off entirely, stayed in (shifted energy and engaged in alternative practices)			1					1			

The next category of four people (Households 1 and 11) did try to shift their practices by reading, chatting to people and taking more time over other practices like cooking and cleaning. Three of them were also out for at least part of the time. However, in the end, all reverted to using gadgets and all four had their phones on and either used mobile phones, a landline or Skype during the challenge. The next lot of volunteers (Households 5, 10 and 11) switched off all their gadgets but went out in response to the challenge. They therefore shifted their energy and practices but in a way that was probably easier than those in the final category. However, Household 5 were at home for part of the time and during this time engaged in real shifting of energy and practices. They did puzzles and talked to each other rather than watching TV after school and neither the CD player nor

the Christmas lights were allowed to be turned on which the little girls accepted but were disappointed by. The computer was kept off too, which the husband missed, though he found it possible to manage.

The last two volunteers "took the challenge seriously" in the words of one of them, by staying in and engaging in practices they would not have otherwise. Of these two, only one person (in one household) completed the challenge entirely as it was intended – staying at home for the whole time and switching off all his work and entertainment gadgets. During this time he was 'lumberjacking' (cutting wood) and then he cooked and ate, read and wrote letters. The other volunteer, working in London, only got in at about 19h30 so only had to complete two and a half hours of the seven hour challenge.

This was the least successful challenge in terms of participation which is felt to be due at least in part to the fact that the definition of the challenge was left quite open, though this was intentional in order to see how the challenge was interpreted and managed. However, it was also the third challenge and was done by all volunteers in mid-winter so alternative activities were more limited than they might have been in the summer. Nevertheless, despite the varied levels of participation, or perhaps because of them, the interviews from this challenge yielded a great deal of insight into the shiftability of ordinary household practices, as discussed in the following chapter.

4.4   Conclusion

This chapter has shown that although it is difficult to bring different data together, having four sources of data and combining them can lead to new insights that would not be available with just one of them. One aim of the observation phase was to pull together the dense energy and observation data on one page in a comprehensible way and this has been achieved in a number of new ways. This way of collecting, analysing and collating data is novel and was done in response to the interdisciplinary agenda. On the one hand, it is hoped that engineers might get a better appreciation of how normal people view energy: meters do little to illuminate what is going and this study has helped to illustrate why. The difference between people's activities and the energy they use is so different that this is not really surprising. First there is the oft cited fact that energy is not used for its own sake but in the pursuit of practices like entertainment, connection, comfort and pleasure. Second, there is frequently a lack of correspondence between energy-use practices and the actual consumption of energy, particularly when machines and humans perform practices in conjunction with one another. Filling the dishwasher or washing machine or preparing food for

cooking does not actually use energy and when the machines are using energy the people are often off doing something else. Thirdly, there is the related fact that rechargeable devices like laptops, mobile phones and iPods are often put on charge when not actually in use and so the energy consumption and the energy using practice are separated from each other. Finally, there is the fact that participants interpret what is included in a practice differently. The challenges were largely self-defined and what this meant for participants was discussed during the interviews. For example, a couple of people mentioned the fact that their fridges were on in the food challenge. However, hardly anyone one discussed 'tangential' energy use, such as having the TV on while eating (though it was mentioned as being on during the ironing on several occasions). There were also other energy uses that seemed totally invisible for participants such as having Wifi on during the work and relaxation challenge which was not mentioned by any of the participants who used their computers on a battery in order to shift their energy use.

It is also the case both that the data can be viewed in different ways and that this reveals new things. In this chapter the way the data is presented has highlighted a number of issues worth pursuing: the temporal rhythms of the household; how (and, to a degree, how much) energy is consumed over time; the locatedness of practices and therefore of the energy consumption in the house; the time spent on particular practices; who is involved in particular practices; how particular practices are performed over a day; what appliances might be involved in those practices; what is included in a particular practice when examined in more depth; how elements of practices might link performances within and across households or, in contrast, how they may lead to the evolution of both the elements and of the whole practice; and how particular elements, like technologies or meanings, 'gather' particular practices around themselves. It may be worth noting before moving on that this analysis has focused on time, rhythms, energy consumption over time, practices, elements of practices, space and performances. This could be contrasted with other energy studies that might trace an individual or an appliance or other practice studies that would tend to trace the historical evolution of a practice and its appliances.

This chapter then went on to present the overall results of the three challenges, showing that it was possible to shift energy-use practices. In the case of the food preparation challenge this often meant separating food preparation away from eating but this challenge was easier than had been expected given that this is considered to be a critical demand practice. For laundry, on the other hand, it became clear that the practice was more complex than had been suspected so that it was more difficult to shift than had been expected. This is not to say it was not flexible: despite the fact that

one household refused to shift their laundry and one person forgot, shifting washing machine use backwards or forwards by twenty-four hours was seen as fairly straightforward by most volunteers. However, it is not merely a matter of pressing a button or responding to a price signal and shifting the laundry gave rise to several interesting lessons that are discussed in the next chapter. The final challenge was the most difficult because it required that practices needed to be put on hold. Work was particularly hard to shift, which will be discussed in the next chapter, but leisure also relied on energy using appliances to a large degree. The challenge was variously interpreted and was perhaps not as strictly adhered to as the others but it revealed interesting learning nevertheless. It was clear through the challenges that it was possible to shift practices both in time and space and even, on occasion, to adapt the actual practice or carry out a different practice entirely. The next chapter will continue the focus on the themes identified by examining what was learned from the interviews, mostly done during the challenge phase of the research.

5   Discussion: What was learned from the challenges?

The last chapter covered what happened during the empirical data collection but it did not deal with the interviews. This chapter will discuss the insights into practices resulting from the whole data collection process, but mainly from the fifty six interviews undertaken during the research (see **Appendix Six** for the four interview schedules that cover the observation phase and each of the three challenges). As might be expected, the insights and their implications are complex and sometimes contradictory. However, they provide five main insights into the nature of practices which are related to the theoretical foundations of practice theory laid out in **Section 2.2**. This chapter starts to relate these insights to the problem of time-shifting demand but the main lessons for industry will be covered in the next chapter. Readers interested in a household by household breakdown of what happened during each challenge compared to normal can read about it in **Appendix Seven**.

5.1   Practices are flexible and dynamic

To obtain an insight into the flexibility of practices, it was important to look at how they relate to one another. The research wanted to explore the dynamism of their connections and interactions because shifting one practice implies displacing another. As explored in **2.2.5**, entire practices (not just their elements) influence the practices around them and normally exist as part of an interdependent web of co-existing or even co-dependent practices (Shove et al. 2012). Empirical studies using practice theory have tended to follow the development of individual practices over time and so trying to understand several practices at once was challenging. However Shove et al. (2010) agree that understanding the rhythmic richness of everyday life requires moving the focus from single practices onto the dynamic interactions between them, suggesting that practices with different rhythms might amplify, enable or cancel each other out. The timing and spacing of practices is discussed later so this section will look at how flexible practices were able to be in relation to each other in the context of the challenges that were set.

Despite some practices having quite rigid edges, the research found that certain practices slotted in and around each other already. Laundry, for example, could be readily interspersed with other practices: "To be honest when I do laundry it's multi-tasking with lots of other things so, you know, putting the stuff in and taking it out and hanging it is five minutes work for a one and a half hour cycle so there's plenty of other things I can do so I don't consider it an active chore" (Interview 8.3). Whereas rigid practices like work might seem more dominant at first glance, in fact, flexible

practices like laundry were more shock-proof, or able to withstand disruption, and may therefore be more resilient. Where flexibility was evident, it was increased by a surprisingly diverse range of considerations, such as access to resources. For example, in relation to laundry, more clothes meant that the washing could be left for longer, help from others enabled multi-tasking and lessened disruptions to the schedule, and more unrestricted time, especially at home, meant tasks could be slotted in between each other. Despite the complexity of practices, therefore, the findings of this work are consistent with the assertion that 'practices-as-performances' are the grounded enactment of practices conducted amid everyday contingencies which readily adapt to fit around events (Hargreaves et al. 2011); a positive outcome from the point of view of time-shifting energy-use practices. They naturally constantly rearrange themselves in relation to one another and the constraints of daily life. Energy availability, or the lack of it, can be viewed as altering these constraints but need not necessarily hinder the practices themselves.

The study found that practices, even so-called 'critical demand' practices like eating, can be flexible, probably because they are inherently dynamic. When sufficient notice is provided, even fundamental practices have the opportunity to adapt and shift in relation to one another. A good example is food preparation practices, which are usually quite closely linked with food consumption practices and have an important anchoring function in most household schedules. Eating times needed to fit around other practices like work and school but were arranged to avoid people becoming overly hungry. Hunger was described by one volunteer as a "primordial drive" and being hungry was seen as negative: "When I wake up in the morning one of the things I'm really happy about is that it's a brand new day and that all the meals I've been allocated that day I haven't even started on yet. It's one of the loveliest things in the whole world (laughs) and so it would take a lot for me to give up… when I get hungry I'm really hungry then that's when I *have* to eat" (Interview 1.2). However, the study revealed that it was possible to decouple food preparation from eating and this made flexibility perfectly possible. Those who thought they would get hungry or had children to feed ate earlier or prepared things in advance. One cooked a stew beforehand and left it in the oven where it remained warm until 17h00 when it was eaten by the whole family who would apparently not have noticed the difference in the quality, timing or temperature of the food (Interview 2.2). Another cooked some chickpeas earlier in the day and then just made a salad with leaves from the garden (Interview 8.2). Yet another cooked two meals the previous evening and consequently found she had plenty of time on the evening of the challenge, which she enjoyed: "Well, that's actually very, very good. That's fantastic because then I prepare the day before two things and then that day I can practically relax and do very little so it's nice" (Interview 4.2).

Timing is not the only issue in thinking about food preparation, however. As was seen in the last chapter, food preparation practices are complex and not only related to assuaging hunger. For instance, food preparation could be a relaxing process: "I kind of use cooking as sort of like a bridge between working and being at home I think. So quite often I'll come back home and I'll have quite a lot of work that I have to do in the afternoon but when I first come back I'll cook. I think I use it as a sort of form of relaxation and like transition" (Interview 1.1). Alternatively it might be necessary to get the evening meal out of the way as this allows children to go to bed and/or adults to clear up and relax: "We normally have our dinner and then we have got a couple of hours to sit down and relax before bed" (Interview 10.2). However, even volunteers who wanted to relax were able to do the challenge as it was possible to just swap their practices in time: "I suppose I thought... it would be a bit more disruptive than it actually was... I thought if we were going straight from dinner to bed or near enough it might mess us around a little bit. We might end up staying up late so we got that relaxed bit in but I think because we did it beforehand it was fine actually. I thought it was going to be harder. Switching the two things, the two activities we normally do in an evening round really didn't make much difference" (Interview 10.2).

As well as being relaxing, cooking was also a creative outlet, which should not be underestimated. The challenge fell on 'creative Wednesday' for one volunteer: "(My husband) and I really like cooking and tend to try and be a bit experimental during the week when we haven't got other commitments. So Wednesday is typically the day we go a bit mad and try some different things out" (Interview 10.2). However, even she managed the challenge: "It probably made me slightly more efficient in how I cooked in a silly way 'cos ... it meant that I got everything prepared and chopped up and in its little piles ready to be thrown in as the recipe dictated, as opposed to throwing in the onions and it saying okay after two minutes you have to add this vegetable and it takes me more than two minutes to chop that vegetable up and so on and so forth" (Interview 10.2). Another, who had had almost refused to do the challenge because she had some defrosted chicken she could not delay eating, brought her cooking forwards to cook two meals the day before the challenge. She also found herself both more efficient and able to be more creative and said of her experience: "Preparing two meals in one evening is actually a very good idea and to be able to have a meal which is home cooked and prepared by myself and everything. And it's nice and also because I have a lot of pressure to have it ready immediately to eat (but) that day I can let it cook very, very well and I was a bit inspired and I started to add things to it (laughs) so it was quite nice" (Interview 4.2).

As is suggested by these quotes, in most cases, the disruption that might have been caused to laundry, relaxation, eating and creative food preparation practices seemed either to be easily managed or happily tolerated. What is interesting to notice here is that practices can be spread or compressed depending on the context and that this does not necessarily affect the accomplishment of the practice, at least in the short term. This allows the normal sequence of practices to be decoupled from each other if necessary, such as when food preparation has to be separated from food consumption, as sometimes happened in this challenge. An interesting feature of the flexibility of practices in the study, as noted in the CLNR study (Powells, G. et al. 2014), was that practices that were more rhythmically 'open', or whose sequencing could readily be spaced more widely apart were more flexible that those that were more tightly wound.

5.2 Practices are demanding but also rewarding

While some practices (like food preparation) were more flexible than might have been expected, given they are connected with a biological urge to eat, others (like laundry) were less flexible than might be imagined, at least relative to expectations and given the optimism with which engineers view the shifting of white appliances. In fact, it became clear that practices were extremely demanding in general. People, as carriers of practice, while not passive or powerless, are not autonomous either. The discussion on practice carriers and recruitment (**2.2.4**) asserted that human 'carriers' of practices like laundry are recruited into performing practices in particular ways because those practices or clusters of practices demand to be done. However, practices were also rewarding and this kept recruits loyal to the practice and involved them in 'careers' of practices. This section will demonstrate how each of these qualities was revealed during the research, starting with the demanding nature of laundry and then moving on to how practices reward practitioners.

5.2.1 Demanding practices

There were three particular ways in which the laundry challenge revealed the demanding character of practices. It became clear that: practices were demanding on their own account in that they demanded to be performed, practices demanded the performance of other practices *and* the elements within practices were demanding. Each of these will be discussed in turn.

The first and most obvious way in which practices asserted their demands was on their own behalf. Although one person claimed that she was excited by laundry and actually had a book of poetry about it, most saw it as a chore. However, for some people laundry seemed particularly demanding. Not doing it was difficult and meant one could not relax. One volunteer said of his experience of

delaying his laundry, "It emotionally destabilised me a little bit because I'm such a clean house fetishist that wants to get it done (laughs). I'm half joking," (Interview 8.3). Carrying out and completing the practice meant one was free: "I try to be very organised I try to do as much cleaning and as much washing and as much everything on Friday and Saturday so Sunday is completely clear and I can just lie down in my bed and think that I don't have anything to do you see? And I love that. I love the feeling" (Interview 4.3). It is little wonder given this insight that the second volunteer quoted here refused to participate in the laundry challenge.

There were other examples of demanding laundry. Some loads might generate enough volume of washing that they could be done straight away as a full load, which may or may not coincide with a particular day of the week. Gym gear, swimming costumes and the accompanying towels, for example, had high priority because of their bad smell or the level of chlorine "Basically the laundry basket is mixed and when it piles up high at the weekend when we've got gym gear… we must do another wash as well" (Interview 5.3). Other absolutely demanding loads were 'emergency' washes generated by spills, pets or accidents with favourite items. Sometimes these required a load on their own such as when a favourite white bunny had been stained with blue pen and was put in the wash by itself (Interview 5.3), but on other occasions the need for an emergency wash would generate a hunt around the house for additional washing to fill the load: "Say it was a Sunday and I needed something for the Monday or the dogs had thrown up on something or we wanted something that was still in the wash then we would probably just find extra things to fill it up that probably weren't desperate for a wash but might have been due soon" (Interview 7.3). On one disastrous occasion the emergency generated both the urgency and volume required for an immediate wash when, on an evening a couple of nights before Christmas one volunteer suffered "a two litre bottle of a very dark red fluid (home-made cherry brandy) sort of exploding across the entire kitchen. So, that wouldn't have been when I'd ordinarily been choosing to do the laundry but it did mean that we had to put in the table cloth, the clothes we were wearing and so on and so forth so we did do it straight away – threw in all the tea towels we'd used to mop up the mess and then threw in a couple of extra things to make up a full wash load" (Interview 10.3).

The demands of the laundry were not restricted just to doing the actual laundry. In many cases, the laundry not only demanded to be done but required the practice carrier to be at home and awake (or actively occupant), even for those with delay buttons and even though the operation of the actual machine was seen as something that would only take "a couple of minutes to organise" (Interview 9.3). In these cases the timing of the laundry depended on when people would be able to

take it out of the machine and when and how they would be able to dry it (and iron it if they did ironing): "I can't stand it if it's sitting in there. (It) takes a while for it to get that musty, mouldy smell but… I'm quite neurotic about both getting the clothes out and drying the drum" (Interview 2.3) or "I need to be around because I don't like to leave stuff in the washing machine after it's been washed so it's rare for me to put a washing load on at night… because I don't like it sitting in there in its own water for hours on end. So if I'm going out or I've got business meetings out then I won't put laundry on and leave it in the washing machine…. I could use the delay timer but I've never thought about it (laughs)" (Interview 8.3). It also became clear during the research that some people were reluctant to leave their laundry to wash overnight (partly because of noise which would prevent them or their neighbours from sleeping) or while they are out (some did not think it was safe and, in fact, washing machines are a significant cause of house fires): "Water and electricity which is never that much of a good mix (laughs) so I don't ever like to just leave it on and go out, 'specially if the dogs are in" (Interview 7.3). These examples suggest that automated shifting opportunities of white appliances may be limited or at least need to take these sorts of issues into consideration.

The second way in which the demands of laundry were experienced was through the indirect pressure from other practices like work and school. On the one hand these two practices were largely determinative of active occupancy (meaning laundry may need to be done on a particular day or at a particular time) and so affected the rhythm of the laundry: "It's easier if you do it on Saturday 'cos then you can iron as well and on Sunday that's too busy 'cos then you… have to go back on Monday. It's too much" (Interview 4.3). On the other hand, it was evident that some practices either create laundry or require that it be done. The laundry might need to be done, for example, because work and school practices demanded it be done by a certain time and to a certain standard: "When it's holiday time I launder less so back to that cultural expectation. You really can't go to school if it's got a stain on it or something… And for me with work… if I'm working from home, i.e. not in the public eye, then it doesn't matter to me… but it really matters to me if I'm standing in front of sixty people. So I'd say that work and school increase the demands on laundry and holiday time and weekend time we can get away with being a bit rougher" (Interview 2.3). The fact that some of the rhythms of laundry are partly determined by other practices reveals two related points: firstly that although laundry is very demanding it is also able to be very flexible (in that it is able to give way when the demands of other practices take priority) and secondly that the way that practices intersect with each other is key in thinking about how to shift them (in that practices are embedded in 'bundles' that may resist being decoupled for various reasons).

The third way in which practices demanded to be done was when particular elements of those practices made demands. The agency of the elements of practices is discussed fully a little later (5.4) and so only two examples are discussed here: technology and engagements. The most common catalyst for the laundry was probably a full wash basket or washing machine load. It may be remembered that, in practice terms, both of these qualify as technology, putting the technology (or 'stuff') of this practice at its centre. Sometimes a full basket or load corresponded with a weekly cycle and so fitted in with the active occupancy schedule: "Basically my laundry basket is a wash load size so it's very easy to say, 'Everything's now falling out the laundry basket. It's time to do a wash load,' and that roughly equates to once a week" (Interview 10.3) but for others the laundry basket might fill up at any time: "I also just choose not to wash my clothes very often. So I'll wear something – unless I'm going out – but even things I go out in I'll wear for a long time before I decide to wash them, before they go into the laundry basket. So that's why it takes three weeks sometimes for the laundry basket to fill up" (Interview 11.3). Either way, it was frequently the needs of the technology that determined that it was time to do the laundry, though not always in an appliance-centred way as might be modelled by an engineer.

Perhaps more interestingly, however, and even more challenging from an engineering point of view, engagements were very important in demanding the laundry be done. In this study the laundry itself has particular meanings attached to it. It was indicative of a well ordered household, good parenting, healthy environmental attitudes, hygiene and presentability, thriftiness and many other virtues. Within these meanings, however, most people accepted the dominant cultural expectation of fresh, clean and crumple-free clothes which are coordinated and changed daily. Competence, after all, is partly determined by collective learning and so is socially constructed (Warde 2010). This meant that not only did clothes have to be clean but they often need to be ironed too and this was really about conforming to cultural expectations: "I suppose my work shirts would get their arms ironed 'cos the arms are pretty much the only things you see 'cos you wear a waistcoat as well" (Interview 6.3) or: "I only iron his shirts 'cos I like to see him looking basically reasonable (laughs)" (Interview 5.3). Sometimes the demands of these practices could be quite stressful for the volunteer but they were often still carried. In one example it was necessary not only to have clean and ironed clothes but they also needed to be different every day: "That was probably the time when I had the most pressure on culturally, in terms of not coming to work in the same thing each day… so that no one thinks that you've kind of worn the same thing too much... I felt very inadequate going in in my very limited kind of smart clothes wardrobe" (Interview 6.3). Surprisingly perhaps, the only teenage volunteer in the study felt that this demand was bogus: "I don't think they'd really care. Like nobody

ever notices what you look like. Even if you spend ages getting ready they just think you look the same" (Interview 4.3).

Highlighting the power of social conventions and engagements, domestic laundry, done in the privacy of the home and for use in the home, was quite different to laundry exposed to the eyes of guests, which became much more demanding because it was exposed to these outside meanings. When people come over to the house it was usually deemed necessary to have the laundry washed, dried and put away by the time they arrived. The house must be neat, fresh and laundry free: "I had things on my radiators when my friends came for tea and I didn't feel very house proud" (Interview 1.3) or "I suppose at the back of my mind if my laundry basket is looking full I'll try and do the washing before they arrive 'cos I don't want them seeing all my dirty washing overflowing. It just doesn't look very nice" (Interview 11.3). If people were staying these engagements made the laundry even more demanding and bedding, towels, etc. might need to be done both before and after their stay: "We might cope with that for another few days but actually that would be quite nice for guests to have a fresh towel in there so it would influence my upping the anti a little bit (laughs) (Interview 2.3) or (a more extreme example): "The main laundry is bedding from visitors either paying or non-paying, bedding and towels, and that could be quite heavy. So, if I've had guests of any sort, if the house has been full, then I've got pretty much two days of non-stop washing machine activity (Laughs) … I would say five loads a day for two days" (Interview 8.3). For those who entertained less often the pressure was not as great, though the demand still had to be managed: "I do have the house full occasionally and then I have to wash the sheets. I don't do it immediately… They get into a basket and then they get mixed in with whatever else I've got to do as the weeks roll by" (Interview 9.3).

Entertaining might also require that something particular is laundered for a special occasion, because it meant that a different set of meanings were applied to the laundry. Similarly, a couple of people commented that new partners had a definite influence on the laundry, presumably because they were still assumed to bring these external meanings with them: "I will possibly iron the pillowcases and sometimes I do iron the sheets and quilt covers. Depends on who's coming and what kind of impression I wanna make" (Interview 2.3). This effect tended to wear off as these meanings shifted: "I used to change the bed sheets when (he) comes along but because he doesn't do it I can't be bothered anymore (laughs)" (Interview 11.3). Domestic laundry for private 'consumption', in other words, might be allowed extra moral space and so could be more flexible but external visitors meant that the culturally agreed meanings of laundry (freshness, whiteness, etc.)

were applied and standards were raised (irrespective of whether these visitors actually brought these standards with them). Where these cultural demands were not present laundry was allowed to assert its demands in its own terms: "For outdoor working stuff I tend to wear it two days, three days but then I am sweating and it is dirty and that will be washed. For going out stuff or casual round the house stuff that would probably only get washed once every five, seven uses, which could be several weeks" (Interview 8.3).

Nevertheless, for most people, particularly in a work context, wearing certain clothes made people feel like they had entered a particular role. There were several powerful examples of this in the interviews, some of which have been cited already but perhaps the best quote came from a man who specifically inhabited different roles even within the same workspace because of the different cultural demands of his job: "In terms of what I wear, I think it is culturally affected by the job I do. We work in the enterprise and business development office so we get caught between cultures. People coming from outside who work in the business environment, say they're patent attorneys or a representative from a company – they tend to be wearing suits or at least shirts and ties and therefore you tend to want to look the same if you're meeting with them, just to fit in. But if you wear a tie and go to see any of the academics at the university they think you're trying to sell them something and they're very suspicious (laughing) … So you end up having to have a jacket and tie behind the door. What's the meeting? Is it shirt or is it a jumper and decide accordingly" (Interview 11.3). In this context laundry equips people with clothes that give them confidence, allow them to inhabit particular roles and enable them to show themselves off to their best advantage. As such, cultural engagements around clothes and, consequently, around laundry, were significant in determining the level of demand made by the laundry and would therefore be likely to make the laundry less flexible than might otherwise be supposed. Whereas shifting the washing machine might have seemed a technological problem before, it can now be seen that flexibility in workplace clothing might be a more fruitful place to direct these efforts, just as was done in the 'Cool Biz' programme in Japan that successfully strove to change the workplace norm of a suit with jacket to one of a shirt with tie so as to reduce the need for air conditioning (Shove et al. 2012).

5.2.2   Rewarding practices

So much for the demands of practices; what about the rewards? The three types of demands discussed (from practices themselves, from adjoining practices and from the elements of practices), mean that there are multiple and sometimes contradictory pressures being exerted on a practice carrier at any one time, each of which would require different strategies to shift them. From the

practitioner's point of view, their encounter with practices happens in the course of their daily life paths (Pred 1981). As particular practices capture significant parts of the day, they will exert a disciplining influence (Hargreaves 2012) which will direct life paths and, ultimately, society and its practices more widely. However, the fact that practices must be performed and must recruit human carriers to carry out these performances means that some human agency is possible (Shove et al. 2012). In order to attract and, more significantly, retain as many recruits as possible, practices must also offer rewards to their carriers. It is thus that the concept of 'careers' in practices can be said to exist. As outlined in **2.2.4**, Shove et al. (2012) list three major reasons for defection from a practice; namely, a failure to: connect with surrounding practices, accomplish normative anchoring in wider society, or provide sufficient development opportunities for their carriers (by which they mean internal rewards, scope to innovate and ability to progress along a practice career path). It is the third of these which is of concern here.

As also outlined in **2.2.4**, carriers are enrolled into practices, perform them more or less faithfully over time and, as a result, either resist and defect from, or deepen their relationship with, those practices. Given that competence is distributed between bodies and objects, achieving a certain level within a practice is often only made possible by the control or possession of the goods and services relevant to that practice (in other words, being good at something requires practical skills but also access to the appropriate tools). In terms of consumption, therefore, it is not only the material things themselves that offer rewards but *the place within different practices* which is the basis of contentment, social acceptability and recognition (Røpke 2009). This is not just about the status of 'having'. Practices must be performed and so the material objects that are consumed in relation to that performance are just part of the picture. The satisfaction comes from the performance itself: it is in the doing and having, not just the having. Consumption can therefore be an expression of capability and it is the practice rather than the product which provides pleasure. This means the double dividend of reducing consumption to enhance well-being and profit the environment is more complex than is sometimes suggested (Røpke 2009). However, it also means that it is possible to get as much reward from competence in a practice deemed socially inferior as it is from one with more social status: hence the fact that well-being is not necessarily enhanced by greater access to money and goods in themselves.

It is worth examining the mutually transforming, intertwining careers of practices and their practitioners (Shove et al. 2012) a little further. Practitioners start as novices, improve their competence over time and may eventually become the practice as their practice careers develop

and they become increasingly enrolled in that practice: "There's not an incredibly sharp divide between my work and entertainment so they sort of cross over a little bit… I don't think I have these strict compartments: what's work, what's entertainment, what's just being alive; not so much" (Interview 1.4). Both newcomers and those with a high level of expertise may transform practices through, in the first instance, mutations resulting from incompetence or, in the second instance, highly competent performances pushing the boundaries of the practice or even breaking away from the practice to form an elitist version. In other words, there is a range of performances within each practice, spanning from adequate to excellent and this leads to internal differentiation, sometimes only recognisable by practitioners themselves.

One implication of this is that individuals are differently positioned in relation to the different the practices of which they are a part. This means that their positions across a range of practices are not homologous. This provides two significant insights. Firstly, it means that the practices to which the practitioner is more committed might be harder to shift and change, at least insofar as that practitioner is concerned. For instance, in the research it was evident that, for some people, particularly demanding and/ or rewarding practices like work were able to spread out well beyond the traditional working day and into the weekends: "I work a lot of Saturdays and Sundays… Being single, I don't differentiate much between a week day and a weekend day as other people would" (Interview 3.4). It is unlikely that an appeal to shift these sorts of practice based on weak signals, like price or information, would yield significant results.

Secondly, the particular practices that are available to a practitioner are the result of the formal, social and recreational associations of which they are a part, which is partly a function of their birth, history, location and social networks (Shove et al. 2012). As practices and their communities are mutually constitutive, this relationship is not as determinative as is sometimes suggested. Nevertheless, as practices become part of society's norms (conventions, laws, etc.), material structures (architecture, product design, etc.) and infrastructures (electricity grid, international supply chain, etc.) so they become part of the status quo and recruitment into them becomes more likely. It is clear too that, as this happens, so the rewards available become greater. This implies that shift would need to happen at a societal level, which might be possible but would require designing significant and on-going change interventions.

Despite the difficulties of change, however, these observations are critical to sustainability as they imply that the intrinsic rewards of satisfaction and self-esteem (Warde 2010) and the extrinsic

rewards of social, economic and cultural capital (identity, status, etc.) (Warde, 2005: 148) may be deliverable through other than materially consumptive means. However, Røpke (2009) warns that the 'double dividend' of curbing consumption to produce benefits both for well-being and the environment, will not work without reference to the interdependence between supply and demand. She argues, as has just been suggested, that the co-evolutionary nature of practices requires a broader socio-technical change to accompany attempted changes to practices, particularly because environmental issues are of little concern and may offer scant reward in comparison with the edicts of everyday life. She stresses there is little point in blaming the consumer and that focus should be placed on collective efforts at change.

Her warnings are pertinent, as a practice which is both demanding and rewarding will naturally be hard to resist and may therefore be difficult to shift. It will therefore be critical to consider how to make sustainable practices more rewarding and demanding than unsustainable ones. In this study, this was temporarily dealt with by the introduction of the challenges. Although people did find themselves driven by the demands of their practices, they found some degree of flexibility within them, partly because the challenge also exerted itself as a practice – the practice of participating in the research. The implication of this was that the challenges came with their own demands and rewards (being a good friend, cooperating with the research, sticking to an agreement, trying something new) and so were temporarily able to puncture or disrupt the fabric of everyday life, which enabled the successful time-shifting of the challenge practices. Although more research is needed to work out how to do it, inserting new practices may offer one way of starting to think about how to shift practices.

5.3   Practices and their elements coevolve

It is clear then that despite the criticism of practice theory as being unable to describe change, it is in fact more than able to do so, both in terms of explaining how practices-as-entities evolve over historical time and how practices-as-performances evolve from one performance to another. Although practices must be performed, this section will focus mainly on practices-as-entities in considering how they change over time. As the next section discusses each of the elements in some detail, this section will focus on technology and engagements because there are good examples from the research, though it would be true to say that all elements coevolve by means of a similar process.

Whereas practices-as-performances only exist in the moment of performance and are different each time, practices-as-entities continue to exist in between performances. In other words, practices-as-entities endure over *time* so that it is possible to recognise laundry practices from a hundred years ago even though they were then more about the body than clothes and most of the elements involved were entirely different. This implies that the elements of practices are 'lying around' between performances and can be used to bridge those performances (Shove et al. 2012). In other words, practices and their elements do not have to be re-invented every time they are performed; they and their elements exist between performances. In some cases, discussed in **2.2.5**, elements can be part of several practices at once and may travel between practices as represented in **Figure 7**. Over time, an element of a particular practice may either create a bridge between two practices or may evolve and change but the practice itself survives as a whole. By implication, therefore, novel elements might be introduced by means of which more sustainable configurations of elements might be generated (Hargreaves 2012). Elements can also travel in *space* so that engagements around cleanliness, comfort, or, indeed, sustainability, might be adopted in quite different cultures, though this is not guaranteed.

Leisure practices in the study offer a good insight into how engagements and technology coevolve and so start to change the way those practices are perceived. In the research sample, leisure practices appeared increasingly to rely on energy-using technology but appeared also to be undergoing a change in meaning. This on-going transformation offers interesting insights into the coevolution process. Over the last few decades, the television has positioned itself as the way to unwind at the end of the day: "Reading is not my ideal pastime at night because my eyes get quite tired so you know if the choice was read a book instead of putting the telly on every night that wouldn't exactly suit me" (Interview 3.5). For those on their own leisure often involved engaging with various media: "Relaxation? For me I just watch something on the laptop really. That's the only pleasure that I get (laughs)" (Interview 11.4) or: "(Laughs loudly) To be honest with you, if I think about it, I don't tend to relax. I don't think there is such a thing for me to relax other than watching a film or a bit of TV" (Interview 3.4). For these people, the television offered an opportunity to 'download' but this seemed to be changing for many others.

For those on their own, relaxation was often experienced differently to those who lived with others. They tended to use electronic media to relax and connect, though they sometimes reported not relaxing much and found the challenge difficult. However, many volunteers in this study were not that positive about television, either because they did not find it that rewarding: "I think that

watching TV is not really relaxing. It's just kind of numbing… you just want something to fill up the time really… whereas properly relaxing is just about kind of being where you are and appreciating it… At the end you could watch TV for 2 hours and then almost feel like you don't know where you've been for the last 2 hours" (Interview 7.4) or because they were ideologically opposed to it: "I think there's a huge part which is about deconditioning yourself from mainstream society and the pernicious influence of it … everything looks very false … and it gets exposed as hollow and foolish and so I guess that impacts on all kinds of things… and that would also inspire you to turn your television off " (Interview 1.4).

Surprisingly perhaps this was just as true for the younger volunteers in the study. One parent who was still in charge of her children's viewing said: "it's an interesting one for us as a family that (the) challenge around entertainment for the children at their current age and stage isn't that hard... because it's not a default that the telly goes on" (Interview 2.4) and another said of her young children: "neither of them were bothered about the television. (One) … couldn't listen to her CDs so she was unhappy about that … and (the other)was most upset about not having the Christmas tree lights on 'cos we cancelled those for the moment"(Interview 5.4). The reaction of two teenagers to the television was ambivalent at best: "I don't think TV's that great anymore… I think it's quite … boring (laughs) you sort of go into a trance and you don't even think. I prefer to listen to music so that's like probably what I do" (Interview 4.4) or they were much more interested in more interactive media: "My daughter… has a TV in her room but more of the time she's more likely to be doing Facebooking and phoning people and reading… so she keeps fully occupied that way" (Interview 13.4).

While television use was on the decline, where it and new media were in use, they were increasingly being used in individualised ways (and sometimes concurrently). For instance, where television was watched, people tended to watch pre-recorded programmes that they could pause and control. It was clear that practices and their technologies were co-evolving as the meanings of leisure were changing, possibly in response to the need to individually schedule and programme complex daily itineraries. Whereas in the past it may have been the case that the whole family gathered together in the evening to relax in the living room, originally in front of the fire and more latterly in front of the television, one volunteer said of his house: "The cat sits by the fire and there's no one in the lounge all evening at home. It's a deserted area (laughs)" (Interview 13.4).

This evolving understanding of leisure time influenced the work and leisure challenge, where the growing significance of new media was increasingly evident. It was noteworthy, for example, that only three people turned off their phones and out of those three, one was writing letters, one reading the paper and the other out with a friend (arguably all part of 'connecting' practices represented by having the mobile phone on). The importance of being connected with others was the most significant feedback from this challenge and for most, but particularly for those who lived alone, this happened through their phones or the internet: "Communication with people is quite a big deal for me because of the insular work environment I'm in that I can go for a day or two or three without physically seeing anybody… and so that ability to communicate on the mobile phone or via email or whatever is quite crucial" (Interview 3.4). Being on the internet either through the phone or computer was seen as fairly essential for numerous reasons covering both work and relaxation practices, such as accessing information, keeping in touch with people, staying abreast of events, remembering appointments and remaining on top of commitments: "I'm normally always on the internet basically. If I'm at home I've got the internet on and I check it a lot. Like even if I'm reading I quite often look things up on the internet, like if there's a word I don't know what it means… I spend quite a lot of the time. It triggers me researching other things" (Interview 1.4). This tendency was even stronger for younger people: "Yes, I've got one nephew who's very much that way. I mean he's sixteen and he's just connected all day" (Interview 8.4). Even those who felt resistant to this way of connecting found themselves carrying the practice: "I do things like check Facebook quite a lot in the evenings. Now I'm not really a big fan of Facebook but I find that I just sort of out of habit, through sheer force of habit – I don't even update statuses – I will just check the home page and I will just do that compulsively once or twice every evening. It's ridiculous (laughs). I get annoyed with myself about it actually" (Interview 11.4).

As phones and computers become ubiquitous so they are increasingly seen as 'essential' tools for relaxation and entertainment as well as work "(I watch things on the) laptop a lot because I don't have a television. I probably would watch television if I had one in my room … but I think laptops and the internet have become so dominant now in people's lives. I think back to home and my brothers … they still watch a bit of television but the two of them they're just constantly on either internet, games or YouTube or you know watching videos on there instead of watching television. So really (I) think that's become really dominant now" (Interview 11.4). It is evident how the ability to be constantly connected has coevolved with practices that depend on being connected and so the internet becomes ever more dominant. The choice to shift these is not merely one of individual decision-making, therefore. While the individual practices facilitated by the phone and computer,

like playing, connecting, working and so on, may be possible to shift on their own, there did not seem to be an alternative tool that provided all of this functionality and without using energy. It may therefore be necessary to consider that some energy uses are prioritised and computers and mobile phones would be prime candidates according to this research, particularly as their shifting-relevant applications are likely to develop over time. Fortunately the energy implications of this are relatively minor and much of the energy that is required can be at least temporarily shifted through using batteries.

Having said this, however, it is worth recognising the in-built fragility of a system based on entirely on these technologies. In fact, the challenge revealed that it was actually the underlying connections that were important and people recognised that these were not necessarily dependent on electricity and, indeed, may be precluded to some extent by the use of electronic gadgets: "You don't need any electricity for that and I think as a family we probably typically favour conversation and basic interaction as opposed to being distracted by any other entertainment" (Interview 2.4). As the interviewer observed, reflecting on one household's experiences: "It's interesting what you said earlier; you spent more time cooking, more time cleaning, more time talking to each other… instead of all going our little separate ways… it's kind of interesting to… spend some time together to get to know each other better really and then that has an impact on other things. I think the more energy people use the less they spend time talking to each other. I think using energy allows you to be independent" (Interview 11.4). This suggests that there may also be merit in redesigning practices so that they re-establish some of the social capital that has been lost by the increasing use of mobile and other energy using leisure technologies, especially as it is through these social networks that new engagements can be seen to travel.

In this regard, connecting with others was often a part of relaxing: "I mean part of relaxing with other people is that you're talking to them… you may be going to some entertainment but you're sort of getting there, so you're communicating with them even if you're going to a film or you're going to a concert" (Interview 9.4) and people take priority over other forms of relaxation that might be more habitual: "So again that's quite typical of our lives in London that people might be staying or passing through … we wouldn't say, 'Ooh sorry we watch the 10 o'clock news'. You know, obviously, real people in front of you are a priority" (Interview 2.4). For those in domestic partnerships, relaxing seemed to include being with one's partner: "So part of the definition of relaxing for you is being together?" "Yeah, I think so – as clichéd as that probably sounds" (Interview 10.4) or "sometimes (relaxing) could just be with yourself or like for us it could be just being together and just enjoying

that" (Interview 7.2) or "The most relaxing thing I can possibly do is being in conversation with (my wife) if the topic of conversation isn't controversial, so relaxed conversation about the world we live in and life in general" (Interview 2.4).

In summary then, it is important to notice that while energy use was not essential for relaxing, it was still strongly implicated in many relaxation practices. The old norm of coming together to relax in front of the fire and, more recently, the television seems to have largely dissipated. Increasingly the meaning and technology around leisure is evolving around more people doing more things in separate spaces which, of course, has energy implications. Individualised scheduling also means that coordinated shifting is becoming more complex. On the up side, however, individual shifting was generally very possible as long as the underlying practice could still be accomplished. This provides the opportunity to redesign practices and/ or their elements with this in mind.

5.4 Agency is distributed across the elements of practice in different ways

This thesis has maintained an on-going interest in agency and how it relates to practices. As Røpke (2009) explains, "Although actions are intentional and practical consciousness can be expressed discursively if people are asked to do so, this seldom happens as many actions are carried out as routines". As has been discussed, practices are complex and so designing change is more difficult than is acknowledged by the ABC approach to policy[4] (Shove 2010a). However, this does not mean practices cannot be altered and as they are becoming better understood so it is possible to theorise about how change might occur (Shove et al. 2012). Locating agency is a part of this understanding. However, while it is all very well to assert that agency is found in practices rather than individuals, it can be difficult to know what this means in reality. While it is important to bear in mind the links between elements and how they are brought together in each individual performance, the elements themselves also have a great influence on how flexible or demanding a practice might be. To demonstrate this point, this section addresses each element in turn, mostly in relation to the laundry. It is impossible to entirely disentangle the elements from each other and so this will necessarily be an approximate process but, as agency is typically located in one element more than another (though this of course depends on the practice and how it is performed on that occasion), it is hoped this will be instructive in considering the shiftability of practices.

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[4] ABC stands for Attitude, Behaviour, Choice and describes the restricted models and concepts of social change outlined in **2.1.2**.

5.4.1 Know-how

Know-how is also known as embodied habits (Gram-Hanssen 2010b), practical understanding (Schatzki 2002) and competence (Shove et al. 2005). According to Wilhite (2012: 89), there are two sites of know-how or embodied knowledge: the body and the artefact. Artefacts (or technology, in the broad 'practice' sense in which it has been used in this thesis) are discussed in the next section but the body will be dealt with here. He claims that bodies learn in two main ways: through exposure to the performances of other bodies and through purposive training. This means that the way a practice is performed has a lot to do with how it has been performed before, both at an individual and socio-cultural level. This exposure/ training might be done formally but is most often informal, as was evidenced in the study where participants had often picked up their know-how (or 'the way things are done around here') from their parents: "I think I was brought up in quite a laid back way and especially having so many boys in the household. The idea is that you wash clothes because they get muddy and mum always associated dirt with living and she hated the idea of children being neurotic about cleanliness and not getting dirty" (Interview 6.3).

As is implied by this quote, the frequency of the laundry was largely determined by what was considered dirty as it determined how quickly the wash basket filled. Whilst determining what is dirty was at least partly decided by societal convention and so might come under 'engagements', how the laundry was done in a private domestic space was frequently as much a matter of 'know-how' as practices were carried out appropriately for individual contexts. At one extreme a volunteer performed laundry every two days even though she was just washing for herself. Having adapted to using her towel more than once and 'only' washing her bedclothes weekly, she still felt the need to wash every item of clothing every time she wore it. This was partly because she worked in a laboratory which meant both that she worried her clothes might be contaminated and that she had developed a strong compulsion, based on her training, to keep things near her body clean and sterile. Curiously, however, she was less concerned about the black mould that had accumulated in her room from drying her clothes indoors, arguably a much more present hygiene issue and a health danger. Whilst these may seem contradictory standards when considered from the point of view of an individual's attitudes or values, a practice theory approach helps make sense of these apparently contradictory approaches to hygiene and health. Although in some cases elements like these might be shared across practices, in this case they were being differently applied because the bedroom was not exposed to the laboratory in the way that the clothes were and so the contexts were seen as completely different (work and cleaning) whereas in another context they might have been considered more complementary (laundry and cleaning).

What this example demonstrates is that although know-how is partly embodied in the practitioner it is not the property of the practitioner in the way that values might be. Hards (2011) discusses the relationship between a practice approach and the understanding of individual values. She reminds the reader that values are not located within, nor are they the possession of, the individual but that people carry and express meanings/ conventions that are circulating in their social environment. Røpke (2009) agrees that know-how is only seen as part of the performed practice and is therefore shared and social. These different relationships with hygiene and health are, therefore, a product of the social context in which they are performed rather than a result of an individual acting in accordance with her consistent values. This means that values do not precede action in a causal sense but that they both shape, and are in turn shaped by, practices.

At the other extreme of the laundry-performing-continuum were volunteers (and there was more than one) who only changed their bed clothes every two to four months and even then "it's usually the case that I'll probably spill something (laughs) and then there'll be the impetus to put it in the wash" (Interview 6.3). Even where children were involved hygiene standards were allowed to slip. One mum, talking about a mark on the bed clothes that looked like 'an accident' said: "you know I'm tired, it's late, it's fine – back to hygiene – it's not stinky, she's wearing pyjamas, it's sort of half way down her bed, it's nowhere near her face, it's not where she's breathing so … I got round to washing that sheet… probably two or three days later" (Interview 2.3). Children were expected to get dirty and so there was no need to compulsively wash their things: "the school uniform… if it has yoghurt down the front of it, it has to go straight in the wash or in the wash pile but normally the school uniform I wash once a week and they just get two clean shirts so I'm not obsessive like some mums in the playground" (Interview 5.3). Where this 'moral space' (Pink 2005) exists, practices were more flexible.

Most volunteers had quite particular know-how (or ways in which they did the laundry), either explicit or implicit. As Wilhite (2012) points out, the strength of this knowledge is reinforced through repetition and the complexity of the objects involved is also relevant. Bodies performing practices with simple or few objects in uniform environments, therefore, tend to result in strong habits. One volunteer, for example, described herself as having "lots of rules in my head. I'm quite … obsessed with order in a certain way, maybe not in a terribly obvious way but I am" (Interview 1.3). She cleaned her house every first day of the month, at which time she also washed her sheets. Towels were done twice a month, on the first and fifteenth. Sheets and towels were more likely to be the

subject of rules partly because this made it easier to remember when they had last been done and also because they tended to make up loads by themselves. General laundry could be treated more flexibly and was done as the need arose. Again, it is important to stress that these rules were not her possession but rather that she was their carrier, as she explains herself: "I've got all sorts of rules... It's very complicated being me. Nobody knows how many rules there are (laughter)" (Interview 1.3). However, this volunteer was not as unusual as she sounds. Other volunteers had rules about washing when guests had been to stay or were coming to stay, washing when the weather was fine or windy or washing before the cleaner came so she could do the ironing and many of these were just as inflexible as having set dates to do things.

Also classifiable under know-how in that it suggested a specific habitual preference, some volunteers also referred to having particular favourite clothes which could need washing even if there were other clothes available to be worn or if the laundry basket was not full: "I suppose one or two favourite items, I'll make sure that they're washed. If they are already in the wash basket then I'll wanna get them done pronto. That's just about looking better and sort of my favourite bits and pieces" (Interview 6.3). In two cases this affected the challenge, firstly by meaning that one volunteer had to wear things she might otherwise not have done, "The only thing that made shifting my laundry slightly not easy is 'cos I'm one of those people who have like a couple of favourite things that I wear all the time and so I want to have those things washed as soon as possible again... And so that ... meant I was wearing trousers I wouldn't normally be wearing but that was okay, I did it... It was fairly easy to just delay your laundry for 24 hours" (Interview 1.3). The other volunteer was put under more pressure as he completed the challenge but also wanted his particular shirts for working away from home and so had to iron them dry so he could pack them to take with him. Reflecting on his experience he said, "I realised that I didn't have any short sleeved shirts in my wardrobe and I like short sleeved shirts for work. I had lots of other shirts. I didn't actually have to do the washing at all. I could have made do but you know how it is. You have certain items of laundry that you like to use and there's obviously the whole reserve wardrobe but you know I wanted them for work. So, that's it. They had to be washed. So they had to be done and dried with the iron and sort of hung up" (Interview 5.5).

Having to conform to ideas about dirt, the ways things have to be done or keeping favourite things available might all seem to make the laundry less flexible but in fact all of these volunteers managed to shift their practices when asked to do so. This suggests that even habitual know-how can be checked under the right circumstances as will be seen later.

5.4.2 Technology

Technologies are also known as 'things' (Reckwitz 2002), 'items of consumption' (Warde 2005) and 'products/ material artefacts/ stuff' (Shove, Pantzar 2005). Engineers and designers would typically understand agency to be located in 'stuff'. Early theories of practice (Giddens, Bourdieu and Schatzki), on the other hand, were restricted to the social but this has changed and, since Reckwitz's work (2002), it has been recognised that practices are at least in part materially mediated (Røpke 2009) and that a certain level of agency is embedded in technology. Wilhite (2012) summarises the relevant studies that describe this relationship. Some, in social science and technology (SST), like Madeleine Akrich, have theorised that the knowledge embedded in material objects has a scripting effect on performances, both enabling and restricting them, while material culturalists like Alfred Gell, envisage more of a two-way relationship, such as that between art and the observer. Wilhite (2012) and Shove et al. (2012) claim respectively that agency and competence are shared between bodies and artefacts: in other words, that the power to change and the knowledge to perform the practice is shared between the body (as discussed in the previous section) and the artefact. Wilhite claims that social context (discussed next under 'engagements') is also important so that "the body, object and social context are agentive in consumption habits" (Wilhite 2012: 90), but that discussion must wait until the next section. In this study, technology was agentive in different ways which will be discussed next.

The technology relating most obviously to energy consumption in laundry practices is the washing machine. Advocates of smart grids claim that delay settings on appliances like washing machines could increase flexibility (Finn et al. 2012) and it is undeniable that technologies can and do script some practices but this is not straightforward. First of all, the 'stuff' of laundry is much more diverse and would include washing products (powder or liquid detergent, stain remover, fabric softener, etc.), the wash basket, the drying mechanism (tumble drier, clothes horse, washing line or airing cupboard) and, if relevant, the products and technologies used in ironing (iron, ironing board, TV, etc.). Each of these technological elements has the potential to influence the *amount* of energy used in the laundry process, for example if the detergent allows a cold wash or the drying mechanism means less ironing needs to be done. However, whether any of these has an impact on the *timing* of energy use is more relevant here. Secondly, all the 'phases' of the laundry process (soiling, collecting, washing, drying, ironing and putting away) have the capacity to influence the timing of the laundry as discussed in 5.5.2 and each has its own set of associated technologies. However, there were three main technologies of interest in this study from the point of view of shifting the time of energy use,

the first two of which were relevant to the laundry: the delay button on the washing machine and Economy 7, which are discussed briefly. The third technology was solar photovoltaic panels, which had been installed by two interviewees and will be discussed in some detail.

Not everybody who had a delay button used it but a couple did. In one case the delay button was used to take advantage of Economy 7 and in another to schedule the laundry cycle so that it would finish at a convenient time: "I put a wash on this morning with a delayed start. That's a function that I use quite a lot… If I know it's going to be a scorcher of a day… and I'm not gonna be back 'til four. I'm gonna miss out on all of that clothes drying unless that's coming out of the washing machine at eight… so I'd absolutely use it to be able to get things hung out" (Interview 2.3). Others, however, had not considered these uses of the delay button so adjusted their schedules so they could switch the machine on manually, so maintaining their own agency rather than transferring it to the technology. Meanwhile, Economy 7 (and another unnamed pricing tariff in use in one home) did serve to shift energy use, though only in some cases and mostly around the laundry as these participants heated their homes with gas. This is discussed in greater detail in relation to price incentives (6.1). However, most people, when asked about it, either did not know whether they had it or, if they did have it, were not sure exactly how it worked: "I am interested in technology but… I find now that I can only really use technology if I'm going to use it regularly otherwise I can't remember and it's so difficult to write down instructions about how to find things" (Interview 9.4). As this quote shows, irregular use or complicated technology meant it was hard for it to be incorporated into know-how and this is a key point with regards to technology – it is not so much the technology itself but how it is used that is key in working out where agency lies. The important point, therefore, is that it is not the existence of the technology but the use of the technology which it is relevant to understand.

Moving onto the solar photovoltaic panels; these were very significant in shifting terms. They had been installed in two homes in the study, one a volunteer and one who did not participate in the rest of the study but became known to the researcher after the main research was finished. These case studies offered an opportunity to see how people might shift in a 'real world' context and without being asked to do so by the researcher. In the first instance the shift was interesting because the volunteer had been using Economy 7 and had subsequently shifted from night time laundry to daytime laundry to make better use of his panels. Doing the laundry during the day was actually easier for him because he worked mainly from home and this meant he could get it out of the machine and hung out to dry. The other volunteer was even more interesting. She had undergone

two big shifts: firstly moving from a 'normal' house with an on-grid electricity supply to a house that was off-grid. Here she started out using a generator which she only operated from when it got dark enough to put the lights on until she went to bed. This meant that, in the summer in particular, her laundry and all her other energy use was crammed into a couple of hours in the evening and she did not use appliances that needed a twenty-four hour supply, such as a fridge or freezer. However, not long before the interview she had installed a solar photovoltaic and battery storage system and switched her heavy electricity use to the daytime. Her new indicator for electricity use was the brightness of the sun, about 11h00 being the prime time, although this was slightly problematic because she worked part-time. She had just installed some automated switches that would allow her washing machine or hot water tank to turn on when she was out but had not used these yet.

In both cases practices shifted significantly around the technology demonstrating its at least partial agency. Although both volunteers had already exhibited shifting behaviour before taking on the solar technology which may show a predisposition towards being flexible, it is increasingly recognised in the literature that energy practices are usually reorganised around domestic micro-generation technologies (McKenna 2013). This is partly because, in taking on these new energy-use practices, people have to engage with institutional knowledge around energy and the available technologies. Certainly the volunteer who lived off grid was very energy aware: "Because before of course it didn't matter quite so much (when using the generator)… but my (present) energy at night time is from a storage bank. I need to make sure I'm not wasting it so I've changed all my light bulbs to energy saving ones… for example I think that one is five watts where it used to be forty and that's an awful lot, you know, four forty watts is over a kilowatt and a kilowatt to me is a lot because my immersion heater is a three kilowatt immersion heater… I think if you can relate to a light bulb, I think people might get that. I don't think they really realise" (Interview 12).

This example is interesting, however, because it demonstrates the agency in the other elements as well. The shift in practices also results from new engagements with energy. Both these volunteers saw themselves as pioneers in some sense, one calling her home: "Chapwick Hinckley (laughs) 'cos I'm not too far away" (Interview 12) and the other noting that he was the first in his neighbourhood to have had panels installed. Although you had to cross the road to see his panels , one of his neighbours had liked their colour and thought they would help him to save gas and the other questioned their environmental credentials as he was a mechanical engineer and had looked up how they were made and transported to the UK. In both cases this had generated a conversation. Each of these volunteers was pleased about getting involved in energy generation and believed their choices

would ultimately make their houses appeal to a wider group. The one volunteer felt her house was more saleable with the panels than it had been with the generator. The other volunteer had actually listened to "a *Which* webinar and they were saying it's too early to tell if it has a positive or negative impact on the value of a property" (Interview 13) but he was confident that in the context of rising energy prices the impact would soon be positive. Both, in other words, felt they were part of a cultural change that would eventually shift some of the conventions/ meanings around energy and its accompanying technologies. Even though the volunteers were happy being pioneers, however, neither was an environmentalist and both considered themselves 'normal'. While it had helped them begin conversations with friends and family, these tended to be about how normal their choices were: "I think they realise that actually maybe I am running as normal a house as I need to run but in saying that everybody's really surprised because even my closest friends and my family said 'You're mad. You're still spending a lot of money and what happens if it doesn't work?' and I said 'It will work. It's going to work'" (Interview 12).

Both had been influenced to adopt the technology by strong financial incentives (which might be considered a form of institutional knowledge), which is discussed in **5.4.4** and it is true that their interaction with institutional knowledge in relation to energy had increased due to their exposure to this technology. In addition, as their energy technology and the engagements around it had changed, so their know-how (how things were done around here) was starting to shift too: "If I had visitors come to stay, they didn't understand… I said 'You're very welcome to stay but lights go out at half past ten. You know the normal rules of the house are: the news and the weather is watched and then lights out because the generator goes off. That's it. And there's no electricity at night so if you are in the habit of getting up in the night here's a little lantern for you" (Interview 13.1). This demonstrates the shared agency between know-how, technology and social context described by Wilhite and Shove.

As Røpke (2009) points out, therefore, technical change can have implications for the temporal and spatial organisation of practices, and the impact would be even stronger in the case of time-shifting technology. Agency is clearly present in the technology to some degree. However, this example also shows that altering practices is even more effective if several elements change at once to support one another. A combination of technology, institutional knowledge and financial incentives supported the emergence of a new set of practices organised around energy generation. These have in turn generated new 'know-how' about energy and the best time to use the systems that have been installed so that practices have gradually become differently organised around these systems.

As these practices establish themselves so they have started to generate new meanings with which friends might engage, which may in turn start to change the cultural acceptance of such technologies. In such ways do practices start to be seen as 'everyday' as will be demonstrated in the next section.

5.4.3 Engagements

Engagements (Warde 2005) are also known as teloaffective structures (Schatzki 2002) and meanings/ image/ conventions (Shove, Pantzar 2005). In Shove's paper on freezing practices, she shows how the freezer initially represented health, freshness and economy (as it allowed people to keep food fresh for long periods and to bulk buy) and has since evolved to represent competence, efficiency and routine (as it now effectively allows people to have a mini-supermarket in the kitchen) (Shove, Southerton 2000). This section will look at how laundry is influenced by similar sets of cultural engagements, using as an illustration the dominance of smell in determining the meaning of clean. As was suggested earlier, the meaning of laundry has undergone a complete transformation over the past couple of hundred years as the technology and meanings of laundry have coevolved. Describing the history of laundry could be done in a number of ways. Despite the apparent increase of laundry over time (Cowan 1986, Schwartz-Cowan 1983), Shove points out that there is "no clear metric of progression" (Shove 2002: 4) and proposes that the history of laundry could be traced as part of keeping the body clean, looking after clothes, changes in what needed to be washed, transformations in how laundry is organised (from a social to an individual practice) or by following the careers of the various devices used in the laundry process like the iron or tumble drier. She also notes that it cannot be claimed that laundry has stabilised as a practice; its elements are continually in a state of "de- and re- stabilisation" (Ibid: 4) and it is this iteration that drives transitions in the meaning and practice of washing well. Shove identifies laundry as a system of systems, each of which mutually configures the other. This means that the elements of laundry are interdependent so that, as machines are developed to wash clothing, so machine washable fabrics come to dominate the clothing market. Similarly, the meanings brought to the practice evolve too, so that, as notions of freshness come to dominate the notion of cleanliness, so clothing is washed because it smells bad even if it does not look dirty, something which is possible because it is relatively easier to do the laundry. Whereas clean used to mean boiled and therefore hygienic it now means fresh-smelling, crumple-free and white.

Some of the volunteers recognised the existence of these conventions, both in terms of the historical evolution of laundry and the fact it was done differently in other countries. One volunteer remembered the sheer slog of his mother's laundry: "I have memories of my mother and me

washing on wash boards in big metal basins, all the sheets and so on, and I remember the knuckles getting sore doing it… putting things through mangles to squeeze them out" (Interview 8.3). Another had a slightly romantic view the laundry in other countries but nevertheless questioned the relatively new idea that the laundry is about keeping the clothes rather than the body clean: "There's more of a wisdom about washing… that we've oddly gone away from… For instance a lot of developing world societies would wash their clothes the same time they wash themselves… And I think that's quite interesting that we made that separate" (Interview 6.3).

Of course what is considered dirty is defined by convention too and smell was the most important indicator in this regard: "Well I guess I tend to stop wearing clothes when I feel that they're a bit smelly and then I wash them when I've got a significantly big pile of things that are a bit smelly (laughs)" (Interview 1.3). This was considered even more important than when they actually looked dirty: "Yeah definitely I would say odour is a really big thing with washing, more than appearance" (Interview 6.3) and was more significant than stains in some cases: "With the children I will often sponge off stains… I mean they're not smelly if they wear them two or three days" (Interview 2.3).

A fresh smell was also an important indicator of cleanliness: "Fabric softener, yeah I like using quite a lot… I'm quite liberal using it 'cos… (laughs) I like my clothes to come out effervescing of fabric softener… I think that (is) part of the illusion of having really fresh clothes" (Interview 6.3). More subtle eco-conditioners were often harshly judged against smell: "They do get Ecover stuff a lot and they would probably be open to something as long as it sort of worked but I think the smell factor and getting that really nice feeling of fresh washing is quite hard to give up" (Interview 6.3). This meant a larger quantity of these products was necessary: "I think that the thing with regular wash powders they're so heavily perfumed that you only need a little bit but with… the eco-friendly ones, sometimes just to get the washing to smell better we put a little bit extra in, like double it up or something" (Interview 7.3). Heavily perfumed laundry was not always seen as important, however, as long as it smelled clean: "I wouldn't think it's so important to me that they smell of fabric conditioner every time I stand up to deliver training" (Interview 2.3) or "They come out smelling clean but not – I don't walk around like she might, constantly smelling myself. It's not quite as lovely as that. It's just I know that the dirt is removed, that's about it (Laughing)" (Interview 6.3). In fact, sometimes products were seen as being overpowering and it may be necessary to dry washing outside to diffuse this smell a bit. One eco solution to a fresh but subtle smell was "just put a few drops of lavender essential oil in and that tends to just give it that nice smell" (Interview 7.3). Some people did not use conditioning products at all but even then their overall smell was still important

to them, in some cases achieved by the smell of the body, again highlighting the link between the cleanliness of the body and clothes: "My aftershave will overpower any (conditioner) (laughs) I'll just put more aftershave on" (Interview 3.3).

The bottom line was that wearing smelly clothes was seen as completely unacceptable by all volunteers, without exception: "If you did occasionally run out of washing and… you have to pick out a shirt you've worn before, you feel uncomfortable during the day for some reason, maybe psychological… I feel uncomfortable wearing a shirt which (has) smelly underarms from the day before (laughs)" (Interview 11.3) and they would do as much laundry as necessary to make sure this standard was upheld: "Well, what I'm saying is that I'm not frivolous with the laundry I do now so I've already made it as efficient as I can. So, if I had to not do as much laundry, then I would lose some efficiency in either stuff smelling a bit or being dirtier than would be personally acceptable" (Interview 8.3) or "In my opinion I'm washing as little as possible… I know that I can't do it any more minimally if you know what I mean" (Interview 2.3). Interestingly, the tyranny of this convention went unquestioned, as is generally the case with powerful engagements and the practices of which they are a part thrive while this is the case. It is clear then, that engagements have strong agency and that it is generally beyond the power of individuals to change them, even in the rare cases when they do manage to resist them.

Just a quick note before closing this section: the difference between engagements and know-how in terms of its relationship with the laundry might be subtle but it is significant. Know-how with regards to the laundry tended to operate in the context of the home and allowed a degree of 'moral space'. In contrast, when laundry is demanded by other practices and will be judged according to externally determined engagements, the result appears to be less flexibility, certainly in terms of the standard of the washing. Also, whereas dirt can be seen as an attribute of the laundry, allowing the laundry to be judged in its own terms, cultural expectations (or engagements) have little to do with the actual laundry and are both more complex and more powerful as a result. Looking at this element more closely demonstrates that flexibility in the washing may have less to do with the machine and more to do with societal conventions. Strategies to achieve flexibility may therefore be better advised to deal with the conventions of the workplace or the school ground rather than the washing machine itself.

5.4.4 Institutional knowledge

Institutional or official knowledge is also known as rules (Schatzki 2002), knowledge/ discourse/ language (Reckwitz 2002) procedures (Warde 2005) and competence (Shove, Pantzar 2005). The cultural conventions examined in the last section include embodied, socially structured institutions and these at least partly circumscribe the types of action and the location of social groups in social space (Warde 2010). It is arguably from these institutions and their social groups that institutional knowledge derives. Although apparently authoritative, institutional knowledge is not generally referenced in everyday life. However, it is popularly believed that providing information or 'educating people' (using institutional knowledge) is what is required to change behaviour and, indeed, according to (Wilhite 2012), while know-how has a strongly determinative influence on how practices are performed, institutional knowledge can be brought to bear on it (Wilhite 2012). However, the agentive strength of institutional knowledge is somewhat limited, as will be seen.

Institutional knowledge is generally referred to in contexts where habitual know-how and conventional meanings become disrupted for some reason. Wilhite (2012) uses the example of bodies that have undergone purposive training such that their performances are routinized (such as athletes or dancers, for example) who can nevertheless behave creatively in relation to other performers or in other contexts when required to do so (such as in a competition or when performing on stage in his example). It could be argued that in these circumstances the practice itself has changed – practicing for a sport is not the same as competing in it and rehearsing for a performance is not the same as being in front of an audience. Nevertheless, the overall point he makes, that these 'socially mediated movements' are not such strong habits as the normal routinized performance because they require the engagement of the reflexive mind, is convincing. Although, therefore, it is possible for uncertainty to be removed from domestic and work environments such that certain performances become habituated in everyday life so that these take on social significance and may become part of a cultural aesthetic or ritual, or even of social variables such as class and age, such habits and routines are subject to disruption if any of the elements are altered as has already been seen. This section will examine ways in which institutional knowledge influenced the laundry so as to cause exactly this sort of disruption, thereby demonstrating that it has a certain amount of agency.

Institutional knowledge is relevant to demand response in two important ways. Firstly, it has the capacity to influence the amount of energy that is used because instructions might indicate particular temperature or spin settings, for example. Secondly, in the context of trying to shift

demand, energy companies are currently positioned as a primary source of official knowledge and so will need to understand how it impacts on practices in order to better assess their own messages. What constituted institutional knowledge in relation to laundry was not defined in the study but was variously interpreted as washing machine manual instructions, the programmes on the actual washing machine itself, clothes washing labels, advice from energy companies (possibly through the bill or publicity of various sorts), signs in the laundrette and usage advice for laundry products like detergent and softener. However, the washing machine manual is perhaps the most obvious set of instructions relating to laundry so makes a good place to start.

Most people had consulted the washing machine instructions at some time, typically when they first got the machine and needed to plumb it in, but it was not referred to on a day-to-day basis: "I think I dug out the instructions purely to work out how to start it, use it for the first time, but other than that I've never used it. I couldn't tell you where they were I don't think" (Interview 10.3). What is evident here is that what was once institutional knowledge transforms into know-how over time as the technology becomes incorporated into the practice: "The first time or the second time you read the manuals and then you just know it" (Interview 4.3). Once this happens a new kind of technological determinism seems to take over: "So with the washing machine most of the dials around there don't actually register… so you just say 40 degrees is what you're meant to do so I'll leave it at that and avoid any of the other directions" (Interview 11.3). After this the washing machine itself is seen as the main source of 'official knowledge' about how it works. "It's got a lot of different settings and possible different programmes on it. I think it goes from A through to J, each letter is a corresponding programme. I've got my letter. I know what that (is). I'm happy with that. I don't think outside of letter E (laughs). I've never given much thought to my washing" (Interview 10.3). If the machine is so important, the purchasing decision becomes relevant and is a place where institutional knowledge could be given an important role: "I tend to get educated about products by going onto people like the Which… I bought it… based on its overall score: its environmental credentials, on its cleaning capability and on its reliability" (Interview 8.3). However, it is not easy to get these sorts of messages across: "I mentally switch off whenever an advert comes on (Interview 8.3) or: "How did I choose my washing machine? I think I just liked it 'cos it was silver and it had a blue door and simple buttons" (Interview 1.3).

Although institutional knowledge may become know-how over time, it is sometimes possible to disrupt this know-how, so requiring reference back to the institutional knowledge. Accidents or things going wrong were good examples of how know-how could be disrupted: "If something

unexpected happened with the washing machine then I would go and check the instructions, like just after we had the new carpet put down, literally the next day or something, the washing machine leaked… After that I spent a lot of time reading the instructions 'cos I was trying to work out what had gone wrong (laughs) but no light was thrown onto the subject" (Interview 11.3). In this case the official knowledge is used to understand the reason for the disruption and may have a permanent influence on practices in the future: "That mainly applies to the drier really 'cos I have frazzled something in the past by putting it in the tumble drier too high so we do tend to be a bit more careful about things that we put in there" (Interview 7.3).

Know-how can also be disrupted when another set of 'official' instructions is brought to bear on them, like those on the clothes washing label demanding that a particular setting be adopted, for example. This might mean the institutional knowledge relating to the washing machine needs to be referred to again: "I use the things that are on the dials every now and then just to remind myself which is which 'cos sometimes I'll do an economy wash for delicates" (Interview 3.1) or "So, for example, if I'm washing a pillow, which I have to do occasionally, I'll follow the instructions not to damage it and if I'm washing the covers from the sofas, which I do once a year, then I'll follow the instructions on that but the rest of the stuff that has a history already will be washed at 40 or 60" (Interview 8.3). However, mostly the clothes label instructions tended to support the technologically deterministic know-how that had set in: "We change (the washing machine settings) for every load but then most of our clothes need the same setting" (Interview 4.3). This is an example of how know-how and official instructions can serve to support each other, so strengthening the resulting practice.

Shove raises this issue of convergence when she discusses the many actors involved in the laundry. The most obvious actors perhaps are the carriers of laundry practices. While individual practice carriers might combine elements of laundry in unique ways that demonstrate both the stability and changeability of practices, it is clear that there is a general convergence around how machine washable laundry is done. A 1988 survey showed that people in the UK rarely use more than three programmes, forty degrees has become the standard washing temperature and most laundry is locked into "distinctive domestic regimes of sequence, timing and theories of purpose, performance, hygiene, freshness and appearance" (Shove 2002: 8). Following Susan Strasser, Shove submits that this is quite intentional on the part of a second category of actors, namely the corporates involved in producing washing machines, parts, plumbing, textiles, fashions, washing products and so on. Together they have established washing machines as normal and necessary and defined what comes

out of the machine as well laundered. These actors have had a profound influence on the meaning of cleaning. The paper also identifies a third set of actors, namely social actors such as government and environmental groups, who are trying to change laundry practices.

Getting back to institutional knowledge, however, despite the fact that it does have an influence, official advice had a significant challenge in terms of its agentive potential in that it was not always taken seriously or believed, particularly if it contradicted pre-existing meanings or know-how: "We changed our washing liquid. I think the instructions say like one cap full but I usually put about three or four in and that seems about right" (Interview 7.3) or "It is hard 'cos with the concentrate it's supposed to be concentrated but it is hard to believe… We modify the guidelines for most things I guess" (Interview 6.3). This implies that trying to thwart know-how and engagements around cleanliness by, for example, trying to embody official knowledge in a product (such as fabric cleaner that comes in capsule or tablet form so specifying the amount that should be used) may inspire a certain level of resistance. Even the volunteer who used the laundrette, which could be interpreted as an environment where official instructions might have more authority over the laundry, had read the signs but admitted to at least partly ignoring them: "There's a sign that says don't cram it in basically… I push my luck but I don't cram it completely 'cos it's got to have time to circulate so that's one rule I try to follow. I'm tryna be economic" (Interview 6.3). Even where ignoring the instructions had caused damage, the practice may be undisrupted: "No. Ignore them (instructions)… I wear silky harem pants which are really fragile… I have to buy new ones every couple of months. I think you're actually meant to hand wash them in cold water" (Interview 1.3) or : "Well I never look at the label because I assume they'll all just say 30 or 40 degrees and wash dark colours and light colours separately… Actually once I didn't look at the label on this skirt and it was dry clean only. Luckily I didn't do it here 'cos it left purple fluff all over the washing machine (laughs)" (Interview 11.3).

It seems fair to deduce then that, despite its popularity as a method for changing behaviour, institutional knowledge might not be as effective in changing 'sticky' practices as some of the other elements, particularly when this is done separately to technology: "So I'm not a good person for reading instructions – so for clothes washing you just naturally assume things are what they are… you assume it can be washed in the normal way" (Interview 11.3).

This section has shown that, over time, institutional knowledge becomes routinized into know-how and, like know-how, its agency is shared with artefacts so that things like machine settings can seem

to become technologically deterministic. While disruption will usually result in institutional knowledge being sought (whether this is in the form of an accident, a new appliance or an irregular practice being carried out where know-how may not be fully formed), and it is possible for institutional knowledge to be brought to bear on know-how, it is not easy to construct messages or put them in places where they will be adopted. At the moment the different locations and sources of institutional knowledge may serve to disrupt or support one another. The status quo tends to be supported by the institutional actors that provide the parameters of the domains of action but forcing these sorts of messages may inspire resistance. In order to shift the laundry, therefore, the message will need to be carefully constructed.

5.4.5 So what?

It may still not be clear what difference this makes to thinking about shifting appliances so it is perhaps worth adding in one more example from the observation phase of how this sort of insight enhances the understanding of what is going on. It became clear that practices had different rhythms and that this had implications for appliances and therefore also consequences for agency. There seemed to be three categories. Firstly there are appliances with a continuous rhythm that ran automatically, usually in the background. Here the agency was mostly with the technology, which took on a strong scripting role. These had their own cycling rhythms (example fridge-freezers, septic tanks and fish ponds) and could fairly easily be shifted using automation, though there were issues around the acceptability of data access, storage and privacy (Darby, McKenna 2012).

Second, there were appliances that seemed to share their agency with practice carriers, such as washing machines, tumble driers, cookers and dishwashers, which were considered to be good candidates for demand response. However, this research has shown that these appliances are embedded in practices that are much more complex than might be anticipated in that their rhythms are more obviously determined by the practices in which they are implicated. As the rhythm of laundry is not determined by the appliance, a technological approach to shifting is likely to be limited.

Thirdly there were those more 'organic' or natural rhythms in the house where agency seemed to be located in the human body or diurnal cycles. These more embodied habits still involve appliances, however, and cookers, kettles and lights are good examples here. These rhythms were partly determined by biological makeup but also served other fundamental practices such as connecting, relaxing, and communicating. As outlined in the introduction, engineers describe this as 'critical

demand' and normally consider it completely inflexible. In this category then, there was perhaps more hope than might be expected from a demand response point of view. As demonstrated in the food and relaxation challenges these sorts of practices with their assemblages of appliances were shiftable but are obviously more complex again as agency is likely to be located in multiple places.

Analysing more carefully where agency lies, therefore, is key in developing shifting strategies for energy-use practices. It also makes sense to make sure that the agentive impulses within change strategies are working in the same direction where possible. Just relying on one element to change a whole practice may not be as effective as trying to develop a more holistic approach, particularly where sticky or dominant practices are involved. It is particularly worthwhile to consider the know-how and engagements of the practices under scrutiny as these seem to have the strongest agency. What this highlights is that change initiatives need to have a broader focus than the individual if they are to have a substantial impact.

5.5   Practices are located in time and space

The final insight into practices that will be discussed in this section is the relationship between practices, time and space, which expands upon the purely theoretical discussion on this subject in **2.2.6**. Practices are defined as "co-ordinated entities that are temporarily unfolded and constitute a spatially dispersed nexus of doings and sayings" (Schatzki 1966: 89 in Gram-Hanssen 2010a: 154). In other words, they form recognisable, interconnected clusters of activities and meanings according to the particular time and space in which they are performed. Their temporal and spatial 'signatures' are at least partly what identifies them as being part of one practice rather than another. The performances of different practices go on in parallel with one another and in so doing they combine with and influence each other, either through competition or through collaboration, and it is through the repeated performances of various interacting practices that people's lives attain their rhythmic beat.

In some situations it does not make sense to distinguish between the spatial and temporal aspects of inter-practice coordination nor to separate their performances from the institutional or infrastructural systems in which they are embedded or of which they are constituted. Hutchins (1995) and Zerubavel (1979) in (Shove et al. 2012), detailing the docking of a ship and the patterns of time in hospital life respectively, demonstrate that relations of co-dependence are tangible and the sequencing of multiple practices necessary. There are many levels at which practices come together and many temporal rhythms involved as one practice cuts into and across "several overlapping

sequences and cycles"… "Sometimes co-existing, sometimes co-depending, the resultant patterns of cross-practice connection are inextricably interwoven." (Ibid: 87). Nevertheless, in a work on shifting in time in particular but also in space, it seems instructive to attempt this process. This section will therefore start by investigating the various relationships between time and practices and will close with a discussion on space and practices.

5.5.1 Practices and time

The application of this work to the problem of time-shifting electricity demand means that the relationship between time and practices was always going to be an important one to explore. Time is about more than minutes. The experience of time is moderated through the rhythm of the day, the season, the physiology of the body, the historical context and so on and all of these will influence and constrain how practices are organised and allocated time (Southerton 2005). This means that time cannot be adequately understood by means of a time-of-use survey, although this might be a useful tool in certain circumstances.

A good deal has been written about time, including, according to Southerton's summary (Southerton 2005) the time-famine debate on why people constantly report having too little time (Robinson, Godbey 1997) the process of 'flexibilization' (Garhammer 1995) whereby working times and locations have become fragmented and dispersed with advantages for those of higher economic status but adverse impacts on those lower down the social scale who have to carry the consequences; the 'time bind' (Hochschild 1997) for women required to multi-task to survive the dual burden of paid work and unpaid domestic work; 'Taylorization' (Southerton, Tomlinson 2005), which breaks tasks down into their component parts in order to reassemble them in a way that achieves maximum 'temporal efficiency' (Southerton 2005); the fact that labour and time-saving devices promise to save time but often merely increase the frequency of the practices that use them (such as the washing machine) and so reduce the net time-saving potential (Cowan 1986); the 'time-space distanciation' (Giddens 1984) and network society allowed by ICT (Castells 1996) which has compressed the space and intensified the pace at which practices can be done and are expected to be done; the 'deroutinisation' and 'informalisation' (Wouters 1986) of society through the erosion of group-based norms and institutionally-timed events that has weakened socio-temporal structures like the working day or family meal; the fact that the relationship between status and leisure is increasingly identified with the volume of leisure experiences rather than conspicuous displays of idleness ; and the fact that being busy is now symbolic of a full and varied life (Darier 1998) and a necessary requirement for reflexive identity formation (Bauman 1988, Giddens 1991) (all references

in this paragraph are from (Southerton 2005)). It is worth noticing that these phenomena all seem to lead in the direction of increased 'individualisation' of practice performances and much of that may be reliant on increased energy use.

It is surprising, therefore that there has been little empirical focus on the temporality of practices and how these shape temporal organisation, particularly in the context of energy-use. **Table 20** serves as a reminder and a summary of the earlier discussion of time in this thesis. This uses Shove's main categories of time: as a resource, as a coordinate and as an experiential construct (see **2.2.6**, as well as sections **5.5.1.1** to **5.5.1.3** below), and cross-references them against historical and day-to-day time. To some degree historical and day-to-day time correspond with practices-as-entities and practices-as-performances, respectively, though this matching is not exact. The main purpose of the table is to make clear the difference between the constructedness of day-to-day notions of time against the actual passing of time, as measured by the moving of the sun in the solar system. The point in this work is not to get too philosophical on this subject, but to use it in the most practical sense possible.

Table 20: Ways of seeing time

	Time as a resource	Time as coordinates	Time as an experiential construct
Historical time	Practices and their elements coevolve in competition with one another	Practices are contextualised in historical time	Historical time is arranged around practices which have since evolved or died out
Day-to-day time	Practices jostle with each other to compete for people's 'life paths'	Practices are located in day-to-day time	Daily life is arranged around artificially constructed notions of time and is experiences on in relation to practices

Source: Developed out of Shove's ways of seeing time (Shove et al. 2012)

Southerton (2005) has done some of the most sustained work on time and practices and identifies five dimensions through which time can be analysed: periodicity, tempo, timing/ coordination, duration and sequence. Although this study focused on a wider range of practices than Southerton's, his categories accord with this study's observations. His five dimensions (to which a sixth dimension, timing, has been added) are therefore summarised in**Table 21**. The table highlights the fact that it is not only how much time is available but how it is arranged and organised that is key in understanding the time allocation of practices. It outlines the following categories: periodicity (the rhythm, frequency or regularity of the activity), tempo (the rate or speed of the activity, particularly

in relation to the experience of being involved in it – whether or not it feels rushed), coordination (the mutual adaptation of activities so as to synchronise with others), duration (the length of time involved in the activity), sequence (the ordering of activities in a fixed or arbitrary arrangement) and timing (the actual time of an activity, relating to its diurnal, biological or societal compulsion).

Table 21: The temporal dimensions of practices

	Definition	Features
Periodicity	The rhythm or frequency of the activity	Primarily related to the regularity of the practice: • Practices with non-household members were irregular even if frequent • Practices with household members were reasonably regular and may become routines • Individual practices were highly regular, either as part of a commitment or as time fillers
Tempo	The rate or speed of the activity	Primarily related to the experience of participating in a rushed or leisurely practice: • A subjective experience – what may seem rushed for one may seem relaxed for another • Contingent on the degree to which other practices infringed upon the practice being analysed • Practices with a fixed time, high degree of coordination or high level of personal commitment were susceptible to increasing tempo if schedules were disrupted.
Coordination	The synchronisation or mutual adaptation of activities	Primarily related to the level of pre-arrangement and coordination with others required • Practices with non-household members required a high degree of coordination and arrangement • Irregular practices with household members required high degree of arrangement but regular ones required no arrangement The degree to which the practice involved others, the spatial arrangement with them and the regularity of the engagement determined the level of coordination required
Duration	The length of the activity	Primarily related to the amount of time involved • Practices requiring higher levels of coordination tended to have longer durations (appropriate as they tended to be fixed into personal schedules) • Practices conducted alone were short, possibly time-fillers between fixed activities
Sequence	The ordering of events	Related to whether practice was fixed in specific time frame, allocated according to a fixed sequence of inter-related practices or arbitrarily allocated • Critical to positioning in the other four dimensions • As practices with non-household members were usually fixed, others were sequenced in relation to those. • Practices conducted alone, even regular ones, were arbitrarily located in the day. Where they took place at the same time each day/ week this was usually the result of them being caught between other fixed practices
Timing	The time at which activities occur	Related to actual time (seasons, days) which sometimes relates to what practices take place • Normally related to diurnal and biological cycles which usually determined the general time of meal times and sleep. • Partly leading from this, constructed societal cycles still determined the time of work and school and, consequently, most leisure. • Some practices were fixed within these overall patterns, with more flexible

			practices slotting between them as above

Source: Derived from Southerton (2005)

Arising out of these temporal dimensions and based on his empirical observations of leisure practices, Southerton posited that daily life is ordered around three main components. Firstly their the range, rather than volume, was significant (whether they are conducted alone, their regularity). Secondly their requirement for coordination was relevant: practices requiring a high level of coordination provide 'anchor points' for the sequencing of practices. Thirdly, their duration (which was dependent on the level of commitment to the particular practice) was important. This meant that the typical day was arranged with respect to fixed practices, around which malleable practices organised themselves and within which time fillers slotted in.

These six dimensions evidently relate to the ability to time-shift practices. If a practice happens regularly (periodicity) it might be part of what is considered normal and so be harder to shift; if it starts to impose on other important practices it may feel rushed (tempo); if it takes up a lot of time it will be difficult to find enough time in another part of the day to move it to (duration); if it upsets the order in which things need to happen (sequence) it will be more disruptive; and, sometimes, certain times of the day or year will make shifting practices more difficult too (timing). The nature of the shift required is also significant. A specific and planned shift required occasionally for a limited time is a very different prospect from a regular disruption (like regular, scheduled load-shedding, for example), unplanned disruptions (like brownouts or blackouts) or long-term change (like regular shifting around renewable generation such as the solar photovoltaic panels discussed earlier).

What the challenges did, effectively, was to place a set of constraints on the performance of particular practices, most obviously in terms of restricting energy use, but also in terms of circumscribing the time during which practices could be carried out. A good example of a practice that was difficult to shift in the challenges was work, which had all the hallmarks of a dominant practice. It might be remembered that, although the work and leisure challenge started at 15h00, several people did not start it until they got home from work. For these people the challenge did not influence their working day one way or another. However, there were several volunteers who usually work from home and for them the challenge was more difficult. In one case work could not be put off because a deadline was looming and so the start of the challenge was delayed: "We kinda half did it. We did it from six 'til ten. From three 'til six I was doing a job application that I kinda decided to do last minute and (my husband) was doing some work on green movies so he had the laptop on and that was plugged in. Both (were) kind of essential so we just did them anyway but

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then when we finished at six we didn't use any more power after that for entertainment or work" (Interview 6.4). Others did the challenge but either found it to be less straightforward than some of the other challenges: "it wasn't 'til about half past nine that I began to get agitated because I had been as well preparing for this interview the next day and found I wanted to print quite a lot of papers ," (Interview 9.4) or felt that on a different occasion it might not have been possible: "It would have made it more difficult if for example it was a Tuesday and I had a lecture on the Wednesday where I couldn't prepare, so there would be times when it would be deeply inconvenient," (Interview 1.4).

One reason for this reduced flexibility was the amount of time taken up by working practices – it was simply less possible to shift that amount of time significantly (duration). Another was that the appliance was difficult to separate from the normal accomplishment of the practice: "Any work I do at home would always involve the use of electricity because it's always laptop based or on my phone" (Interview 2.4). A third is that other people were involved in this practice (coordination) and so the practice was very demanding in that it needed to be performed at least partly in relation to them: "That would be my focus; get it done, get it turned round, get the stuff back to the clients as quickly as possible. So it's all part of my reputation there. I'm doing a good job, dealing with the goods, in a fast timescale. So that's how I'm driven in terms of prioritisation" (Interview 3.4). As a self-employed person in particular, opportunities could not be missed or compromised, even for a few hours and so staying connected was important: "If anything urgent came in as we'd discussed if I had to deal with it I would deal with it. I can't compromise my business situation" (Interview 3.4) or "As freelancers and people who work quite flexibly… I certainly think the biggest challenge would be being unwired in terms of work" (Interview 2.4). This corresponds with the CLNR study, which also found the need to be constantly connected was pretty unnegotiable (Cardwell, J 2012).

Work also demanded the best personal energy available and so timing was an issue: "My brain just works miles better when I've just woken up and (so) I've got all my classes scheduled for first thing in the morning 'cos that's when I've got all my liveliness and energy" (Interview 1.4) and may require a certain amount of isolation: "There are certain types of work that I would only consider doing if there was absolute certainty I wasn't going to be interrupted … so I would say the kind of work I do absolutely is determined by whether I'm on my own or with others" (Interview 2.4). Certainly the work load needed to be managed: "there's more work to do than time available in the day generally but I smooth that work load out so it spreads out to be equivalent to half a day to a day" and only when it was done could people be free of the demand: "I can relax much better if the things I

actually need to do are done so I tend to do them in the morning and as it gets later I'm more likely to be doing the things that are only tangentially related to work" (Interview 1.4). All of this meant that there were certain times that were more appropriate for work than others (sequencing, timing).

Coordinating with others was crucial to how time was experienced: "Well I think naturally I tend to be very flexible. I'm not bothered about doing things (at) any particular time but the routine you get forced into, is by (the) demands of others" (Interview 11.4). There were some houses where the individuals were fairly independent of one another: "Well it's interesting I suppose because for us … we're not alone 'cos there are other people in the house but in a way we behave as if we're alone, although we don't go dancing naked round the house; not normally anyway (laughter)" (Interview 11.4). Even in this house, however, people had to work around one another to access resources like the bathroom and kitchen. In other houses there was some attempt to organise schedules so that people came together at certain times of the day: "(We) try and eat as a family if (my husband is) around. It depends when he's back from work but we'll try and eat around half past five, six o'clock" (Interview 5.3) or: "Generally we get in and have a sort of hour winding down period immediately after we get in… so it's generally around about six and seven when we just get in and we usually put the computer on straight away and sit down and watch something… to really wind down… I think that's probably our most relaxing point in the day" (Interview 10.4). While coordination of the various demands within each household or family unit was essential, coordinating with people outside of the immediate household was generally more complicated again: "The other thing I was thinking of along those lines is that if you're going to go out you usually go out at the weekend with friends and things because if people are working during the week or have children… it's always got to be at the weekend 'cos you're not going to be there or you're going to be too busy anyway so you end up going out Friday night, Saturday night or both or doing something on Sunday or arranging it in advance 'cos that's the only time you can do" (Interview 11.4).

One of the reasons why practices like work seemed to be so dominant was that they not only took a lot of time, involved others, demanded to be done at a particular time of day and often felt rushed, but also that they were able to be flexible. In other words, while work was normally a fixed time commitment, it seemed also to be able to mould itself around other practices if required to do so: "We're part of the modern phenomenon of flexible family life that everyone aspires to in a way. 'Cos the old-fashioned notion of the daddy going out at 8 o'clock every morning and back at 6 and then the mum looking after all the home stuff – you know we don't do that. I dropped the kids at school this morning you know and I'm going to be leaving for work at 1 o'clock or so and variety, flexible

working is what to me is the buzzword" (Interview 2.4) or: "Just do it whenever really. I fit it in around… It's difficult because I don't do full (work) days anymore and it's only in between the school day but if I've got just one job on that day then I might have a couple of hours … just when I'm not working and I get bits of time so I fit it in … slotting things in" (Interview 5.4). Work's flexibility meant it would insist on being done whenever and wherever which was both the result and cause of the reliance on appliances for work, which also served to increase the difficulty of shifting the energy use associated with this practice.

For some, however, the challenge provided a great excuse to escape this otherwise domineering practice. For one person whose computer was normally on from first thing in the morning until last thing at night, the challenge brought a sense of liberation: "I can remember just rushing towards three o'clock and then thinking 'Okay, I've got to turn off the computer' and turning it off and having this enormous sense of relief actually. For the first time in maybe five years I turned the computer off and just didn't feel guilty. It was absolutely fantastic" (Interview 13.4). This represented a sub-group of volunteers who prioritised other practices than work, even if it meant a very busy schedule. One volunteer who'd finished work at 02h00 because of a deadline the previous night so that he could go to the theatre with a friend said, "A deadline is always fine-tuned senses which is why I was up 'til two o'clock this morning (but) if I'd gone to the theatre and then to Ronny Scots the deadline would have been to finish at four o'clock instead" (Interview 2.4). For others, practices like exercise and friends gave fundamental structure to their lives and they fitted work around this but this was rare: "So I structure my week around yoga classes … (and) I probably see a friend once or twice a week in the evening but otherwise nothing particularly regular for the week" (Interview 13.4).

While many did manage to complete this challenge, therefore, proving that work could be shifted to a degree, its relationship with time and its reliance on appliances meant this was difficult. Nevertheless, many of the relevant appliances can be used on battery power for a while, which offers some scope. The level of commitment to practices like work (the rewards it offers, as discussed earlier), and the fact that it involves others, may be the greatest challenges to overcome for dominant practices.

This section has so far discussed time in a reasonably general sense. There are other ways to consider time, however. The following sections are based on the discussion about time and practices begun in **2.2.6** where the theoretical basis of the relationship between time and practices was explored. Here the empirical data will be used to both flesh out and deepen this theoretical

exploration, mainly with reference to the work and leisure challenge. Three main relationships between time and practices are explored: time as a resource, time structured by the temporal demands of practices and time as a construct arising out of the performance of practices.

5.5.1.1 Time as a resource

Practices-as-performances take time. According to this conception, time is seen as a resource and so practices must compete for it, which generally left volunteers feeling as if they were involved in a juggling act, which could be stressful. Routines may be established but these were prone to disruption, as a result of which quite a lot of flexibility was required to enable the day to run smoothly: "Our whole week got thrown into disarray where we suddenly had to rethink (my husband's) routine, my routine, who's going to have the kids. I need to now do this course that I've (found out about) at 5 o'clock at night on Tuesday I had to be somewhere at 8.30 the next morning which is quite unusual set of circumstances" (Interview 2.4).

Despite it sometimes leading to a feeling of being rushed, a certain amount of flexibility was prized by those who wanted it: "Absolutely, I don't want to be tied down. I don't feel comfortable being tied down to routine. That's part of the reason I'm doing what I'm doing" (Interview 3.1) or: "'Would you say that your time is more structured or flexible do you think?' 'Flexible' '(Laughs) And how much do you value that?' 'One hundred per cent'" (Interview 8.4). For these people each day was different as the practices they carried bent the available time around their demands: "I adapt my day depending on what's required" (Interview 2.4). This was particularly true if they did not need to coordinate what they were doing with anyone else: "What's the main thing would you say that your life is structured around?" "Me (laughter)… It's true. It's literally around me, what my plans are" (Interview 8.4).

However, even for these people, certain practices were dominant and inflexible and their injunctions had to be obeyed. The school day was one such: "The structure comes from the school day which starts at 8.55 and ends at 3.25. That is fixed and a given. This is very prescriptive actually; this is the thing that gives rhythm to our lives" (Interview 2.4) or "For me school structures everything, whether I'm going up to school … during the school day that I'm working or going to the gym or helping out at school or gardening club or whatever" (Interview 5.4). Work also had to be prioritised: "When you have a job, that would be the thing around which you organise other things" (Interview 3.1) and although, for some, it did not necessarily have to be done at a particular time: "Our work is freelance and very flexible" (Interview 2.4), some had no control over the times they worked and for

them the working day had a similar rigidity as the school day: "We're tied to market hours so once the market is shut there's very little I can do" (Interview 10.4). Practices involving external appointments also constrained flexibility: "The rhythm to my day would be what am I doing? Where do I need to be? When do I need to be calling?" (Interview 2.4).

These sorts of inflexible or dominant practices with hard deadlines put people under pressure, giving them a harried and hurried (Southerton et al. 2001) aspect: "'Cos I know how much of a backlog of stuff I've got to do (laughs) … so you know I've always got stuff to do" (Interview 3.4). Taking a practice theory approach to understanding what is going on in the household is not a matter of identifying how the pace of life has speeded up but rather of understanding new configurations and combinations of doing, such as multi-tasking: "I just whiz around doing lots of bits and pieces… that is just how I tend to live my life… I'll do what I need to do when I need to do it and I don't schedule in… I'll just do them as and when the priorities come up kind of thing" (Interview 3.1) or "No, it's just when I'm not working and I get bits of time so I fit it in… slotting things in" (Interview 5.1). This is not so much a time squeeze as a compression of practices and it is the range of practices rather than the volume which makes them feel pressurised (Southerton 2005).

As the carriers of these practices, some volunteers had experimented with the relationship between time and practices in their lives, one procrastinating on essential tasks (which somehow seemed to get done anyway) in favour of desirable tasks: "So I usually work – I could start earlier than I do and I ought to but I distract myself doing other things so I guess I'm tryna put it off really" (Laughs) (Interview 7.4). Others had defected from particular practices altogether: "I think now we're kind of simplifying our life more down to the main priorities, making sure that we get those in each day – it just feels like life becomes a little bit more productive that way and you do the things you really want to prioritise" (Interview 7.4). Effectively, volunteers were defecting from these harassing, unrewarding practices. This had not necessarily been inspired by the need for more time but had had the effect of freeing up certain amounts of time which they were then able to use for other things. However, commenting on this new-found freedom they said: "It's hard to tell when you've got more time really. You get used to it" (Interview 7.4).

In summary then, where time is interpreted as a resource, competition between practices generally ensues and the result is that people feel pressurised. Although some prized flexibility, time was still arranged around particular fixed points, as observed by (Southerton 2005). These were difficult to shift because they involved others and, sometimes, had a long duration. However, ironically perhaps

and precisely because these sorts of practices are so dominant, they are prone to disruption in everyday life.

5.5.1.2 Practices have temporal and rhythmic injunctions

From the point of view of the practitioner rather than the practice, enacting practices properly implies cooperating with their existing rhythms and temporal injunctions. There are four issues here. Firstly, time (as does space) provides the coordinates by means of which practices are located and/or contextualised (Shove et al. 2012). This means that particular practices are appropriate and meaningful at particular times but also that the time at which practices are carried out gives a particular meaning or provides a particular context to the practice. Secondly, a particular practice may also need to be done at a particular time, for a particular duration or in a particular sequence (Southerton 2005) to be performed competently. For example, someone who cooked the dinner for only half the required amount of time or who ironed the clothes before washing them would be seen as performing their particular practices somewhat incompetently because they had not fulfilled these time requirements of the practice. Thirdly, and related, long-term carriers of particular practices become increasingly skilled practitioners over time and as they follow their practice careers and increasingly submit to the injunctions of the practice. Fourthly, collaborating with practices implies cooperating with their rhythms, such as the laundry rhythm discussed earlier, for example, and gives structure to the day and even the life path.

The temporal and rhythmic injunctions of practices became evident during the challenges. One significant organising practice was the timing of meals and cups of tea: "I do structure the day around eating. When is it time for tea (a cup of tea I mean), when is it time for food? So that is a structural part of my day" (Interview 2.4). Although it has been seen that preparing meals could be flexible, arranging the day around basic biological needs was fairly fundamental in most cases, though there were those who forgot to eat when a practice overtook them completely: "I have been known not to eat anything all afternoon or evening depending on what the situation is and how hungry I am – I do have odd eating habits" (Interview 3.1). Sleeping was another fundamental practice that mostly dictated when other practices took place though again, it could be temporarily shifted for a particular deadline in certain circumstances, as seen earlier.

Mostly, however, the rhythm and sequencing of the day was broadly similar for most people, most days: "So I'll get up first. You'll probably shower about ten past, quarter past seven won't you? And then around the time between seven and quarter past I'll have put the microwave on for the

porridge and put the kettle on for a cup of tea. So that's pretty regular apart from the weekend but you're probably delaying it by an hour or something. Same schedule but different time" (Interview 5.1). Several other people mentioned this: "Each day has a certain type of structure. Although it may not happen at the same time, it happens in the same order, the same type of rhythm I guess" (Interview 4.4) or: "Not strict times no. It's just more of a sequence I guess but there aren't really any times you know" (Interview 7.4) or "Yeah, I mean we have a bit of an example of that every Thursday I start work at eight as opposed to my usual nine which just brings everything forward an hour – I get up an hour earlier, leave the house an hour earlier, get back and hour earlier, eat dinner an hour earlier" (Interview 10.4). Building up repetitive practices in this way gave a certain rhythm to the day and the week and even the month and the year.

Having a certain structure or routine was seen as helpful in general: "(Laughs) No structure? We've got to the point where we always have a list of things to do now but otherwise we just kind of get lost in the moment and don't do anything … (Being) more structured (is)… something that is definitely positive in your life. If you're all over the place that gets more stressful to me than if things are more ordered and you just allot certain times for certain things and it kind of feels like it's more productive that way" (Interview 7.4). Mostly, routine was helpful in getting practices done: "So yes – if you've got a certain amount of work to do it's useful to have a routine just to get to work, as a way of working through things. 'Cos (the) natural tendency, which you may like more, would be to leave things 'til later but that doesn't do… for any sort of job really… Routines are helpful for just getting through things" (Interview 11.4) or: "Yes, I have a discipline. It's very important when you're on your own. I usually start work by nine and I do about two hours then I wander off and do something… (and) come back and then I set myself … targets. You finish them before you start something else even if it's going to take all day. Otherwise you never really, you're always coming back… Yes, well I have a pattern" (Interview 9.4). Submitting to the disciplining, demanding nature of practices' routines, in other words, is necessary in order to get through the challenges of the day.

These routines also gave meaning to the flow of everyday events: "I think we have a routine that is flexible (laughter). We definitely have a routine … we like routine and I think that's something I instigated when the children were young and I try to keep a bit because it gives some sense to everything we do but we are very flexible now because the demands have changed and we have grown up" (Interview 4.4). Not having a routine meant that valuable things might be missed out of the day: "If things get unstructured then we don't have time for that so we miss out on it" (Interview 7.4). Once a routine was set up it did not seem to be that flexible: "I think the only thing we could do

is get up earlier and go to bed earlier – you know so just shift the day but apart from that we are not actually that flexible with the way we do things – I mean I could work later into the evening and start later but that wouldn't really work out very well because we like to have our evenings together – so we're not actually that flexible" (Interview 7.4), primarily because it had been refined until it served a purpose and used time as efficiently as possible: "As I've been living here for longer than 2 years now it's turned into less time consuming and more of a routine activity so it doesn't bother me in terms of time. I can get it washed and get it hung up inside and hour" (Interview 6.3)

In fact, routines seemed to be a primary tool for coordinating time. Although they were structured around practices, they did change over time as people came and went from the household: "I prefer it when (my brother) is around and we have set routines but there's no one to keep them for now so there's no point" (Interview 4.4). In these cases, the arrival of a new practice carrier brought with it new practices that needed to be accommodated into and coordinated with the household: "On a Friday night (my husband has) come home and there's … a full load" (Interview 5.3). For those who have less need to coordinate their time with others in the household, coordination with those outside the household may still be necessary and can have a significant impact on routines: "My life is very different depending on if it's term time or not so outside of term time and when it's not the weekend" (Interview 1.1).

As suggested here, however, the need for and appreciation of routines may also change over time: "I think I resisted structure for a long time (laughs) but it's never really got me anywhere other than being frustrated – I've always preferred to try and be more free and loose but it doesn't really work especially when you've got two dogs that absolutely need as much exercise as you can give and when you've got a fulltime job as well and other things you want to do – it just kind of becomes inevitable that you need a structure" (Interview 7.4). The challenge itself caused several people to think about their routines. In some cases people found this difficult and the challenge helped to entrench practices: "I'm quite happy with what I'm doing (laughs). I'm not going to change" (Interview 11.4). However there were several cases where the interruption of routines was positive: "I mean it made me think and it's good for us oldies to have our patterns challenged to show we can be flexible" (Interview 9.4) or "it was good to be forced to break the habit, the routines that you do, that you go through" (Interview 8.4). The implication of this is that disruption, such as that caused by the challenge might allow other practices some space to change, though this is not guaranteed.

In summary then, as most practices were arranged around basic biological practices of eating and sleeping (although these may be temporarily deferred where practices were very absorbing or rewarding), the rhythm and ordering of each day across most volunteers was broadly similar most of the time and so felt familiar. Even where times were altered, the structure of the day and the sequence of practices were often maintained. Building up repetitive practices in this way provided a rhythm that spread out beyond the day and allowed certain patterns to develop over time. These were generally valued and were not seen as flexible. Regularity and routines were seen as positive because they facilitated getting things done, gave meaning to the everyday and meant that valued pursuits were included in the schedule. As routines served their purpose over time and were refined and made more efficient, so too they seemed to become less flexible although they would stretch and move to accommodate the practices brought in by new people. Despite this, however, the challenges did release a certain amount of flexibility and caused some people to reflect on shifting their routines. While some declared themselves happy with the way their lives were structured, others welcomed the disruption and none really minded the temporary disruption of the challenges.

5.5.1.3 Practices take and thereby make time

Although the title of this section may seem provocative, a practice approach would argue that an individual's experience of time results from participation in practices because time is constituted by practices. This is the concept of 'timespace' (Schatzki 2010), within which time and space come together through action and so are treated as constitutive dimensions of practices. Here it is acknowledged that although days pass and the seasons follow one another (so that time, in the objective sense is understood to pass) the experience of time is no longer seen as a resource but is instead understood as a construct.

Time is only really differentiated by the practices that fill it: "Any day of the week can be the same. Weekends will only be different if people are coming to stay or I'm going to see someone else" (Interview 8.4). The implication of this is that consumption is not just a drain of time (and other resources) but also the way the experience of time is created. From a practice point of view, the structuring of time in fact involves the coordination of practices and, more challengingly, the attempt to fit in with the practices of others. Especially for practices with a strong synchronous or sequential aspect, like meal preparation, for example, where things must be done in a certain order for a meal to be cooked successfully, time is an integral part of the performance of the practice. It also takes time to complete the practice and this therefore, almost by definition, structures the experience of time. How practices are managed in time was obviously an area of interest and so this

section examines the various ways in which practices are organised in relation to others, both in the lives of individuals and in coordinating practices with others in the family and in wider society.

Some people were able to carry their day-to-day tasks in their heads: "Well it's mainly because I have deadlines and things that I need to deliver so that kind of reminds me that 'Oh yeah, I do actually have to do things I'd better get on with it 'cos tomorrow I've got that to do and then I've got that to do so I'd better do it today'... Well I always put everything in my diary and kind of everything else is just in my head" (Interview 7.4). However, most needed aids to manage their time, either an old-fashioned paper-based list: "I think the situation ... I have been (in) over the last year or so is having too much to do .... So I look at my job sheet every day. Everyone laughs about my job sheet and I never get through it" (Interview 9.4) or a more high-tech, gadget-based version: "If I didn't have my calendar synced to my phone and whatever I'd be lost 'cos have bits and pieces going on all the time" (Interview 3.1).

There were some who were able to arrange their work schedules to suit themselves: "I'm in the fortunate position where I'm flexible enough to rejig my daily schedules. I think if you're less flexible then it becomes a harder challenge. If you're at the office from eight in the morning 'til eight at night it gets difficult to do those tasks, to some extent" (Interview 8.2); others who would have preferred to have a flexible schedule: "At the weekend or if I was working for myself I tend to do things very randomly and not be bothered by it but if you have to be in the office for certain hours and do things that have bigger diary appointments, then you're driven by that really during the daytime" (Interview 11.4); and yet others who were more like the general population and needed to be in the office at specified times: "(My husband) has a 9 to 5 job (and) I tend to stick to those sort of times because we can do the commute into work... (and) it's a good discipline for me so that dictates when I work even though I've in theory got a lot more flexibility than the other people in my office and I could work far more flexible hours than I do" (Interview 10.4). One person reflected rather sadly on how practices drove his work life: "So you have a flexible tendency but you're just stuck in a routine because of how things are... it's just like a round peg in a square job" (Interview 11.4).

How time was structured by participating in practices was really highlighted by the volunteer reflecting on his leisure time: "I suppose there's no barriers. If you finish work in the evening you could do anything really... but you don't... There's no barriers but it's mostly habits I suppose. You don't always question what you're going to do: get home from work, put my feet up for a bit, go for some exercise, having something to eat, read for a bit and that covers everything... The evenings are

very uniform really" (Interview 11.4). Nevertheless, there are those whose leisure was more extemporaneous: "I can adapt (to) … spontaneous situations. Last night my mate and I went to go and watch a play a theatre play but the actor turned out to be sick so we ended up having a drink in the pub so we just adapted. You know, that's what I do" (Interview 2.4) or who could be flexible: "We came in and probably did things in reverse order. Usually we have dinner and maybe sit down and watch a film or something like that, so we just did it in reverse yesterday" (Interview 10.4).

At a fundamental, although perhaps philosophical level, the way the day is organised creates the day: "(Laughs) It varies so much honestly. I dunno. We look at (it) and discuss. We look at iCal …'cos we publish diaries … and we basically take it in turns to do stuff. I mean, you know, I can't think of a typical week. Can you, at all?" (Interview 2.4). On a broader level, as touched upon elsewhere though not discussed in detail in the interviews because the focus was mainly on households, it is necessary for the individuals and households to coordinate with the outside world, such as co-ordinating with the external help coming in: "Usually it's because (the domestic helper) comes once a fortnight and so I have the sheets done (and) change the beds before she comes" (Interview 5.3). Households also need to synchronise with wider society in some way: "I guess only in that we tend to live in a nine 'til five society and if you don't go with that then you kind of find it more difficult to do things 'cos then when you want to do work if you've got to communicate with colleagues and so on if they're not there then that's a bit difficult" (Interview 7.4). Even more broadly, this was important on a cultural level so that certain moments of coming together as a society were important: "She has to see some sporting events live because she wants to be in tune with the rest of the population so if it's like a Wimbledon Final or something it's got to be live" (Interview 2.4).

In summary then, the coordination of practices was necessary to meet hard deadlines and help people feel organised. For this various aids like diaries, lists and high tech gadgets might be required as practices jostled for position in the day. This was usually necessary for those planning the challenges, as they responded to the notice they had been given. Although there were those whose work schedules were flexible and those who would have preferred a more accommodating schedule, for most working practices and schedules were fairly intractable. The result of this was generally that leisure practices had become fairly routinized too. However, where the challenge or circumstances forced a degree of malleability, leisure practices seemed to be flexible enough to slot into spaces that became available so that some flexibility was present even in full and scheduled timetables. A certain amount of coordination was essential where other people and practices were involved and facilitated: access to resources within the household, people gathering together at certain times, the

efficient accomplishment of tasks and coordination with people outside the household. Although synchronisation with those outside the household was more difficult, it had benefits such as allowing people from outside to help with the running of the household, making social engagements with others possible and fostering a sense of cultural cohesion. From a shifting point of view more coordinated households is useful in that it allows a degree of predictability to energy use and potentially allows more shifting to occur at a level that would be more useful for the grid.

5.5.2 Practices and space

Similarly to their analysis of time, Shove et al.(2012) also see space in three ways: as a geographical location, as a resource and as an outcome of practices. All three of these had resonance in the research and so are discussed in turn. Firstly, and perhaps most obviously, space is seen as a geographical location; it is clear that space and place are of similar consequence here. Practices take up a certain amount of space. Each phase of the laundry requires space, for example; collecting clothes is done in a wash basket, drying clothes are hung up somewhere or put in a drier, folded clothes are put away in the closet. Practices may also require a particular place. It is more convenient, for example for the washing itself to happen where plumbing and electricity are available. If these material elements are absent then the practice will necessarily change. Performing a practice in one place or another also has the potential to give it a very different meaning – doing laundry by wearing one's clothes in the shower on holiday is very different from washing them in a machine at home, which is different again from taking them to the laundrette.

There are several implications of the time and space dimensions of practices. First of all, practices take up time and space so that carriers are limited in the numbers of practices they are able to carry at any one time but also during any particular period. In other words it is only possible to do one thing at a time in one place at a time, so that it is only possible to carry out a certain number of practices over a particular time period and these will need to be in places that are near to each other. There are three possible reactions to this. Firstly, practices may compete with each other for time and space, jostling with one another in such a way that time will feel pressurised or space will feel crowded as discussed below. Secondly, one practice may eventually emerge as dominant, such as the emergence of showering over bathing (Shove et al. 2012). However, practices that are co-located in terms of time or space may equally well support one another. It is easy to see how practices that rely on particular plumbing arrangements might congregate around a certain part of a building, for example, or how practices that happen concurrently, such as relaxing and television watching perhaps, may come to influence and support each other or may even seem synonymous

with one another. Thirdly, practices that are co-located in time and space may transform each other, such as happened above in the use of the Internet to service relationships with friends and family, transforming both computer use practices and inter-relating practices. A practice's time and space attributes, therefore, mean that it may come to compete with, complement or change concurrent or collocated practices.

Seeing space as a resource implies that it may be limited and therefore the subject of competition as just stated: "I certainly don't want to clog up important space… I don't want, you know, airers where they can run around – I want space" (Interview 2.3). The significance of space for drying the laundry was particularly important and was discussed by several participants. For some people having laundry hanging about was not a problem – as one volunteer commented "No one's ever complained" (Interview 6.3) – but for most it was clear that space was at a premium. The laundry had a physical presence that was undesirable and even oppressive. It could feel "like, you know, you're stuck in a Chinese laundry" (Interview 2.3) and could restrict more important activities like children's play. Where more space was available and volunteers were relieved of the "visual intrusion of the laundry hanging up" (Interview 10.3) which reminded them "too much of student days" (Interview 2.3), they were also able to be much more flexible. Several people commented on this: "I've got enough bedding, towelling (to) cross over between housefuls of people so there will be stuff drying either on the rack in the utility room or in the airing cupboard when people are here" (Interview 8.3), or "I'm lucky. The house is big enough that I can leave it stacked up in one of the bedrooms" (Interview 9.3), or "Now that we've got a spare room and we can just shut the door it wouldn't affect us in the slightest" (Interview 10.3). Getting the *ironing* done added an extra dimension to the problem of space and was managed in various ways; by not ironing: "I do try and wear clothes that don't need ironing and buy clothes that don't need ironing but that I think is a huge reason why my laundry schedule is as flexible as it is" (Interview 2.3a), or by not minding ironing hanging about: "Sometimes I do two, three loads (of washing) and (the dry washing) just piles on the sofa and then I get on with it and spend an hour just (ironing)" (Interview 3.3). Where ironing was not demanded by (for example) the cultural expectation of the workplace, both space and time were freed up. A final point of interest about space is that it was not only the amount of space that was important, but often the quality of the space was important too, so that airers needed to be in sunny places or washing hung in airy spaces.

Thirdly, seeing space as an outcome of practices was evident in the study as well. This leads to two profound points in practice theory. Firstly, practices and their elements co-evolve over time. As

current laundry practices become more ubiquitous, so kitchens or utility rooms come equipped with space for the washing machine: "I think it's one of those 'household essentials' in inverted commas… I think as well even if we hadn't had one when we moved in we had this huge big gaping hole in the kitchen where a washing machine would automatically go so we'd have had to have done something with that" (Interview 10.3). Spaces thereby come to be partly constitutive of practices and vice versa. One volunteer explained that the reason she did her laundry at her parents' house was largely to do with space: "It doesn't take up time or space in the house here which would be quite a big inconvenience… we just realised it was probably going to be a bit less of a hassle because you've not got reams and reams of washing in a small space" (Interview 6.3). People are short of time, money and effort (Guy, Shove 2000) but space is also precious: I don't just whack the socks on and throw the things. I'm trying to be efficient with space when I'm packing it away 'cos space is at a premium" (Interview 6.3). These sorts of co-evolutionary developments lead in part to the stickiness of practices, or the fact that they can be difficult to change. Secondly, practices actually create and transform the concept of space, in a similar but perhaps more obvious way to that in which they create time, as discussed above: consider how flying or driving both creates spaces (airports, road networks) but also transforms how space is thought about (it becomes possible to live and work in different places and holiday abroad).

The physically spatial aspect to laundry is connected to its temporal spacing. Each of the temporal 'phases' of laundry (Shove 2002) (soiling, collecting, washing, drying, ironing (or not) and putting away) has a particular spatial aspect too, which could have a significant impact on the frequency and urgency of the laundry and therefore on its shiftability. Drying has already been discussed but where clothes are soiled, for example, is relevant for frequency: there are 'dirty' places like the gym and 'clean' ones like the office. Where and when clothes are to be worn is relevant for urgency. If they are not needed for a particular occasion in a particular place, they can probably wait. Where clothes are collected is significant for timing too. The size of the wash basket determines how much it can hold and where it is kept is relevant for whether it needs to be kept tidy or can be left to overflow a little. Moving onto the actual washing, the location of the washing machine is important in influencing when the laundry can be done. "Our washing machine makes an absolute colossal noise when it's in operation and I'm kind of thinking of our neighbours with our washing machine jumping across the kitchen" (Interview 10.3). The machine's capacity to be shifted is reduced if it is noisy as it cannot be operated during the day when people are in the kitchen or at night when it might disturb sleep or the neighbours.

Achieving flexibility in the washing machine, therefore, can now be seen as a much more complex business than engineers might have hoped. Though more subtle, the spatial aspects of the laundry might be just as significant as the temporal ones when it comes to shifting the laundry. It is worth noticing some of the features of practice that have been made clear in this section, namely that they require a particular amount of time and space to be practiced normally and that the quality of the time and space allowed them makes a difference to the competence of the performance. Not only that, however, but practices have rhythms, sequences and even schedules and disturbing these has implications in the competition between practices.

There are two things to notice before closing this section, however. Firstly, while energy use was not essential for leisure, it was still strongly implicated in many leisure practices. However, some of these are shiftable in *energy* terms – television can be watched on iPlayer, phones and computers have batteries, hot water can be stored and so on. Others might be shiftable in *time*: "We normally have our dinner and then we have got a couple of hours to sit down and relax before bed .... I thought it was going to be harder switching the two things… round (but) really (it) didn't make much difference" (Interview 10.4). Others can be shifted in *space*. As was clear in the challenge, many volunteers went out and most of these were involved in leisure. Still other leisure practices are shiftable in terms of the actual practice undertaken so that it is possible to read a book rather than a Kindle, write a letter rather than an email or spend time with a friend rather than calling one or do something totally different like go to a yoga class rather than making a phone call or prepare a meal rather than watching a film on TV. This implies that there are a multitude of ways in which relaxation practices could be shifted.

Secondly, like work, relaxation did not have a specific time or place. There certainly were times and places when people relaxed – in the bath whenever everyone was out, in front of the ten o'clock news (though this may have been recorded), when the children had gone to bed, watching the sun go down in a Jacuzzi bath, at the gym on a Saturday morning, in a yoga class, in the hour when both partners arrived home from work, in the quiet time at the end of the day when things were discussed and so on. However, while some of these did have particular times, they were specific to the individuals and circumstances involved and so it would be impossible to generalise about them. As suggested in the paragraph above, this implies that these practices could be quite shiftable in time and/or space as was the case in this study.

5.6   Conclusion

This chapter has discussed the main findings of the challenges in relation to what was learned about practices and shifting. These may be complex and sometimes even contradictory as a result of the focus on multiple practices in different households and just because practices are complex and dynamic. However, each of the five sections examined a specific feature of practices that has an impact on its ability to be time-shifted and is therefore relevant to demand response. The implications of this chapter are various. Firstly, it is clear that in the context of this study practices could be shifted and changed. It has been hypothesised that this is because they are inherently flexible and dynamic, though it is recognised that some practices are more rhythmically spaced out and so likely to be more flexible. Anyway, in this study, it was possible to shift practices or at least decouple them from their energy use, which is cause for optimism. However, this is not a linear process, nor a straightforward one.

The fact that practices are also demanding and rewarding makes them particularly compelling. Understanding the nature of the demands and rewards will make it clearer where interventions might be effective, such as the suggestion that intervening in the workplace rather than the washing machine might be more effective for shifting cultural conventions around the laundry. This understanding could also aid the development of alternative, more sustainable practices that are able to make their own demands and offer their own rewards. The challenges offer examples of successfully introduced practices that resulted in shifting and so suggest some first steps to thinking about this process. Certainly, in order to recruit new practitioners, alternative practices will need to link in with existing practices, start to feel 'normal' and offer the opportunity for career progression within that practice. This is not just about a delay switch on the washing machine or sending a price signal to a smart appliance, though these may have their part to play.

The chapter then turned its attention towards the subject of change, first looking at how practices and their elements coevolve, with the implication that it might therefore be possible to design them to evolve in a particular direction. At the moment this process seems to be leading Western society down the route of virtually-connected, individually-organised practices. However, it was clear that some of the impulses underpinning this evolution in technology and cultural convention were the age-old desire to connect with each other and this can be done in various, non-energy dependent ways which might, in fact, be precluded by the obsession with 'connecting' technologies. It was also clear from this section, however, that certain energy uses may need to be prioritised as non-

intensive. Staying connected on the internet might be one such but is not particularly energy intensive and so may be manageable.

Understanding the change process better required locating agency and so this was examined in the context of each of the four elements of practice. This was an illustrative rather than definitive process as practices are all different and it is not really possible to separate out their different elements as was done here. It is probably possible to argue that know-how and engagements (or habitual knowledge and cultural convention) demonstrated the strongest agency in the study, both elements that are often avoided by those trying to influence energy-use practices. In the context of know-how and engagements, technology was likely to be 'misused' (or used according to the user's prior knowledge of similar technology). Institutional knowledge, meanwhile, was not referred to unless know-how and engagements were disrupted (and even then, it might not be trusted if it went too contrary to these). As engineering solutions, particularly to shifting energy use, tend to be dominated by technology and institutional knowledge, there is room for improvement. However, all is not lost. The challenges showed that energy-use practices could shift quite substantially, at least temporarily in the short term and the example of the interviewees who had fitted solar photovoltaic panels demonstrated that they could shift substantially and permanently where new and stable arrangements of practices were put in place. However, in this latter example, it was clear that all the elements surrounding energy-use practices had altered and that was what had made the difference.

Finally, the chapter dealt with the subjects of time and space, obviously relevant in the context of time-shifting practices. Similar issues arose: both can be seen as a scarce resource which leads to competition and means both feel pressurised, both help to contextualise and give meaning to the practices of which they are a part, submitting to the requirements of each is part of a competent performance of most practices and the quality and not just the quantity of each is significant. More contentiously, perhaps, the section argued that both coevolved with practices, so that practices were not only the result of time and space (on both a day-to-day and historic level) but that the reverse was also true. These issues have deep implications should demand response become a significant part of a future energy management strategy, not just for shifting energy use but for society as a whole because time-shifting energy use will implicitly and fundamentally change energy using practices. This will require further research.

This chapter has shown that practices are complex but has hopefully provided some insights into where flexibility might exist. Even with this knowledge, however, practices are not easy to design as

they are horizontal and the institutions trying to change them are vertical (Hargreaves et al. 2011). It is also the case that practices and institutions are mutually constitutive so it is impossible to stand outside practices to design and change them. However, it is certainly the case that change involves more than the individual consumer and efforts should be focused at more collective efforts. Thought needs to be given to how to make sustainable practices more rewarding than unsustainable ones. It might also be fruitful to consider what other practices might insert themselves, like the challenges did, so as to enable the shifting of demanding and rewarding practices. The next chapter will consider the lessons for the electricity supply industry.

6   Implementing the lessons for policy and the electricity supply industry

The last chapter explored the challenges in detail. This chapter will pull together the lessons learned there insofar as they relate to policy and the electricity supply industry. While it will suggest that current approaches to demand response could be extended, it will also argue that there is plenty of space to increase the scope of demand response if different tools are utilised, though these may challenge the normal assumptions made by policy makers and business models used by the electricity supply industry.

6.1   Pricing and feedback are limited in view and therefore scope

As was seen at the start of this thesis, most clearly in **Table 1** which looked at residential demand response options, it is often assumed that a combination of automation and/ or price variability will lead to demand management. As discussed in Darby, McKenna (2012), though they *might* increase flexibility, this cannot be guaranteed and even where it does happen the reasons are not well understood. While price and automation were not the focus of this study and so were not thoroughly tested, it is possible to comment on them based on comments made by volunteers. Automation has already been discussed (**5.2**, **5.4.2**) and so pricing and feedback will be the main focus in this section.

On the one hand there were those who did respond to price signals. Several participants did have Economy 7 and in a couple of cases this had prompted them to do their laundry at night. Although a different sort of signal, there were also two interviewees who had installed solar photovoltaic panels and had significant financial incentives to do so. The first installed them when the FITS was at its peak and so had calculated a reasonably short pay-back period and eventual profit from his panels: "With the government about to change its incentive I moved pretty quickly and it looks like I'll at least get 21p a unit but it looks like I might get 43p… if I get 43p a unit my payback is about six or seven years. If I get 21p a unit it's about eight or nine years. Either way is fine. For feeding energy into the grid at the current rate over twenty five years I'll make about an eighteen thousand pound profit so there's benefits in a number of different ways" (Interview 13). The other volunteer needed a new energy solution as her generator was no longer sustainable: "I think the biggest thing was that as the generator got older… it got more unreliable which meant you… didn't know if it was going to work" (Interview 12). She therefore spent £32,000 on her new system, including a new roof for the barn onto which she put the panels but this "was still cheaper than going on the grid and of course I have no further cost. My electricity now is free. My electricity before would have cost me £60,000

plus all my (electricity) costs" (Interview 12). She did not benefit from FITS as she was off-grid and so once the system was installed, her shifting would not have been motivated by financial considerations but by the time of day and desire to keep her batteries charged up. In both bases the panels inspired significant shifting that was seen as perfectly acceptable and even better than the way practices had been organised before. As seen earlier (5.4.1) both of these interviewees demonstrated significant shifting behaviour prior to this and so it is impossible to attribute their flexibility either to the technology or the cost incentive on their own.

On the other hand, many were not responsive to price. Most did not know if they had Economy 7 and some who knew they did were vague about how it worked. Even where the price of electricity was considered to be "important, it is important, very important" (Interview 4.3) and Economy 7 was in place, this was not always enough of an incentive to shift the use of the washing machine. "I could (set my washing machine to come on later) 'cos I have one of these plugs that I could switch on… but the problem is that I'm not very organised nowadays. I used to be very organised when I had very little children. I used to put the washing machine at night time, wash them in the night and then the next morning I used to dry it or put it outside… on the line" (Interview 4.3). This clearly demonstrates that price variation does not guarantee a change in practices. It is far more likely to incentivise a change that already works in the context of other practices, such as the example cited here where laundry and childcare practices supported one another or Gram-Hannsen's findings in relation to stand-by consumption (Gram-Hanssen 2010b). This volunteer's other problem was that she did not really know how this pricing tariff worked: "I have the feeling that (it starts) about 8 or 9, I don't know" and that she felt powerless about the price, saying "there's very little I can do about it isn't it?" (Interview 4.3). This implies both that messages need to be more clearly conveyed and that there is a danger that customers could become demoralised and cynical about price (which is arguably already the case in relation to energy prices) so diminishing the possibility that price will motivate them.

Even assuming that price was the most significant driver of behaviour, the price of energy is not the only cost in relation to the laundry and is, in fact, virtually insignificant compared to the cost of clothes and the amount spent on washing products. Notwithstanding the fuel poverty debate, several participants recognised that laundry was not expensive, relatively speaking, even those who went to the laundrette: "I don't think I begrudge the prices of the laundrette at all because you'd easily spend £2.50 on a drink on a night out and for your washing to get clean it's not a large amount to pay" (Interview 6.3). Here it is seen that practices as a whole are compared in relation to cost; the

laundry versus a drink in the pub. This way of thinking about things tended to make more sense to people than talking about energy (or its costs) in isolation.

Convenience, rather than the direct cost of the laundry, was important, both in terms of time and space, which have already been discussed: "It doesn't take up time or space in the house here which would be quite a big inconvenience I think so it's cost in terms of time with laundry more than cost in terms of money" (Interview 6.3) and in terms of the potential knock-on cost of not doing the laundry when it needed to be done: "So I will wash stuff when it needs it not when it's just nice to do and I won't worry about the cost of doing so because I know I don't want to leave it any longer to save what would be pennies" (Interview 8.3). This shows that actually these apparently 'irrational' customers have a much more holistic appreciation of all the costs involved (financial and otherwise) so that energy pricing signals are likely to be too subtle compared with the other demands being made on people in relation to their energy-use practices.

The results of the study also threw up an interesting corollary on pricing. If pricing is an incentive to be flexible, the implication is that if flexibility had a cost it would act as a disincentive. However, despite the fact that flexibility did occasionally incur a financial penalty (in that takeaways were more expensive than home prepared meals and energy consumption was sometimes moved to more expensive times of the day), demand did shift and so this assumption was found to be questionable. The relationship between price and flexibility in a domestic demand context, therefore, is not an uncomplicated one.

Not only is the signal itself weak, but the current means by which price is signalled to the customer, the bill, is problematic too. It was not well understood and in fact was mostly not referred to at all as most people paid by direct debit: "I just pay a standard fixed charge each month and then it all levels out at the end of the year" (Interview 8.1). Certainly people did not consider the energy cost of their practices and their understandings about the amount of energy implicated in these practices was generally limited. Where they did think about their energy use, they generally overestimated the amount of energy and it's cost or they simply had no idea what consumed energy, as in the case of one volunteer: "I listen to music that's really loud so that probably uses a lot of energy" (Interview 4.1).

This 'invisibility' of energy (Burgess 2008) has been cited as the problem for why people use energy as they do. Gadgets like (variously smart) energy meters are being proposed as a potential solution

(Darby 2006) with the government's roll-out plan to have a smart meter in every home by 2020 well underway. There have been very few qualitative studies of people's experiences of using these meters but participation in the schemes that have been run seem to come at a cost to householders. (Hargreaves et al. 2010) noted the centrality of energy use for certain practices from two main points of view: necessity and 'reasonableness' and reported the stresses caused by participants being reminded that 'necessities' were consuming energy. Each household had its own list of things they considered as necessities, including a tropical fish tank in one case, and in the context of using these, meters were ignored or were an unwelcome reminder of energy consumption. The additional point to make here is that what some consider discretionary energy use by some may be thought of as fundamental by others. Again, however, energy use is understood in terms of the practices it enables rather than for its own sake. One might, therefore, argue that energy is in fact very visible, in that it is possible to see the practices it enables.

These conflicting perspectives on energy-use practices applied within households as well between them in Hargreaves' study. Those who engaged with the meters were often different from those who were using most of the energy in the household (often split along gender lines). Where energy-use practices were put under pressure, meters were seen as a form of surveillance or a means of control and the result was sometimes intra-household conflict and resistance to change. Given that the 'side-effects' of energy meters were anxiety, resentment and guilt it is hardly surprising they were gradually given less and less prominence in the household and those trying to instigate changes in a hostile environment eventually gave up. This accords with the experience in The Netherlands discussed in **1.4** where people resented the possibility of energy companies monitoring them. Interestingly, however, (Strengers 2010) found that volunteers who felt as if they were being monitored by the energy company were actually motivated to participate, which suggests there is more work to do to understand these dynamics.

Although current approaches to shifting practices are limited, this does not mean that demand response is doomed. In fact there were several areas of potential suggested by the empirical research and the literature, which will be explored in the rest of this chapter.

6.2   It is possible to change practices

Despite the pessimistic analysis of demand response's current tools, this study suggests that it is possible to be optimistic about changing practices in general and, more specifically, about the possibility of managing demand in a renewables dominated future. For most of the volunteers in this

study the challenges were not a negative experience: "I'd say it was positive really 'cos I think anything that makes you think about your energy use is always a good thing and like I said it did make us realise that we're pretty flexible and we don't actually need to use electricity for our food at least which is quite a good feeling" (Interview 7.2). Even the participant who had to feed her husband snacks to get him through the experience said, "I think it wasn't necessarily a negative experience. It might just mean in future if we were asked to do it again we'd probably have a much quicker meal to put together or something or deliberately choose our food round it if you like" (Interview 10.2). Having said this, it is of course, relevant to distinguish between the different kinds of changes that would be relevant. It is clear, for instance, that there is a distinct difference between energy companies making relatively infrequent but irregular demand response requests of different durations and a more sustained and coordinated multi-actor approach to change the way energy is used to continuously respond to demand. While the current policy framework is more likely to operate within the former of these two frameworks, it could be argued, and will be put forward in the sections that follow, that a sustainable energy system might need to move more towards the latter.

It is important here to remind the reader that social theories do not lead directly to prescriptions for action (Shove et al. 2012). Practice performances are emergent and contingent so that even repeated observations do not allow the future to be predicted. The difference between a practice approach to change and more traditional behavioural approaches are outlined in **Table 22**. The implication of this is that strategies can be discussed and tried out but should not lead to the expectation of a undeviating change trajectory with pre-definable targets and timescales. The nature of the task is more messy than that and will require continuous monitoring and interventions to assess what is going on. Part of appreciating this fact is the realisation that policy makers and other actors trying to direct the system do not and cannot stand outside that system as external, objective actors (Shove et al. 2012). By definition, they are part of the change process and will inevitably be influenced by its flux.

Table 22: Behaviour and practice

	Theories of behaviour	Theories of practice
Basis of action	Individual choice	Shared, social convention
Processes of change	Causal	Emergent
Positioning policy	External influences on the factors and drivers of behaviour	Embedded in the systems of practice it seeks to influence
Transferable lessons	Clear: based on universal laws	Limited by historical, cultural specificity

Source: Shove et al 2012: 143

Nevertheless, social theories are relevant in determining the sorts of interventions that are deemed possible, plausible or worthwhile and so it is possible to pull together some of the insights gained so far to suggest ways in which changes might be thought about in a practical way. (Shove et al. 2012: 146) suggest that there are four ways to change practices, namely by changing: the relationships between practices; the elements of the practice; the careers of practices and their carriers; and the way practices reproduce themselves. Perhaps coming from a slightly more practical rather than theoretical perspective but overlapping significantly, this thesis has also suggested various strategies, including: changing the spatial and/or temporal context and/ or signature of the practice, altering one or more of the elements of a practice or trying to influence the way the elements link together in performance.

The subsections that follow, therefore, will point to ideas suggested by the literature and confirmed by this research that make use of these sorts of strategies. Some of the suggestions may seem radical in the context of the current energy generation policy framework. This is because they arise out of a fairly radical analysis of the problem. It feels necessary to take this radical approach because, ultimately, the integration of renewables and the consequent need to shift energy demand to match it represents a major opportunity to influence the electricity grid in a positive way. As will be seen below, not only do renewables offer the prospect of cleaner energy from a technical point of view but, by emphasising the materiality of the grid, they have the chance to shift practices in a more sustainable direction too. Ultimately, therefore, the task here is to work backwards from the desired result; a renewables dominated energy system that balances supply and demand, and think about what needs to change in order to get this result, rather than focusing too quickly on the tools for change (a frequent reason that change strategies so often fail), for example, smart meters and

appliances or pricing tariffs. The sections that follow, therefore, suggest ways of thinking about these changes, almost as thought experiments.

6.2.1 Disruption is normal

Everyday life has been defined as "the never ending flow of activities being done in a continuous time period, regardless of where the person is located" (Green, Ellegård 2007). This study wanted to gain some insight into the everyday and it seemed a disappointing result when several volunteers claimed there was "no such thing as a normal day" (Interview 3.1). There were certainly some volunteers whose lives lacked a daily routine but, on closer inspection, even for them, the basic pattern of the average day was remarkably similar. Most people woke up between about 06h00 and 08h00 on a normal day and went to bed between 21h30 and 23h30 and this would cover the normal waking day of most people in the UK. During this period people engaged in similar practices: eating, washing, taking care of their homes, traveling about, working, socialising, and looking after others. "This is what gives society its pulse" (Shove et al. 2012: 95).

However, within this normal pattern disruptions were common. It is for this reason that practices needed to be flexible and dynamic (see **5.1** for this discussion). Despite this flexibility, it was assumed that disruption would be a problem because, even though most participants were not consciously aware of the cultural conventions and embodied habits influencing their practices, they did have certain expectations and beliefs about what was 'normal' and therefore reasonable. Accordingly, lack of available time and inconvenience were expected to be major reasons why people could not be flexible (Southerton et al. 2001, Dobbyn, Thomas 2005, Allcott 2011). However, even the most harried people were happy to suffer some inconvenience to carry out the challenges. The first finding from the food preparation challenge was that most participants managed to shift their food preparation practices either in time or space and were able to manage the resultant disruption. Most of those agreed that it was not particularly difficult to do: "It was straightforward. I precooked some chickpeas earlier in the day and then just made a normal salad using lots of fresh stuff from the garden – so yeah, that was my meal" (Interview 8.2).

As argued in (Trentmann 2010), disruption is normal, a 'regular feature of everyday life'. He explains that disruptions actually reveal the 'material world as fragile and tenuous' (Ibid: 81). Trentmann sees daily life as a process in which fragile schedules are constantly interrupted and re-established; in which habit and routine are the results of repair work rather than a default born of inattention. People have little control over externally determined practices which structure the main part of their

days and so are used to disruption. This is normal and it can be mended. Habits and routines are not as much external, Foucauldian governing structures as the outcome of the interaction between practices and their internally produced rhythms, strains of coordination and pressures of technological and social agency. More than this even, they are seen as having liberating features too (Shove et al. 2010). There is a "spectrum of rhythmic performance in everyday life, ranging from successful synchronisation to tension and disruption" (Shove et al. 2010: 10). The fact is that disruption and stress are as much a part of normality as routine. Everyday life is flexible and open and requires continuous coping strategies to reproduce itself.

However, consumers are not just the 'victims' of disruptions but play an active role in managing them. In this regard, participants noted that managing disruption was easier if they were able to plan: "So I found it quite easy peasy but shall we say it had to be planned" (Interview 9.2). The implication of this was that notice was required so that planning could take place: "Say for example I'd have had more notice… quite often I cook up like big batches of food that you can eat cold and I have pots of them... So, if I had more notice there would have been more likelihood of me doing it" (Interview 1.2). Notice also allowed practices to be brought forward as well as being shifted backwards. This was important in the case of one participant whose food might have become too old to eat had it not been prepared before the challenge, which would have precluded her participation: "I had already bought the chicken and I had to prepare it... So it was a bit of a problem and if I had not cooked it then I would have had to throw it away (and) I'm not really very happy throwing food away" (Interview 4.2). Having said flexibility is possible, there may be implications for women as the main users of everyday energy appliances in the home. In the sample under study, wherever couples or families were involved it was the woman in the relationship who smoothed what happened in the household to the extent, as one put it, that "they wouldn't have noticed any difference in terms of the time that they ate or even what they were eating or the quality of the food" (Interview 2.2).

(Shove et al. 2012) writes that practices that are "less constrained by path dependencies or by strict temporal order are better able to accommodate diversion and interruption. In these situations temporary defection, multi-tasking and contamination between practices is perhaps more likely than when practices are held together by strong routines." In line with this, some participants thought it would be inconvenient if one was forced to shift food preparation regularly. However, one participant thought this was possible: "I honestly think you can adapt to it … I mean you can get into a routine where you prepare stuff from eight 'til nine for the next day or something if you want to –

either eat later which is one solution or just prepare stuff later for the next day. I think you can always adapt and change but people don't do anything voluntarily. You'd actually have to either force them to do it or incentivise them to do it because people like to just carry on doing things exactly the way they have been" (Interview 8.2). Overall, this work serves to support this view and suggests that different arrangements of practices can be accommodated. In fact, permanent changes may be easier to incorporate over the long-term as then the elements of the altered practices have time to coevolve into their new forms. Here it is worth noting the difference between occasional, irregular, short-term shifting such as is currently envisaged by the energy industry and the more substantial changes in trend that are discussed in the upcoming sections.

It is worth taking a moment to think about these temporary changes. What basically seems to happen here is that the normal engagements around practices are able to be temporarily suspended. The challenges, for example, revealed various engagements around food preparation practices such as, that food should be cooked fresh each day, that it should be healthy and that it should be affordable. Three in particular were relevant to thinking about disruption: seasonality, cost and healthiness. The season was deemed important, not because people wanted to eat seasonal food, though one volunteer did manage the challenge by picking salad from his garden. The more major concern was that in winter warm food was more desirable: "There are huge parts of the year when I wouldn't use the oven or any sort of energy really to prepare food because it's easy to prepare meals for those seasons. But I think particularly now we're just coming into the cold, (you need) stews and things which are much heavier on energy or what you feel like eating, cooking" (Interview 2.2) and: "It made me think about… what I'm eating and why I'm eating it and times of the year. And the reality is I get benefit from having hot food in winter" (Interview 3.1). These volunteers did participate, however, one by cooking in advance and the other by getting a takeaway.

The cost and healthiness of food were often discussed together because several people got takeaways in response to the challenge and these were usually quite expensive and not particularly healthy. The student couple who participated also got a takeaway but in their case they managed to buck this tendency: "I think what we had was some humus and salad in pitta from the shop and I think that's £2 or £2.50 … we were going to make like a pasta meal and I don't think a few chips and salad and pitta would have been more calorific than what we would have had and I don't think it would have been more expensive… so we didn't feel like it was a big inconvenience at all" (Interview 6.2). For the others, takeaways were seen as an occasional indulgence and did not influence their participation in the challenge. In other words, for the period of the challenge, all three 'engagements'

around food were negotiable or at least able to be put on hold temporarily. What is clear here is that although a particular performance of a practice may be compromised, this does not necessarily mean the practice will change long term. On the one hand this is helpful: from a resilience point of view, the odd unexpected disruption and need to compromise on 'standards' or meanings is not necessarily problematic. On the other it suggests that practices are harder to change than might be expected and, even after they appear to have fossilised completely, may still be revived unexpectedly.

Figure 31: Food preparation practices

Trentmann also points out that greater material and technological interdependence has both increased the risk of breakdown and the consequences of failure as safety and basic needs rely ever more heavily on complex systems and infrastructures (Shove et al. 2010). This is an intriguing paradox in which "security begets risk and in which routine and rupture are never far apart" (Ibid: 8). As Strengers points out, however, this is based on four illusions: firstly, that nations can secure themselves from physical climatic changes, secondly, that it is possible to ignore the changes in the way people live, thirdly, that it is possible to think of infrastructures as "stable, uniform, seamless,

and universally available" and fourthly that energy systems can be "rationally, instrumentally and discretely managed, irrespective of their relation with the world and people who use them" (Strengers 2011a: 2). She points out that these illusions erase the links between supply and demand, create a fantasy of security of supply and sustain the increasingly fanciful idea infrastructures can be and are controlled and managed by one set of actors.

In the context of shifting energy practices, therefore, the attempt to create a seamless and perfect automated shifting system is most likely to be unrealistic and, if it teaches people to rely even more heavily on technology, may increase the system's fragility. More than this, however, it may potentially be unhelpful as it prevents people unlocking their creative responses to disruption such as was imagined by one participant: "I just thought about how life would be if we were constrained to having an energy supply only at certain times of the day, how I'd do things, so it provoked thought for me… I thought it would be quite fun… in the sense that it's (phone rings) – if you had family around you, you know, you'd all get involved in planning the day and the day would be a bit more focused on what you need rather than lots of things that you don't need. And then I thought it would be fantastic if there was no way that you could watch TV or surf the internet for periods of every day" (Interview 8.2). One final point to make about disruption is that moments of disruption may actually be helpful in that they can fracture the normal links between the elements of practices and so help to shift them. In this respect, it is interesting to think about timing (as in moments in time), such a house move, new baby, refurbishment and so on. The focus needs to be on the mutual adaptation of the material world with the behavioural if practices are to be shifted long-term. One without the other will not work (Wilhite 2012).

There are several important points to note from this section. Firstly, small, irregular disruptions (like requests to shift) are possible. Secondly, notice of these disruptions enables time to plan and smooth out the worst effects of the disruptions. These shorter term changes are possible because it is possible to suspend meaning and mend disruptions for short periods. However, this work would argue that ultimately more radical change is needed which will, of necessity be visible. In contrast to what is commonly believed, however, this section argues that these changes are possible and that, in fact, their visibility increases their likelihood by releasing creative responses, exposing the illusions of inexhaustible resources perpetuated by centralised infrastructural supply and, thereby, allowing practices to change over the long term. This represents a massive social change and will require more research. However, some first ideas about ways in which this might happen occupy the next two sections.

6.2.2 Materialising energy and its systems results in bigger shifting opportunities

While it is clear that volunteers in the study managed to shift their practices, sometimes considerably, it has been argued that this was because the challenges asserted themselves as practices. Based on the interviews and the literature it seems like this was a much more powerful signal than tools like feedback from a meter or pricing are likely to achieve. The argument, therefore, is that more significant shifting opportunities may be afforded if a practice based approach is adopted. This section will look at how materialising energy systems would aid that process.

In thinking about how the change process and how to change relationships with energy use, some people discussed the idea of an 'absolute limit' in relation to the infrastructures of provision that underlie energy-use practices. This was understood to be a physical constraint either in terms of available energy generation or in terms of an absolute environmental limit (by which was meant that it was beyond the control of policy makers, for example, when brownouts occur as a result of the Hoover Dam not being full enough due to lack of rain). A couple of people who had lived in other countries where electricity was not as reliable as in the UK discussed this explicitly. Though they said it could be difficult to live with an intermittent or unreliable energy supply, they acknowledged that it was both possible and could inspire additional flexibility: "If I knew it was part of something more collective, other people were doing it too and it was part of a coordinated initiative that I would be letting down by not doing it so that it had a higher purpose, I think that would motivate me to do it … if it was something like we lived in a country where they have brownouts, I think as a household we would be quite flexible" (Interview 4.3). There were several people in the study whose experiences in other contexts (either in the past when certain things were not available or in other countries) helped them understand the necessity for flexibility in certain contexts, even if they didn't currently identify the UK as one of those contexts: "I grew up in Libya so there was a lot of times where you just couldn't cook at that time because there just was no energy and then obviously you don't. So, if it's enforced then obviously you don't but if it's not enforced then it's highly unlikely you'll do it voluntarily. It's certainly highly unlikely that I'll do it voluntarily. I think I'm probably fairly typical in that" (Household 1.1).

Here energy becomes materialised as part of normal daily practices, as opposed to just visible in the way that Smart meters might hope to achieve. The notion here is to make the supply (or generation) and/ or use of energy part of the experience of the practice. Examples would include things like

smoothie-making bicycles, wind-up torches or, indeed, the solar photovoltaic panels used by the two volunteers in this study. Whereas energy is always an element of energy-use practices, its presence is often invisible and therefore taken for granted. In countries where the supply is intermittent, energy becomes a much more explicit element, is recognised as a material part of the practice and has a determining influence of the time of performance. While this may seem radical in a Western context, it does show that intermittency, or the threat of it, materialises energy in a way that might make it possible to reconfigure energy practices.

Strengers makes this argument in her paper on materialising energy and water resources (Strengers, Maller 2012). It is worth summarising her paper briefly because there are a number of pertinent points. Firstly, she points out that there is an artificial separation between supply and demand in which supply is secured and protected for and from consumers and yet they are made to feel personally responsible for the impacts of their demand. This breaks down the links between resource provision and consumption, supply and demand. Secondly, she reminds the reader that supply infrastructures are material 'things' (technologies) in the constitution of practices and that wasteful appliances are in some sense the legacies of such large-scale infrastructures. These infrastructures also provide the 'connective tissue' (Chappells and Shove 2004, p. 132 in Strengers, Maller 2012: p3) that lock providers and consumers into 'distinctive regimes of resource management'.

Thirdly, Strengers bases her conclusions on interviews with migrants who have experienced three very different systems of provision across three generations. These migrants have lived in other countries where they experienced disrupted and scarce resource supply but are now living in Australia. When they first arrived, they experienced abundant water and energy supplies due to the more reliable systems of provision in Australia but, since then, in the context of severe drought and climate change respectively, they have again encountered scarce water and problematized energy supplies. She points out that the systems in their original countries that highlight materiality, diversity and scarcity encouraged common understandings around careful, resourceful and specific resource use that is manifested by the disruption of supply and valued because of the hard work that is required to produce them. Collecting water and energy required axes, buckets and donkeys, so highlighting *materiality*. Water and energy were treated in such a way as to be used for very specific practices and were therefore of different qualities (drinking, bathing, heating, cooking), so highlighting *diversity*. Finally, they were exposed to the vulnerability of supply because of disruption but also because of the hard work required to collect them. This made the resources valued, to be

used carefully and conservatively. It also encouraged resourcefulness. Disruption was normal and acceptable because the things that rely on the abundant supply were seldom in use.

In contrast, migrants exposed to the abundant supply systems developed ways of using their resources that centred around using and consuming, rather than not wasting. However, when later exposed to the more vulnerable systems they were well equipped to innovate in their attempts to save, collect and harvest resources, install systems that would do this for them and exploit incentives that were made available to encourage these sorts of practices. They did this despite the fact that water was at its cheapest during this period and electricity very affordable, at less than 2% of household income. Strengers (2011) suggests that it may be possible to engage householders as co-managers of their everyday practices by making 'energies' and 'waters' an active rather than passive element of everyday routines. As she points out, however, this is not in the sense that they constantly demand attention but rather that they are "actively involved in configuring what makes sense for them to do".

This is distinct from educating people about resources and their impacts, or designing devices and feedback programmes that constantly keep resource use in people's minds. Instead, (it refers to) to repositioning energy and water resources as something on which routines and practices depend – as a 'thing' or 'things' (energies and waters), rather than an immaterial, homogeneous and abundant supply that magically flows when the bill is paid" (Strengers, Maller 2012: 4). She posits that resourcefulness will then flow from direct experience of and familiarity with resources. Certainly, this is what was shown by the experience in this study with the two individuals who had fitted solar photovoltaic panels and this has been borne out by other studies (McKenna 2013). As she points out, the key insight here is that if policy makers want to create resourceful, adaptive, resilient or flexible householders, they need to focus on the characteristics of the resource systems and how they interact with practices (Strengers, Maller 2012). One way of doing this may be to highlight the link between the weather and energy, which is the subject of the next section.

6.2.3 Practices are already arranged around the weather

As one strong example of how practices might be materialised, the study found that the weather, as well as diurnal and seasonal cycles, could be constitutive parts of the performance of practices. The reason the weather has been specifically picked out here, is that shifting around the weather would be particularly interesting from the point of view of renewable generation, particularly where large

appliances like the washing machine were able to be shifted in this way. The weather was important to all three practices tested through the challenges, though it was most relevant to the laundry.

In general, good (sunny and/or windy) weather was mostly seen as a good time to do laundry and was important for a number of reasons. Most obviously perhaps, sunny and windy days were ideal for drying: "I find I really like to get my towels outside because otherwise if I just dry them inside … I just find they never ever, even if you've got the heating on, I don't feel they dry properly… they always feel a bit dank and damp" (Interview 11.3) and good weather might even encourage laundry that might otherwise have waited: "On average the machine is run once a week but only after I've had a houseful here I'll run it, if it's good weather. I never do two a day but I might run it three times and say 'It's a nice week, let's get all these sheets and duvet covers done and dusted and put away'" (Interview 9.3). For those that liked to put their clothes outside this was better than a tumble drier: "Tumble driers I tend to use only when it's raining 'cos they tend to not dry very well. I find, particularly if you put towels or sheets into them, they end up in a ball so things get over dry on the outside and things are a damp ball in the middle and it's just irritating to get things right. So things are still damp or they're all over dried and crisp and wrinkly" (Interview 13.3).

Getting clothes outside also meant they were not hanging about the house or at least would have to hang around the house for less time when they were brought in though in winter there was a balance to be struck between whatever drying might be possible in the colder conditions and the amount of work needed to hang the clothes outside and bring them in to hang them up again. When the weather was considered important, schedules were arranged around it "I tend to do (the laundry) first thing in the morning if I remember 'cos then they can get out and get the maximum sunshine, particularly in the winter. I sometimes leave things on the line for two days waiting for the sunshine (laughs)" (Interview 9.3) or "If I know it's going to be a scorcher of a day, a bright sunny day – we're in winter and I'm thinking about sunny spots in the house … I can hang it before the school run or before I go to work or whatever" (Interview 2.3).

Figure 32: Shifting the laundry around the weather

The sun was also seen as a disinfectant, bleacher of stains and whitener of 'smalls': "Let's say with children: its carrots and tomatoes that stain. I would peg them out on the line so the sun is beaming, like the heat of the sun is beaming, and they get absolutely vaporised if that's a word. They get completely bleached out. Did you know that?" (Interview 2.3). An older volunteer made this the link between her current practices and more old-fashioned 'boiling' of whites washing practices: "I'm a great believer in the sun as a good whitener of classic white underwear rather than bleaching and boiling" (Interview 9.3). This believe in the sun's powers could mean less use of chemical stain removers and less energy as washing machine temperatures are able to be lowered.

Apart from drying and bleaching them, drying things outside helped the smell of the clothes: "I don't like the really strong smell of the detergent that you use. I like the fresh air to have diluted that a bit" (Interview 11.3) or "(I) suppose the family tradition would be to hang things outside and if I was around and about in the house and not out working all the time I would do the same because you usually get the feeling that things which have been hung outside … are fresher 'cos they've actually been cleaned properly when they're outside" (Interview 11.3). Passing on this information

to future generations was also seen as important: "I remember saying it to my wonderful mother-in-law and she sort of said well I've always known that and yet (her daughter) hadn't known it … these are important things to tell. Anyway it's a known fact and I didn't know. I had no idea until it just happened. I discovered it, like penicillin, you know, it happened by chance" (Interview 2.3).

Overall then, the weather already plays an important part in the washing, helping to get it clean, make it smell clean and get it dry. From an energy and shifting perspective its importance is no less significant as potentially the laundry can already use less energy if properly coordinated with the weather. Most relevant for this work, is the fact that the laundry is already shifted in favour of exactly the sort of weather that would power renewable generation in the future, which is very encouraging from a demand side management point of view. This suggests that increasing the importance of a particular aspect of a practice, in this case a material or physical aspect, might serve to shift that practice or help to arrange it around that aspect.

Perhaps then, as suggested in the previous section, additional flexibility is not best sought through technology but in searching for more "material" signals around which practices can arrange themselves. It is clear that everyday life has always been organised around the weather. This is hopeful for a renewables future where energy depends on the sun and the wind and energy forecasting could readily be added to the weather forecast much in the way the pollen count is reported on already in the UK (Higginson et al. 2013) or dam storage levels are reported on as part of TV news bulletins in Australia (Strengers, Maller 2012). As long as energy as a resource is attributed to those who generate and supply it, rather than those who demand it, it is unlikely to be possible to get householders to feel responsible for it because it is beyond their control and does not "play an active role in the configuration of practices" (Strengers, 2011).

 Strengers et al. (2012) suggest that energy can be seen as a "material element of social practices (and) that policy makers may inadvertently reduce householders' capacity to respond and adapt to climate change impacts by prioritising the resource characteristics of immateriality, abundance and homogeneity. (She concludes) that policy which prioritises the resource characteristics of materiality, diversity and scarcity is an important, underutilised and currently unacknowledged source of adaptive capacity" (Strengers, Maller 2012: 1). She argues that a centralised energy grid (or water supply) actually serves to worsen the problems of resource management because it distances the consumer from the resource. In her view it is only when the consumer interacts directly with the resource that they come to see it as precious and this releases a variety of creative management

strategies. Like Trentmann, Strengers argues that trying to create 'invisible' coping strategies that deal with disruption and scarcity by creating complex engineering systems that try to hide the fragility of the resources supplying those systems is to approach the issue from precisely the wrong angle. Instead, to have a hope of unleashing the creative competence of practices it is necessary to materialise both the practices and the infrastructures and resources that supply them.

6.2.4 'Apprenticeships' and communities of practice offer promise

One of the difficulties in materialising energy practices is the lack of the necessary knowledge and skills, as well as a missing context within which these might be supported and eventually developed into new cultural engagements. In general, helping people develop new habits (or break old ones) is not an area that is addressed by government policy and certainly not by energy companies. Long-term structural changes around identified 'sticky' practices need to take into account how practices elements are embedded in the cultural, built and infrastructural environments in which people live and so will not be changed overnight (Wilhite 2012). Weak policies like altering labels or providing information are unlikely to change strong practices, as has been argued throughout this thesis. Instead, reviving skills and knowledge around how to naturally shift energy requirements or reduce or remove them altogether, is required. This has the advantage of being less technical and likely to break down as discussed in the last two sections. In addition, when people have control and autonomy their quality of life is enhanced as discussed in 1.4.1.

Reviving or introducing skills and knowledge requires that new practices are learned by means of cognitive *and* bodily processes. In the study, there were several volunteers who identified themselves with particular groups or communities of practice and this was one way in which practices had changed dramatically. One example was a sub-set who engaged in particular relaxation practices. While this does not speak to their energy-use practices directly, it did have a lot of explanatory power in relation to how they experienced the relaxation challenge and may therefore help to explain how community of practice might work.

It may help to look at this more 'stressed' group first. At first, it seemed that leisure and relaxation were less demanding practices than some of the others looked at. It was likely that relaxation would not be prioritised, particularly by women in domestic relationships who spent their free time doing domestic chores to free up time to relax with their partners later: "Chores ... so as soon as you've got some free time you do all your chores so you can have some proper free time" (Interview 4.4) and women in particular spent free time on their own doing housework so that they could relax later

when their partners were at home: "For me what's relaxing is when the kitchen is tidy again (laughs) so actually it's not a sit down and relax. It's great, the kids are down, (my husband's) not back, radio on" (Interview 2.4). However, this may have been simply that they were more variable and very malleable. Some people struggled to relax but this was partly because they defined relaxation either as 'doing nothing': "Well it's quite a problem relaxation … I'm afraid being stimulated mentally is my way of relaxing but there you go" (Interview 9.4) or as a set of practices in which they were not involved: "I probably don't relax at all. I don't consciously relax. I don't do meditation, yoga or anything like that and I suppose I have a bath and a bit of a wallow in the bath. That's about it (laughs). That's probably my only relaxation time" (Interview 3.5). Although all the volunteers in this group engaged in some form of relaxation, even if they had their own definition of it, they tended to find the challenge difficult.

As far as the 'relaxation' sub-group was concerned, the leisure challenge was usually experienced as positive and being relaxed was normal. The people in this group carried a set of 'relaxation practices' and were informed by a strong set of engagements relating to the 'meaning of life' which meant that, in contrast with other volunteers in the study, they were able to relax and felt relatively unstressed about life, despite being just as busy as other people:

> Interviewer: "Okay, and what makes you decide to relax?"
>
> Volunteer 1: "(Laughs) Well that's kind of what I'm just naturally aligned with (laughs)"
>
> Volunteer 2: "And everything else is a deviation from that"
>
> Volunteer 1: "Work is an effort. Relaxing is just no effort so (all laugh)" …
>
> Interviewer: "Is there a particular time of day?"
>
> Volunteer 2: (Laugh) Yeah, if we take our eye off the ball, basically we're relaxing so anytime (All laugh a lot)" (Interview 7.4).

Within this broader approach to life; either life just was not that serious: "(Me)ism is quite a broad and non-descript approach to life – you know me I'm just fairly chilled out about things anyway – I just tootle along" (Interview 3.4) or being relaxed was seen as a natural state of being: "So there's a certain order to things (laughs) but I don't have any problems relaxing, or children. The two are probably very much related (laughs)" (Interview 1.4). These volunteers were involved in specific relaxation practices like yoga, meditation and various kinds of self-development to achieve a state of well-being and they recognised this as a particular approach: "Normally when I don't do the relaxation thing, whatever it is, it's the time I most need to be doing it (laughs)" (Interview 8.4). For them the challenge was at least not theoretically difficult and some even welcomed the opportunity

to realign their practice: "Actually (my husband) said to me the day before the challenge, 'It's going to be really good actually, I'm looking forward to it' – gave us an opportunity to get our schedule more how we want it where we just eat our dinner without any TV or anything and then just have a really early night or do yoga and then go to bed" (Interview 7.4). While this relaxed approach to life had positive side-effects in terms of flexible (and often reduced) energy-use practices, the point to make here is that these people's practices had been able to alter in the context of this wider set of engagements because of which they had developed alternative sets of knowledge and skills that allowed them to relax.

In a different sub-set, those in familial relationships, this contextual influence on practices was strongly evident. For them, for example, it was seen as inappropriate to engage in individualised relaxation practices: "I think it makes a difference whether you're on your own or not… Say it's over the weekend, there's always something to do or to talk about so you'd be anti-social if you suddenly sort of said 'I'm going to the gym now or I'm going to read now for an hour or two'… you behave differently I think" (Interview 13.4). Even though individual members of families might tend to 'do their own thing' much of the time, coming together was important: "I think at home we do tend to do our own thing really and maybe that's why things like board games … (and) mealtimes would bring us together… we haven't done this enough" (Interview 2.4) or "Same for me really. I work on my own. I very rarely work with other people and when I'm relaxing … if I'm going home I will very much participate with what they're doing; join my brothers in something, like play card games with them or, I don't know, whatever it is that they might be doing, I'll try and get involved somehow (and) if I'm with (my boyfriend) obviously I'm not doing solitary activities when I'm with him" (Interview 11.4). Actual togetherness was a precious but fairly rare phenomenon in the hustle and bustle of daily life: "I'd say the actual stopping still would happen later in the evening and normally it would only happen if (my husband is) around as a shared experience" (Interview 2.4) or "When he's here, once the children have gone to bed, then that's our time" (Interview 5.4). These performances or 'doings' of relaxation within the family context were much like the communities of practice just mentioned, but more intimate. Relaxing in each household involved having access to the know-how about that particular household relaxed and this was only really understood by those performing the actual practice. However, in all cases where there was a community engaged in the practice, its performance was judged appropriate within the context (the engagements, know-how and institutional knowledge) or that community.

As well as relying on particular practices with energy-friendly communities of practice to recruit people as carriers it may also be possible to direct this process somewhat. Wilhite (2012) suggests that this might be done through apprentice-like schemes, demonstrations, peer group learning *in the context* of technology and engagements that support the emergence of new practices. Again, there are good examples of this from the leisure challenge. As was discussed in **5.2**, connecting and/ or communicating with others was largely non-negotiable, and this was done mostly, or at least substantially, via technological means: "I suppose it made me (think about) the extent to which these days we are sort of augmented by our computers, by our various devices, and we kind of feel almost like we don't exist unless we're in conjunction with them… Humans are social animals, we thrive in social groups, but it's amazing how modern media has really shown that need in humans. So, that obsessively checking for connection; we all do it; it's not that it's just some sort of disorder in us. It's part of being human, this need to connect in some way, and I guess because we have these kind of atomised lives we're doing it through media but I think it's really interesting the extent to which that's been revealed – you know how strong an urge that is in us," (Interview 1.4).

Despite this reliance on technology, in comparison with work, entertainment practices were relatively easy to shift at least for a few hours and in fact some people quite liked it: "It was quite an enjoyable alternative way of spending the evening. I spent it (writing letters and) reading a bit as well" (Interview 8.3). This was partly because there was a wider range of technologies involved in leisure practices than with work practices. Whereas it was difficult to separate out work from its energy using appliances such as phones and computers, the range of activities included in leisure and relaxation practices was much wider and so this separation was potentially more possible. Relevant practices seen in the study included reading, bathing, cooking, having a drink (tea or alcohol), being with loved ones, talking to people, writing letters, going out, playing games, tidying up, listening to the radio, being with nature, having 'cowboy nights' and exercising.

This revealed a new insight, however. It was observed that certain participants in the study had a greater range of knowledge and skills on which to draw as far as either carrying out alternative practices or carrying out the same practice but in a different way. These participants tended either to be older or to have different experiences of the technology upon which the other participants had come to rely and so could perhaps perform their practices in a less technology driven way. Strengers et al. (2012) draw similar conclusions in their work. They note that migrants responded to calls for conservation not because of media campaigns or personal accountability but because of their previous experience with material, scarce and diverse supply systems. In contrast, those in the

second generation required extensive coercion and control from their first generation parents to change their practices because they had not had this exposure. However, those in the third generation who had been born into an era of scarcity and so had their parents' influence, as well as school and wider information campaigns *and* the day-to-day experience of "re-materiality, conservation and diversity through innovation, have received practical education and are experiencing new forms of materiality that are embodied in their practices" (Ibid: 3).

Some authors such as Hards (2012) suggest that (re)skilling in carbon-friendly practices requires apprenticeship-like involvements in order to to shift know how, engagements and, eventually, institutionalised knowledge. Importantly, as Strengers points out, this is not to advocate breakdowns and disruptions with accompanying hardships and anxiety experienced by some of the migrant households in her study prior their arrival in Australia. "Rather, we conclude that creative, innovative and flexible thinking is needed to replicate certain resource characteristics in modern systems of provision. Encouraging diversification of different energy and water resources for different purposes, incentivising innovation, sharing practical experiences, and ensuring energy and water is physically present in our everyday lives are the beginnings of some practical suggestions for what this might involve" (Strengers et al. 2012: 3).

6.2.5 Co-managing practices requires a radical shift in approach

The problem with efficiency and demand management strategies is that they may temporarily reduce demand but, unless they challenge the practices underlying those demands, they will grow as they recruit more people and co-evolve and the efficiencies will be overtaken by the increases. People's practices are considered separate from the technologies, infrastructures, resources regulations, standards, etc. necessary to make them possible (Strengers 2011a). However, all of these things create the context in which it makes sense to perform a certain practice in a certain way.

An important implication of this, is that energy supply practices are inextricably a part of energy consumption practices. In order to change the latter, therefore, the former needs to change too. Not only this, but the other infrastructures of provision that service practices have to be considered as well – the laundry is as much determined by the provision of water as it is by the provision of electricity, both of whose infrastructures encourage consumptive practices. What starts to emerge, therefore, is that practice theory is not only about consumption, the position with which this thesis began, but about supply as well, because they are part of the same thing. One would not exist

without the other. This is almost poetically true in the electricity system where supply and demand need to be so finely balanced on the grid.

What the challenges in this study did was to create a new context in which it became sensible to perform the challenge practice in a new way. This happened just once but it may be possible to facilitate this happening continuously so as to change practices completely. This is not a matter of managing demand. The history of demand makes it clear that demand is not something static that can be predicted and provided but that it evolves and changes all the time. It is not even a matter of co-managing resources or systems of provision (Southerton et al. 2004) because, again, demand is left unquestioned.

What is more interesting is to engage with demand directly by looking at practices. Strengers (2011a) proposes co-managing practices. This is not an attempt to control or curb demand but to understand practices. Remember that it is the practices that are doing the demanding and so by understanding them it will be possible to come to grips with demand. Remember too that the technology is a fundamental part of the practice, not an impartial tool. It will have an impact on how the practice evolves. As was seen with the volunteers who had installed solar photovoltaic panels energy practices start to be reconfigured under these circumstances. The current hard distinction between supply and demand starts to blur and so too do the roles and responsibilities of those concerned start to change. The idea here is to "collectively reconfigure practices in less resource-consuming directions, rather than engaging consumers with their consumption" (Ibid: 48). It is then no longer necessary to make energy visible or keep it in the forefront of people's minds because the practices themselves have changed.

The difference here is a radical one as is seen in

Table 23 but it frees the debate from one of whether it is education, pricing or automation which is required to change what people do. Crucially, it also demonstrates the urgency of this insight. As smart meters, appliances and grids start to sweep through the system, so a new era of resource consumption lock-in looms and threatens to make the situation even worse. Rather than resolving the problem of demand response, these technologies are likely to make it even harder to materialise energy and co-manage practices. Although feedback may reduce energy use initially, it has been shown that the size of the reduction tends to be limited and the impact of the feedback lessens over time. For smart systems that automate demand response, the situation could be even more pernicious because they would seem to facilitate the current illusion that energy is limitless. It may be possible to use smart technology to change the way practices are performed but this would need to be part of a strategy to redesign practices.

Table 23: Distinctions between the demand management and co-management of everyday practices paradigms

Characteristics	Demand-management paradigm	Co-management of everyday practices paradigm
Concept of choice	Choice is an individual, autonomous and calculated process based on one's preferences, attitudes, opinions and beliefs.	Choice emerges out of the composition of dynamic and malleable practices with reference to practical knowledge, common understandings, rules and material infrastructures.
Concept of change	Change is a linear process premised on technological and economic efficiency, and the removal of behavioural 'barriers'.	Change takes place through processes of practice reproduction which is shaped by the complex and changing configuration of practice components and those who 'carry' them.
Methodologies	Concerned with understanding how and why **people** change within the conceptual context outlined above. Focused on targeting consumers and their consumption. Identifies the best sources of technological and economic expertise in managing a resource problem or constraint and prioritises the most cost-effective solution. Targets behavioural barriers in isolation from social and technical contexts.	Concerned with understanding how and why **practices** change based on the conceptual context outlined above. Focused on reconfiguring practice components through which new forms of reproduction emerge. Aims to attract (or detract) new practice recruits. Aims to instigate crises of routine. Recognises and prioritises the expertise and skills of the carriers of everyday practices (i.e. householders).
Relationships and roles	Provider-consumer relationship dominates. Role of the provider is to provide centralised and unwavering supply of energy and water resources and to educate, inform and encourage the consumer to curb their demand in the face of resource constraints. Role of the consumer is to pay a fair price for the resources they consume and to use those resources efficiently during periods of resource constraint.	Relationship of co-management dominates, whereby carriers and facilitators of everyday practices are mutually and collectively responsible for their composition and enactment in everyday life. Flexible and interchangeable roles emerge across multiple scales. Householders and communities co-manage practices within the context of the household, through their interactions with others, and with reference to their relationship with utilities, governments and material infrastructures.
Strategies and approaches	Narrow range of possible strategies primarily involving pricing regimes, consumption feedback, resource education and information and efficient or controlled technologies and devices.	A suite of approaches emerge across multiple scales (household, community, jurisdiction, state, country, etc.) which reconfigure practice components (rules, material infrastructures, practical knowledge, common understandings) in ways designed to instigate new and less resource-intensive processes of reproduction.

Source: Strengers 2011: 46

Strengers does not go into great detail about what a co-managed practice might look like, though amongst others, she does cite the Cool Biz programme discussed in **5.2.1. Table 23** suggests that policy making needs to take better account of practices, implying more complex interventions

targeted at multiple levels. So, for example, smart meters and variable tariff (dealing with household level consumption) would need to be linked into programmes that would actively reconstruct energy demand *and* supply, as these are two sides of a coin. Rather than inserting a simple technological intervention, energy using practices as a whole would need to be problematized or disrupted so that their elements could be reconfigured. In particular, the meanings and know-how of energy use practices require attention. The point is, however, that it is not possible to produce a list of recommended actions. Each context will demand the specific set of actors involved to collaborate together to co-manage those practices, rather than the paternalistic, top-down control and management implied by the current demand response tools. The key focus, however, is on practices and creating contexts in which it makes sense for them to be performed in less resource-intensive ways and this is a job for utilities, policy-makers and energy users to work out together.

6.2.6　Changing the time at which practices occur will naturally change them

Lefebvre (2004) argued that we simply must do things when we do – that our bodies require it – and it has been seen that practices have particular temporal-spatial signatures. However, the challenges have shown that it is relatively easy, at least occasionally and temporarily, to shift energy use (either in time or space, though the former is the focus here). Technology can help here. In the same way that a freezer 'freezes' time and a video recorder 'records' time (Southerton, Tomlinson 2005), it may be possible for new technologies to liberate time (such as the way in which iPlayer or digiboxes to release television viewing from the tyranny the television schedule). However, it is worth noting that although many technologies promises to save time and sometimes do save hard labour, life is in fact as busy as ever. Cowan (1986) points out that women may take less time to do the domestic chores but they are done more often, for example. The relationship between time, practices and technology will certainly have implications for 'smart' technologies, something the literature so far researched as not discussed at all.

Also worth noting is that 'privatising' time, scheduling and shifting it according to individualised requirements, breaks down the 'hold' of institutionalised time and events and so has broader societal implications as the collective temporal organisation becomes deroutinised (Southerton 2003). As time is 'Taylorised', or broken down into increasingly small component parts, and 'Flexibilised', or made more flexible (Southerton, Tomlinson 2005), it has various repercussions. Firstly, it makes coordinating time with others much more difficult. Contrary to solving problems for the electricity grid, this may compound them but it is difficult to tell until some empirical data has been collected. Secondly, the fragmentation of time and simultaneity leads to sense of speeding up

(Southerton 2007) as already discussed. Introducing technology to manage time should therefore be undertaken with caution. As Shove and Southerton (2000) point out, when the freezer was introduced it helped 'beat the seasons' and so manipulated time it that way. Now the freezer helps people manage and juggle time by allowing them ready access, rapid preparation and the security of long-term storage. It does not necessarily save time but does help with ordering, scheduling, co-ordination and timing (Guy, Shove 2000). It is now not so important to have frozen food but instead to manage time and domestic labour.

However, she also points out (Shove, Southerton 2000) that what freezers are good for is a consequence not a determinant of their use. In other words, freezers have at least in part created the problems which they then claim to solve. In fact, appliances are indicative of the challenges and demands of domestic life, the structure and character of the social worlds in which they are situated. This reveals levels of tension, inter-dependence and co-determination which help to explain the escalation and persistence of unsustainable consumption. Freezers promise to help cope with the pressure and fragmentation of time but thereby lock users into certain habits which in turn call on extensive supporting infrastructures. "Though sold in the name of convenience, freezers help manufacture some of the problems to which they represent a response. Even within households, gadgets and appliances script the actions of their users in ways which simultaneously create the illusion of choice while also closing avenues of possible action … the proliferation of energy consuming convenience devices has the unintended consequence of tying people into an ever denser network of inter-dependent, perhaps even dependent, relationships with the very things designed to free them from just such obligations" (Shove, Southerton 2000: 315). At the level of the household, the pressure on time and labour might be pressure alleviated but those pressures are at least in part a consequence of the redistributions of time and labour.

It is therefore not surprising that many volunteers experienced time as fragmented and rushed. (Shove et al. 2012) suggests that the seemingly even more intense pressure of the modern world is not because of lack of time but because time is becoming harder to organise and manage and this accords well with what was found in this study. It seemed that the relationships between practices were changing due to the challenges of sequencing, coordination and scheduling. Shove asks if practices are becoming more time hungry or if they have become more fragmented and postulates that the difficulties of coordination and the character of social and material networks might push people towards more solitary practices.

Although that might be the current trend, it is helpful here to remember that time can be seen as a construct as well as a resource. It is therefore possible to consider manipulating it in just the way that the previous sections have discussed influencing practices. Rather than ignoring the fact that shifting demand requires practices to shift in time, it will be necessary, in other words, to think specifically about changing the time sequence of the practice and what this means. Again, it is possible to do this. In a small example of this, the challenges ultimately required that volunteers manage the contradictory demands of the challenge and the practice, requiring them to take control of their schedules in ways they might not normally have done.

In fact, the volunteer who brought forward her third load of washing to test whether she could dry three loads was actually explicitly testing the temporal spacing of her laundry practice, although she did not frame it in these terms. Finding that she was able to compress the process this had a liberating effect later when she returned from holiday to realise this third load of washing had already been done: "It also just took the pressure off… I wasn't consciously noting it for you but I do remember… and it shows you that actually… that's not quite a stressful as it often used to feel" (Interview 2.3). In contrast, others found it liberating to be able to stretch out the timing of the laundry: "As I said before, I don't feel driven on the day my guests leave to wash every bit of bed linen and every towel" (Interview 9.3). Other practices may also 'allow' this temporal stretching, either by asserting themselves strongly so that the laundry is deemed relatively less important, such as the volunteer writing exams who delayed her laundry by a week: "It's definitely not ideal because we're reaching saturation point with the dirty washing drawer… but then that's more to do with the exams than the challenge… having to defer lots of domestic things while… I've been in exam mode" (Interview 6.3); or by receding so that the laundry is deemed less urgent: "I was gonna do the laundry last Friday and opted to leave it and in fact I left it 'til this week, just because I could. There was no pressing need for it" (Interview 8.3).

Again, therefore, the thesis points to a new way of thinking about such issues and offers hope in tackling them, even if this is just a starting point. It is clear that this is a radical agenda, however, and that relationship between customers and energy companies will have to change if the suggestions above are to have any traction

6.3   The relationship with customers will need to change

As has hopefully been demonstrated above, the dislocation between the systems of supply and demand is no longer a sustainable one. Indeed, it has turned out that this unsustainable gap is at the

very heart of the problem this thesis set out to investigate: in a very real sense, there would be no need for demand side management if the system was co-managed, rather than being conceptualised as two distinct systems – one of supply and an entirely separate one of demand. Within these two systems, it is the responsibility of the utility to secure and provide electricity, while it is the role (and right) of the consumer to consume it (Strengers 2011a). Perhaps, as the thesis draws to a close, this disjunction is also at the heart of the solution.

Firstly, it is worth reviewing the starting point of this thesis and remembering that the current challenge to energy companies trying to engage customers in shifting is to get them to sign up to variable pricing tariffs which is hard, as seen in **1.4**. Even once the schemes are running, getting people to participate is difficult. Strengers (2011b) found that householders rarely identified money saving as their chief motivator even when explicitly asked and yet they consistently cut back on all electricity consumption during load shifting events. Interestingly, some studies have found that notification and interventions seemed to have a positive influence on participation. Strengers (2010) notes that although information feedback did not play a substantial role in getting people to participate in demand response pricing trials, the notification of an event was significant. While it did not necessarily get them to shift their cooling practices, it did place them in a contestable space for a short period of time. She suggests that while some researchers may call this the Hawthorne Effect (an experimental effect that makes people more likely to respond because they think they are part of a trial, whether they are or not), it could also be interpreted as a form of engagement which may heighten householders' ability to respond. In fact some of her volunteers reported seeing participation as interesting and fun, a finding confirmed by this study.

Lutzenhiser et al. (2010) also found that while information seemed to have no impact on behaviour and price only a minimal impact, their interventions did have an impact on people's behaviour with some volunteers making substantial efforts such as shifting mealtimes or getting up early to put on the washing. Even so, energy impacts were minimal. There are several points worth noticing here. One: these efforts were insubstantial in an energy sense and therefore would not warrant substantial resource investment from the electricity supply industry as they stand. Two: residents experienced constraints in their capacity to alter their practices despite really trying to do so. Where changes were made they reported a 30% decrease in convenience and comfort and 10% reported increased tensions in the household. In particular changing meal times or restricting certain energy-use practices was difficult. Three: women generally bore the brunt of the impacts of trying to shift

energy usage. Four: where vulnerable people required a particular temperature for their health energy usage seemed very inflexible.

Secondly, it is clear that the normal way of engaging with customers using mainly institutional knowledge (expert advice, bills and information leaflets) is weak from a practice perspective. Pricing and feedback have also been shown to be fairly weak unless they work in conjunction with practices in a way that makes sense. Apart from anything, there is substantial issue here of the lack of trust in energy multinationals which meant that many (not all) volunteers were less likely to alter their arrangements to suit a company: "If it's about them maximising profits then I'd feel very differently so the motivation for the change would be my first question. Then, if it was environmentally motivated, I would be interested and continue to be quite flexible with the way I do my washing and work around it, absolutely … and that's even if I was working full-time. I really would have no problem with coming home from work and saying 'Right I've got to put it on now'" (Interview 2.3).

Thirdly, it is clear that automation and the attempt to create an 'invisible' solution, apart from being unlikely to produce enough demand response in the context of wind-dominated generation, is likely to produce more problems than it solves as just discussed. While the energy supply industry currently considers it inconceivable that energy supplies ever be disrupted, deconstructing and debating this normative view might be necessary. The fact is that demand response is a crisis-driven approach (Strengers 2011a), motivated by a looming energy shortage and the spectre of catastrophic climate change. However, it is based on the fundamental problem that it does not problematize the notion of demand itself. It assumes that consumer 'needs' are non-negotiable and thereby seeks to maintain and preserve existing systems of provision and levels of supply (Ibid). This is what creates and enables current ways of life and maintaining these systems will ensure they continue into the future (until they finally shatter under the strain). Debating future provision requires a substantial opening up of the normal dialogue between consumers, energy companies and the government and it is hard to know how this would work in the current fragmented and privatised system which serves to further distance supply from demand.

Fourthly, although not explicitly discussed in the interviews, the implications of what some volunteers said and of some literature (Gneezy, Rustichini 2000) suggest that the transactional relationships were less flexible than relationships based on social capital. The nature of transactional relationships creates expectations on the part of the customer which are then difficult to negotiate. Strengers (2011b) points out that most householders expressed a sense of social responsibility in

responding to critical peak pricing events and that this motivated them as much if not more than the possible financial savings. This suggests that while a regular energy supply was non-negotiable once it has been paid for, a different relationship between energy companies and customers might be negotiated. Customers could be engaged as co-managers of their energy alongside energy companies (Strengers 2011a), as discussed above. A new relational paradigm would require large changes in current business models but is not impossible and is already being explored in the context of 'prosumers' benefiting from micro-generation. New relationships are necessary. As demonstrated by this thesis a relationship based on trust and mutual regard meant volunteers were prepared to compromise their own immediate interests in favour of another's, at least occasionally.

Fifthly, and really a hopeful note, is the fact that shifting energy involves shifting practices. To start with, this requires working with engagements and know-how as well as institutional knowledge and technology. It is clear, therefore, that a single approach will not work and that whatever is done will need to accommodate the emergent messiness of how practices change. Certainly, if an energy company wanted to communicate with its customers on these sorts of issues, the volunteers had some advice. Firstly, they acknowledged that it would be hard for energy companies to convey their message: "I don't read things that people put through my door and I don't watch telly so I don't know how they'd communicate with me" (Interview 1.3) and because they were not aware of their bills: "Not really 'cos I just pay a standard fixed charge each month and then it all levels out at the end of the year so (I don't really look at the bill)" (Interview 8.3). Secondly they said the message had to be properly thought through: "It really matters how it's presented to me. If it was just something dull attached to a bill it's not going to grab me. Probably huge amounts of expense associated with branding (or) even a campaign that's wholesome but I do think that would be the most effective way to get me to sit up" (Interview 2.3). Finally, a volunteer raised an important point about the content of the message: "You know, 10% is quite a hard thing to quantify but if you say 'Two days a week you don't use…' I think that's… an easier thing to plan for" (Interview 6.3). This is important. Volunteers understand their energy use in terms of time or practices, but not in terms of kilowatt hours, carbon emissions or even, really, money. One of the successes of the challenges is that the request was made to shift a particular practice by a few hours. It was specific, time-limited and allowed other practices to take the place of the ones that had been shifted.

Finally, it seemed that any such message would need to be made meaningful by finding ways to disseminate it broadly, so that it became part of the acceptable social conventions of that community: "Okay if we reduce peak energy use we are all going to stop using washing machines on

Saturdays in Leicester and Nottingham and Birmingham together … then you could really see that there is a difference" (Interview 4.3) or "I'd be really interested in someone saying we've put together a five minute presentation on why the nation (laughs), to think big, … has to tune in to when it does it's laundry …You know; a campaign" (Interview 2.3) or "Told about it? That's difficult. I think probably it would have to be disseminated locally. I think it would have to be quite a decentralised thing for people to be persuaded to do it and it would depend probably on the strength of the community and how communicative local communities are with each other so I suppose through local politicians and councillors and people that I know socially; friends who would probably be very supportive of such an initiative, who through social networking would probably promote it to me. And there might well be a big social network thing about it that people could sign up to the group to say they're doing it and it's a declaration of that. I think there are similar things like the 10% thing" (Interview 6.3). Creating a sense of community helped to increase the visible impact of the effort, normalised what was being done and so lent authority to the need to change practices.

There may seem to be a lot to take on board. This is not just about tinkering around the edges of the energy system. However, in the end, the change required of that energy system is profound. Even in the initial analysis it was clear that it needed to turn on its head by becoming a system that is based on supply rather than demand. More than that, however, it needs to respond to the needs of a growing population with increasingly fewer reserves (both financially and in resource terms) in a climate change constrained world. The challenges are necessarily profound.

7 Conclusions

This chapter will explain how the aims and objectives were met and drawing final conclusions. It will then outline the limitations and contribution to knowledge of this work and suggest areas for further research.

7.1 Achieving the aims and objectives

The overall aim of this work was to investigate the possibility of increasing domestic demand response by better understanding energy related practices in the home. This led to **Chapter 1** introducing demand response, presenting an overview of work in this area and concluding that, with some exceptions, current strategies to achieve it are limited, particularly in a domestic context. **Chapter 2** identified the need for a more holistic theoretical approach to behaviour than has typically been used by those implementing demand response and practice theory was selected and explained, making practices the unit of analysis throughout the work. **Chapter 3** outlined the methodology used to collect data to support the research.

The objectives are reviewed next, in the order in which they were originally listed. The first objective was to examine current domestic energy-use practices. This was done during the twenty-four hour observation and is reported in **Chapter 4** and a little in **Chapter 5**. It helped to set the context for the rest of the work and was the foundation of the challenges. The second objective was to test the flexibility of energy-use practices. This was done during the three challenges to shift food preparation practices, laundry practices and work and leisure practices and is also reported in **Chapter 4**, though mainly in **Chapter 5**. The challenges also helped to meet the third objective which was to investigate the consequences of flexibility on practices. This is discussed in detail in **Chapter 5**, and the lessons for implementation are drawn out in **Chapter 6**. **Chapter 6** focuses mainly on the assessing the implications of the findings in the context of demand response, which was the fourth objective of the research.

The final two objectives were less about content and more about process. The fifth one was to contribute towards the development of data collection processes in the context of a practice theory approach because it was found that these were under-developed. This is covered in **Chapter 3**, most specifically in relation to the twenty-four hour observation and coding the data but also more generally. The final objective, to find ways to map and simultaneously represent quantitative energy

data and qualitative practice data, was met in the first part of **Chapter 4**, during which the different data were drawn together.

7.2   Conclusions

This study has taken an unconventional approach to understanding demand response and is based on a small sample of households which are not representative and cannot therefore be generalised. Nevertheless, it has yielded some rich insights, some of which speak to demand response as it is currently envisaged and some of which are more radical and suggest that conventional demand response may exacerbate the problems it is trying to solve.

Within the range of conventional demand response, this study suggests that it is probably possible to shift demand occasionally and temporarily and suggests a broader range of tools to achieve this outcome. It became clear that a range of demand shifting strategies might be employed. Practices could be brought forwards or backwards in time; they could be moved into different physical spaces; they could be adjusted in some way (such as decoupling them from their energy use); or they could be substituted with alternative practices. Ways of doing this might be technical (using storage like batteries or time shifting technologies like iPlayer) or they might be more practice-based (such as swapping practices for each other, like writing letters instead of emails or relaxing before cooking instead of after it). Although they were only asked to do each challenge once, participants did not mind these temporary disruptions but it was more effective to communicate about practices and appliances than about energy or money and providing notice of such events allowed planning and helped to smooth disruptions.

The thesis has also reflected at length on whether it is possible to consciously design or change practices. There was a substantial theoretical discussion on this point in the literature review but mostly this has been the subject of practical deliberation, such as the consideration of how practices and their elements coevolve into more or less sustainable arrangements from an energy point of view. Energy companies and policy makers most commonly employ institutional knowledge in an attempt to change behaviour but it is quite weak and therefore cannot be relied on to change practices on its own. However, the evidence in this study show it became stronger when engagements and know-how were disrupted for some reason and so making use of moments of disruption could also be helpful. These included accidents, the point of purchase and unusual occurrences. Where possible, it would be helpful to make sure that all sources of this advice agree in order to reduce agentive conflicts. Any attempt at designing practices needs to be holistic, looking

across all the elements of practices – not just their appliances (technology) or rules (institutional knowledge) but also their engagements and know-how, not traditionally areas that energy policy-makers and energy supply companies get involved in.

All of this was part of a deepening understanding of where agency was located and a concomitant recognition that, even within the same element of a practice (like technology), there were sometimes conflicting agentive impulses. Having become aware of this, however, it becomes easier to imagine designing strategies that engage as many elements as possible to try and get them working in the same direction. These may also need to go beyond a narrow focus on energy. A practice approach recognises, for example that practices are served and enabled by intersecting infrastructures of provision so that water and transport systems may also need to be thought about. This is certainly a different sort of agenda to what energy companies and policy makers might be used to and it may feel overly complex to try and tackle multiple infrastructural projects. However, it does provide an interesting thought experiment and, in this case, the practice approach helps to simplify things. It is possible to step back and notice what underpins specific practices. Quite often the needs being met by high resource practices might be fed by lower resource practices. However, it is an agenda that needs to include more actors than just energy companies or policy makers working alone.

Another important theme of the work was the relationship between time and practices and it had some profound implications for energy use. Time is part of practices – correct sequencing and timing is part of their competent performance, as is a relationship with a particular practice over time (a practice career, in other words). The timing of different parts of a practice did influence the use of appliances but this was able to suggest as well as limit shifting strategies. Most practices seemed to be able to be temporally 'stretched' and even critical demand practices like eating could be flexible, though there is probably a limit. Shifting things forwards seemed less obvious than pushing them backwards but served to increase flexibility further. However, it was recognised that squeezing practices and fragmenting time could cause stress and it seemed clear that time was precious and inconvenience to be avoided where possible.

Nevertheless, the common understanding that practices must compete for the limited resource of time, was less powerful than had been expected. Coordinating with other people and managing time were particular skills and competence in this area was highly correlated with flexibility, even where people were extremely busy. One of the reasons practices could be time-shifted with such

remarkable ease, relatively speaking, is that time (and space) are constructs created by practices themselves so that shifting the practices automatically shifts the time and space available to do them. However, this also means that it is unlikely that time-shifting energy-use practices could be done invisibly. Demand response using a practice-based approach would necessarily have significant repercussions for how energy-use practices are performed.

The thesis then adopted a more radical stance and hypothesised that making demand response visible might in fact be a virtue and might allow shifting beyond occasional demand response requests. It might even allow the implementation of more profound and permanent changes to energy-use practices such as reconstructing demand around supply. After all, disruption is a normal (sometimes good, sometimes bad) part of everyday life and it can be managed. Although security of supply is a fundamental pillar of the current energy supply system, this was proposed as being unsustainable in the light of the current range of challenges facing this society. In fact, the findings of this work suggest that security of supply need not apply to all electricity demand all of the time. Allowing this opens up a huge space for debate about how this should be handled and allows innovative approaches to be discussed.

Rematerializing energy practices, for example, would help to break down the artificial separation between supply and demand in recognition of the fact that wasteful energy practices are in a very real sense a legacy of large-scale infrastructures. Rematerializing energy practices is not the same as making energy visible or raising energy awareness but rather reframes energy so that it is recognised as a material part of the practice and so influences on both the method and time of the performance. One way in which energy might be materialised is through the weather. Conveniently enough, practices are already arranged around the weather and laundry in particular was often coordinated to coincide with sunny and/ or windy weather, which is perfect from a renewables point of view. Unleashing the creative competence of practices is much more likely if both the practices and the infrastructures and resources that supply them are materialised.

The problem with materialising practices is that much of the necessary knowledge, skills and context for doing this are missing. It was proposed that these might be supplied through communities or practice and/ or 'apprenticeships', although these were only discussed and not tried out in the study. However, it was noticed that those with experience of other cultures (and energy systems), those who identified themselves with a counter culture of some kind (even if this was the family) and those who were older (and so had a longer experience which included different energy regimes)

were all able to adapt to the challenges more easily because they had access to a wider range of alternative practices. This finding has been corroborated by other studies.

Access to 'mentors' or communities of practice might help stimulate the next proposal, which was that energy practices should be co-managed. Co-management is a function of its particular context but it would involve certain features, such as: reconfiguring practices so that it 'makes sense' to do them in less resource-intensive ways, sharing the roles and responsibilities within the system so as to blur the hard distinction between supply and demand and highlighting the resource characteristics of materiality, diversity and scarcity. In this new context, demand response could take on a whole new meaning. It is feasible that there would no longer be any need for a 'signal' because the practice would include the notion of scarcity and so renewables' intermittency would automatically be catered for. A good example of someone using her electricity in this way was the off-grid participant with solar panels and battery storage discussed in **5.4.2** whose indicator for energy use had become the sun. The point is not to promote an agenda of lack and anxiety but rather a more robust and diversified energy system. Within this system it is likely that some of the supply and ownership of energy would change hands and those who were consumers would become prosumers.

Two main conclusions are therefore presented in relation to the original aim of this work. First, in this study practices were flexible and shifting domestic energy-use practices was therefore possible. In order to take this into account, the way demand response is conceptualised might need to change to focus more on practices and their elements than on tools like variable tariffs, automation and smart technology. However, this study suggests that it might be possible to shift practices in terms of the actual practice itself, and also in terms of the time, space and energy use of practices, and some of these shifts were able to be quite substantial. Conceptualised this way, demand response would require different relationships with customers based on trust rather than transactions, with communities of practice co-managing practices rather than with individuals consuming invisibly supplied resources they have acquired the right to expect through paying for them. This is already quite a significant departure from the current regime.

The second main conclusion is of a different order and is a more fundamental challenge to the system. It is based on the notion that infrastructures of provision (like the electricity grid and its actors) actually underpin and facilitate practices and that, therefore, changing practices requires these infrastructures to change too. This is because the infrastructures are an integral element of

the practice (the technology) and so enable particular sorts of practices. This suggests that purely technical solutions that try to 'invisibilise' the problem of intermittency by automating demand response through smart technology, may actually exacerbate the problems they are trying to solve. In much the way that modern appliances promise to save time and labour and yet ultimately trap users in their reliance on an ever deeper web of inter-dependent and unsustainable infrastructures that fragment time and labour and so add to an overall sense of pressure, so too efforts to hide and automate the management of demand response can be argued to lock in the wasteful, energy-unconscious practices which have become so ubiquitous in today's society because they do nothing to make energy-use a tangible part of energy-use practices. Unless they are used as part of a suite of measures aimed at redesigning practices, smart technologies may divert resources and attention away from designing sustainable practices. While they might reduce energy use and carbon emissions in the short term and there is the potential to use them as part of a strategy to support innovative energy-use practices, at the moment there seem to be few plans to implement them in this way, with the result that they are likely to leave practices unchanged and may even facilitate increased energy use over time.

Ultimately, which of these two conclusions seems the more convincing depends on the way the question is framed. Is the objective to create a low carbon grid that will continue to support current energy-use practices, more or less without question? Or, should the objective be to interrogate those practices and their facilitating infrastructures and consider how these need to change to achieve sustainability? These may seem philosophical questions but they are fundamental because it is in the framing of the questions that the solutions become evident. These questions are also urgent. As the energy industry gears up to make some of the most significant infrastructural investments in recent times they may well be locking in and encouraging the very practices they are hoping to change and may potentially be making the situation worse.

7.3 Limitations

While they need not undermine confidence in the findings outlined above, it is important to recognise the limitations of this work. As is common for qualitative studies, it should be noted that the volunteer sample size was limited and so care needs to be taken with extrapolating the results. A practice approach would counsel against such extrapolation anyway because it recognises that practices are absolutely located in their context and will be different every time they are performed. A related limitation is the fact that, for reasons previously discussed, the participants in the study were known to the researcher prior to the research and means that the sample was not

representative of the whole population. Of course selecting a representative sample was never the intention, as the sample was selected to represent a range of active occupancy profiles. It could also be argued that, from a practice perspective, demographic profiles are less critical than in other studies. Nevertheless, the sample was mostly well-educated, mostly white and mostly middle or upper-middle income, mostly adults.

As has been acknowledged, this experiment was largely hypothetical because today's grid does not include a high percentage of intermittent generation and the resources available to an individual PhD researcher did not allow for the possibility of experimenting with tariffs or technologies. This meant that asking people to participate in the challenges did not represent a reaction to a real energy induced disruption. However, as has been discussed, the challenges were disruptive practices in their own right and so did allow the researcher to gain some insights into how disruptions are handled.

7.4 Contributions to knowledge

This thesis contributes to knowledge in a number of ways. Firstly, it contributes to the methodological development of practice theory. Practice theory is still developing as an approach and has, until very recently, focused mainly on theoretical development and the historical analysis of practices rather than being based on empirical research. This means that the methodological implications of taking a practice approach for data collection, coding and analysis were all underdeveloped. The twenty-four hour observation (which was developed specifically for this study), the way the interviews were structured and the data coding were all driven by practice theory and so this will contribute to the rather scant literature on this subject. In addition, the interdisciplinary combination of methods within a practice theory approach has been encountered very few other studies.

Secondly, this work contributes to the theoretical development of practice theory. It represents a sustained examination of how practices change, the relationship between agency and practices and the way practices are located in time and space. This is not unique but it does represent a significant contribution to understanding these relationships better, particularly because it is based on empirical data.

Thirdly, the interdisciplinary of thesis leads to an area of significant novelty with regards to the simultaneous presentation of different forms of data. Consequently, almost all the work in

Section 4.2 is entirely original. Various attempts were made to draw together energy use data, photographs and observation data into one place, which proved to be a difficult task. Nevertheless, exploring ways of doing this will contribute to attempts to do something similar in the future.

Fourthly, the work brings new insights to the domain of demand response. It helps to shift the focus away from technical solutions. Moreover, it shows that doing so helps to increase the scope for flexibility in energy-use practices. This helps to open up new ways of thinking about demand response. Both policy makers and the energy supply industry should be able to take away new ideas from this work.

Fifthly, this study tested the flexibility of a wide range of everyday and fundamental practices relevant to a UK context. Demand response is still a relatively new area of research in the UK and this study adds to this new domain of knowledge. Although practice theory has been applied to the area of demand response, only one other instance of this was found and this was in an Australian context relating mostly to air conditioning (Strengers, 2010 and 2011b), which is quite a specific application. This study also paid much more explicit attention to the issue of time and space than any other studies of demand response that have been encountered.

7.5 Further research

There are many areas of further research that could arise out of this work but four are covered here.

From the perspective of reducing the carbon intensity of the electricity grid, the real necessity is to increase the level of renewable generation. This introduces the problem of balancing the grid, as previously discussed, which is unlikely to be solved purely technologically. The potential for balancing the grid using some of the methods discussed in this thesis is therefore a very valuable area for further research. It would require the extension of the empirical work done here to increase the generalizability of the findings of this study and it would be useful to work more closely with the energy industry in this endeavour. The work of the CLNR project, cited in this thesis, is an excellent start towards doing this

.

In addition, given the conclusions reached in this work, in particular the idea that energy-use practices are underpinned by infrastructures of provision, an obvious next step, but one that would take the research in quite a different direction, would be to investigate how infrastructures of

provision facilitate energy-use practices and what happens if other systems are substituted. Interesting work in this area has already begun, such as that done by Van Vliet, Chappells and their colleagues (Van Vliet et al. 2005, Southerton et al. 2004) and by Strengers (Strengers, Maller 2012, Strengers 2012). Basing this on empirical research would be extremely interesting. This might serve to subvert the normal question asked of studies such as the one presented here about how to motivate the sort of flexibility reported and asks a different question around how to facilitate different sorts of relationships with energy provision.

Related to this and also arising out of the conclusions of this work, further research needs to be conducted into how what re-materialised systems, apprenticeships and co-management models might look like. This echoes Strengers and Maller (2012) who call for policy makers to pay further attention to the characteristics of current and future systems of provision, and how they encourage and discourage conservation, shift demand, and develop adaptive and resilient communities, through their integration and intersection with everyday practices.

Another useful step forwards would be to consider the change process in more depth. This is a vast subject which is covered in some depth in this work, particularly in **Chapters 5 and 6**, but only from a practice theory perspective. While practice theory's understanding of change is strengthening all the time and is starting to incorporate how change happens at a societal level, there is already some interesting work being done using the Multi-level perspective (MLP), also known as transitions theory, to plug some of the gaps in practice theory.

MLP is a model of sociotechnical innovation developed by Rip and Kemp (1998), Geels and Schot (2010) and Shove et al. (2012), which suggests that innovations occur in niches at a 'micro' level. These are shaped by but can also shape the 'meso' level regime above them, which in turn has a similar relationship with the 'macro' level landscape above it. Each level is more complex than the one below it so that the higher levels are more complex and harder to change. This model has been used to track the careers of specific technologies and particular appliances and sees them as competing in a battle to outcompete others for market share.

There are similarities between MLP and Practice Theory. Both locate themselves between structure and agency in trying to understand how sociotechnical systems stabilise and change. They both recognise that there are many actors involved and that the processes are non-linear and will variously demonstrate forms of co-evolution, emergence, path-dependency and lock-in so that, to

the extent that governance can influence what happens, it must be adaptive and reflexive (Shove, Walker 2007, Hargreaves et al. 2011).

There are also significant differences between the approaches. While one describes the stability of normal and mundane everyday life, the other describes dynamic and novel large-scale changes. Practice theorists like Gram-Hanssen point out that large integrated technological systems like the electricity grid are built to deliver a particular commodity to a consumer and the object is to deliver a "uniform, continuous and mainly invisible product to its end-users, who seldom (have) any choice as there is only the same network and as (the) products are essential for basic practices within the household" (Gram-Hanssen, K. 2007: 8). Theories that describe systems like these do include actors but the system approach adopted may seem far from the single practice. Meanwhile transition theorists compensate for the large scale focus of their system by claiming that energy service provision in the home is like the 'sensitive fingertips' of the electricity infrastructure (Van Vliet et al, 2005 in Hinton, E. 2010).

Hargreaves et al. (2011) derive a neat model that incorporates the "horizontal nature of relations between practices by contrast to the hierarchical and vertical relations between the levels of the MLP" (Ibid: 9)and assert that "whilst the MLP allows one to examine the emergence of novelty through the interactions between the vertically-ordered levels of niche, regime and landscape, STP (Practice Theory) focuses attention instead on the horizontal dynamics of practices that cross-cut multiple regimes and systems as practices and their elements follow their circuits of reproduction" (Ibid.).

These fascinating subjects must await another time and place, however, as it is time to draw this thesis to a close. The hope is that it has stimulated some new ways of looking at demand response which will inspire innovations in how to develop sustainable energy-use practices in the future.

Information sheet for Volunteers

Loughborough
University

Thank you for informally agreeing to participate in this research. This information sheet is to help you understand what will happen and your rights in relation to this research. In particular it deals with the following:

1. **Description of research:** The purpose of and motivation for the research
2. **Research process:** Your likely commitment in getting involved in this research
3. **Data collection:** What information will be collected and how it will be stored and used
4. Frequently asked questions
5. **Contact details:** Who is responsible for the research should you have questions or complaints

You should take some time to read this form before agreeing to participate in the research. If you have any questions at all please ask the researcher to answer them for you. Once you understand the information in this form and have expressed your willingness to participate, the researcher will arrange to meet you so that you can sign a consent form.

1. Description of research

Name of research project: The rhythm of life is a powerful beat: Flexible domestic electricity demand. This PhD is funded through the Transition Pathways project, which is funded by the Engineering and Physical Sciences Research Council (EPSRC) and E.ON, Grant reference P/F022832/1

Motivation for research: In electricity networks, demand and supply must be continuously balanced because it is not possible to store energy efficiently or cost effectively. At the moment in the UK, householders can use electricity whenever they wish because we have a flexible electricity supply, made possible by the fact that our electricity is partly generated using fossil fuels. However, climate change means we need a higher percentage of renewables on the electricity grid and renewable generation is inflexible (obviously we cannot turn the sun or the wind on and off when we wish). If the grid is to be balanced, therefore, the implication is that demand must become more flexible. In a low carbon future, it will therefore become necessary to manage not only *how much* energy people use but *when* they use it. Much work has been done on energy reduction but shifting the time at which energy is consumed is less understood, particularly with respect to people's reactions to it. This forms the main area of interest for this research.

Purpose of project: The project is undertaken to fulfil the requirements of a PhD and may be used to offer insight for energy companies implementing renewable generation and flexible demand.

2. Research process

This section will explain your involvement in the research and how long each bit will take. The research process will run as follows:

- An energy meter will be installed in your home prior to the study starting. This will give us an opportunity to discuss any questions and make sure you are clear about what will happen. The researcher will ask you to sign consent forms and, if children are to be present during the research and are old enough, they will sign willingness to participate forms. A date and start time for the observation will be set. This will take about an hour.

- You will first be observed for up to a 24 hour period (or while you are at home during this time) on what you deem to be a 'normal' day. The aim is to find out what you do on a normal day. The researcher will be present and recording what is happening by taking notes. Where you have given written permission, photographs of particular practices may be taken. This will take up to 24 hours but you will be at home and carrying out your own activities.
- The researcher will interview you either at the end of the observation period or as soon afterwards as possible. This will take no more than an hour but might only take 10 minutes. Where permission has been given this will be audio recorded. Interviews will be written up.
- The researcher will contact you with a challenge adapted to your particular circumstances and agreed with you specifically. This will probably be agreed by phone and email (to discuss the possibilities and then firm them up officially). These negotiations will take half an hour or so.
- The intervention will involve asking you and/ or your family to temporarily change when/ how you use electricity/ particular agreed appliances. These requests will be made via text, email, phone and personal visits. Sometimes the request will be for immediate action but sometimes a longer lead time will be given. Incentives might be offered for particular challenges. There will likely be several requests over a month to change the timing of energy practices but you can refuse any/ all of these requests. This will take less than half a day over a month, although it might not actually involve you doing anything you wouldn't have been doing anyway.
- During this process you will be asked to fill in 'practice diaries' to help the researcher understand what is happening from your point of view. Each diary entry need not take longer than 5 minutes to complete.
- 'Recording packs' will also be left in your home if you want them. They will consist of a digital camera, volunteer diary, audio recorder and, if requested it, a digital video camera (or, if you have any of this equipment, you may use your own). This will be available so that you can record your impressions of what you are being asked to do in a way that is most convenient to you. Depending on how you use these packs, the time involved will vary.
- At the end of the challenge period you will be interviewed again. Interviews will take about an hour.
- During the research period, your energy will be logged – this does not involve any time commitment on your part
- You will also be invited to interpret/ discuss the findings if you are interested by means of focus groups or one-to-one discussions, depending on how many other volunteers wish to be involved and where they are located. If you choose to do this it has additional time implications (a focus group would take a couple of hours and one to one interviews about an hour) but it is not compulsory. This will be decided later in the process and discussed with you.
- We would like to offer you an energy survey of your home if you are interested. This may involve you in a limited time commitment of around an hour.

3. Data Collection

Data is any kind of information collected about you during the study, from your name and address to the information about how you reacted to the challenges we set and the correspondence between you and the researcher.

All data will processed according to the Data Protection Act of 1988. Specifically, the university's eight Data Protection Principles and Rights of Data Subjects under the Act will govern this research. These are available if you would like to see them. Numerical and statistical data is required to be held for 6 years and all other data for 10 years in case the basis for the research is questioned during this period. The researcher has ensured procedures are in place to ensure this is held securely by the university.

Different types of data will be collected as outlined in the table below. Before being used, data will be checked with you to ensure it is accurate and that you are happy for it to be used. Any data that relates to your identity, such as your name and address or the ID code that will be assigned to you, will be kept separately from data that relates to information about you, such as your energy usage or interviews. This means that no one will be able to link your data with you, so protecting your confidentiality and ensuring your anonymity.

Type of data	Method of collection
Personal data	Collected by the researcher in correspondence with you
ID numbers	Compiled by the researcher
Energy data	Energy meters installed in the house
Observational data	Notes and timelines collected during 24 hour observation period
Interview data	Interviews will be recorded and notes made. Recorded interviews will be written up (transcribed) afterwards
Questionnaire data	Questionnaires will be filled in by applicants and returned to the researcher to be coded, analysed and written up
Challenge responses	Challenges and responses collected by emails, text messages, phone calls and face to face discussion
Practice diaries	Volunteers will return diaries to the researcher to be coded, analysed and written up
Additional recording pack results (optional)	Cameras, videos, audio recorders and note pads will be used by volunteers and returned to the researcher for capture and analysis
Focus group discussion (optional)	Audio recording and notes will be written up (transcribed) afterwards and coded for analysis

Data will be anonymised before being shared outside the project team (volunteers can request that this happens before information is shared within the project team too if they wish). This means that you will only be represented in documents by an ID number and, after this ID has been assigned, your data will no longer be linked with your personal details. However, you should be aware that your energy data is ultimately held by Alert Me and that Loughborough University will store the rest of the data collected. Both organisations have strict data protection policies and procedures in place.

Raw, paper-based data will be stored securely in a locked drawer or safe and will again be kept separately from any information that might identify volunteers personally. Correspondence data like emails are accessible only to the researcher on password protected laptop. Information from emails that needs to be stored will have the addresses removed and be stored in Word documents. They will then be deleted from the inbox and deleted items folder.

Digital data will be stored on a password protected computer, a section of which will be encrypted for this purpose; an encrypted, password protected memory stick and backed up on the university's U drive, which is only accessible by the researcher and senior members of the IT department. Permission to access this drive without the researcher's express permission can only be obtained from the head of IT services in agreement with the Head of Department of Electrical Engineering. Digital data held on insecure devices like digital cameras will be deleted once it has been saved in a secure location.

The data will be used to inform the original research being conducted in the pursuance of a PhD. As such it may be published in academic outputs such as papers and posters and will be used in internal reports and the researcher's final PhD thesis. Data will also form the basis for internal reports. Shared internal documents will include headers/footers indicating authorship, date and status (e.g. confidential, not for circulation beyond research team, content under review, content agreed by volunteers). Any research materials including copies of consent forms, transcripts, audio recordings and photos will be shared only with the researcher's direct research team.

In addition we would like to inform you that you have the following rights:

- You may request to know what information is held about you and who has seen it
- The data will not be processed in a way likely to cause damage or distress
- The data will not be used in direct marketing
- You will not be subject to automated decision making processes
- You retain the right to take action for compensation if you suffer damage by any contravention of the Act.
- You retain the right to take action to rectify, block, erase or destroy inaccurate data.
- You retain the right to request the Commissioner to assess whether any provision of the Act has been contravened.

Frequently asked questions

Once I take part, can I change my mind?
Yes! After you have read this information and asked any questions you may have we will ask you to complete an Informed Consent Form. However, if you wish to withdraw from the study please contact the main investigator. You can withdraw at any time, for any reason and you will not be asked to explain your reasons for withdrawing. Your data will then not be used in the study. Although you may know the researcher, this will not impinge on your rights as a volunteer nor oblige you to participate

My commitment: Will I be required to attend any sessions and where will these be? How long will it take? What will I be asked to do?
Mostly, the researcher will come to you. Sessions outside your home are voluntary. Please read the section explaining the research process for full details of what will happen and the time commitment involved.

My preparation: Is there anything I need to do before the sessions? Is there anything I need to bring with me? What type of clothing should I wear?
Apart from reading this information sheet, there is no need to prepare for the sessions in general though you may be asked to undertake certain tasks. Please read the section explaining the research process for full details of what will happen. There is no need to wear anything special or do anything different from normal (except where we explicitly ask you to do so). The whole point is to behave as normally as possible.

My information: Who should I send the questionnaire back to? What personal information will be required from me? Will my taking part in this study be kept confidential? What will happen to the results of the study?
How the data will be collected, stored and used is dealt with in the section about data. The researcher will collect all the research materials left with you when you have finished with them. The research does not require the collection of personal information beyond basic demographic information (age, gender) and the general area in which you live. We are interested in your energy data but you will not be able to be indentified from this data. As is specified in the section about data, your data will be anonymised, safely stored for only as long as necessary and treated with the utmost confidentiality. Any risk to confidentiality will result in that data being excluded from the study. This study is being done to fulfil the requirements of a PhD research project. Results may be shared with the energy industry and project partners through the project consortium which is funding this PhD. More details on this are available if required.

What's in it for me: Are there any risks in participating? What do I get for participating?

You will not be paid for your involvement in the study. However, we hope you will find it an interesting and enjoyable experience. There should be no risks to you, your family or your home. We will offer you an energy survey of your home if you are interested, though this may not be an officially accredited survey. For certain tasks you might be offered incentives, though this will depend on how the research develops. Eligible expenses, such as travel to a focus group for example, can be reimbursed on production of receipts as long as they have been agreed up front. If you would like to make a claim for such expenses please inform the researcher and she can provide a claim form and guide you through the process.

Questions and complaints: I have some more questions who should I contact? What if I am not happy with how the research was conducted?
The first person to approach with any questions, worries or complaints is the researcher. However, if she is unable to help, her supervisors' contact details are on this information sheet. If you have an official complaint, the University has a policy relating to Research Misconduct and Whistle Blowing which is available online at
http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

4. Contact names for research project

Primary researcher
Sarah Higginson
CREST (Centre for Renewable Energy Systems Technology), Department of Electronic and Electrical Engineering, Loughborough University, Ashby Road, Loughborough, LE11 3TU, Email Address:
S.L.Higginson@lboro.ac.uk, Tel: 07896 153 732

Supervisors
Dr Murray Thomson
CREST, Electrical and Electronic Engineering: M.Thomson@lboro.ac.uk, Tel: (01509) 635 344

Prof Tracy Bhamra
Design School: T.Bhamra@lboro.ac.uk, Tel: (01509) 228 316

Information sheet for Children

Thank you for agreeing to be part of this research. Research is when people take time to investigate something. They try to use methods that other people can understand and do again if they want to. The reason people do research is to discover new knowledge about a subject.

This information sheet is to help you understand what will happen during the research and what part you might play. The sheet will explain:

1. Why we are doing this research
2. What will happen during the research
3. What information we will collect and what it will be used for
4. Your rights during the research
5. Who to contact if you have any questions or worries about the research

If you have any questions at all please ask the researcher to answer them for you. Once you have read this information, you will be asked to sign a form saying you are happy to take part.

1. Why we are doing this research

We are interested in producing greener electricity. This may mean that people have to learn to use their electricity differently, or that they may need to use it at different times. It is very important for researchers to understand how this will affect people so that we can help make peoples' lives as comfortable and happy as possible. This project is trying to understand this better.

2. What will happen during the research

This section will explain what will happen and how long each bit will take.

- To start with an energy meter will be put in your home to measure how much electricity you use. The researcher will talk to your parents about what will happen in the project and you are welcome to come along to ask questions.
- Next the researcher will come to stay in your house for about a day to watch how you use electricity on a normal day. She will be taking photographs and notes. You will not have to do anything different to what you would normally do at home.
- The researcher will talk to your parents after she has visited and you are welcome to join in. She will write notes about what the people in your house have told her.
- The researcher will set the people in your house a challenge. Now and again she will email, text or call to ask your family to use their electricity a bit differently to how they might normally use it. You might be asked to get involved. If so, the researcher will ask your parents to talk to you about this – remember, you don't have to do it if you don't want to.
- While the challenge is going on, the researcher will leave some diaries for people in your house to fill in. It would be great if you could join in! Depending what your family decides, there may also be a video recorder, camera or a sound recorder for you to record what is happening. Of course if you just want to draw a picture or write something in your own words that would be perfect too!
- At the end of the challenge, the researcher may invite your family or maybe a group of families to talk about what has happened. If you would like to join us you may.

- Someone may come round to your house to work out how you use energy in case you could use it better in the future.

3. What information we will collect and what it will be used for

There are laws controlling what information can be collected and how it should be used and stored. We are being very careful not to break any of these laws. If you would like to know more about this, the researcher can explain. However, you may like to know that we will collect information about the energy you use, what you do during a normal day, pictures and videos of your activities during the day (but no pictures of your face), information about things you said to us when we talked to you and things you wrote down, for example, in your diary. We have different ways of using and looking after all of this information which the researcher will be happy to explain to you if you have questions about it. You should know, however, that no one will be able to use this information to find out who you are, what you do at home or anything else about you. None of the information will be used unless you and your parents are happy for us to use it.

4. Your rights during the research

All the people in a research project have rights but children have special rights designed to make sure they are always safe. Here are some important ones:

- You are welcome to be involved in the research but if you don't want to take part in the research, you should let your parents or the researcher know. It is okay not to take part and you won't get into trouble.
- Even if you have met the researcher before and know her she will not be allowed to spend time with you on your own while she is doing this research.
- If the researcher wants to set a special challenge for you, she will contact your parents and talk to you about it so you understand exactly what is involved before you agree to it.
- We will not use any pictures of you that may lead to you being recognised. If you and your parents are happy, however, we may use pictures of you doing something if your face cannot be seen.
- Taking part in the research should be fun. If anything in the research upsets or confuses you, you should let the researcher or your parents know as soon as possible and we can stop straight away.
- You will not be asked to eat or drink anything as part of the research.

5. Contact names for research project

Your parents or an adult you know will be present at all times when the researcher is with you. However, if you want to contact anyone to do with the project, here are their names.

Main researcher
Sarah Higginson, Email Address: S.L.Higginson@lboro.ac.uk, Phone: 07896 153 732

People in charge of the research
Dr Murray Thomson, Email Address: M.Thomson@lboro.ac.uk, Phone: (01509) 635 344
Prof Tracy Bhamra, Design School, Email Address: T.Bhamra@lboro.ac.uk, Phone: (01509) 228 316

Consent form for Adults

Loughborough University

Thank you for informally agreeing to participate in this research. A copy of this form should be signed by every person in the household who will be present during the research. Children will be asked to sign a separate "Willingness to Participate" form.
Signing this form will make your involvement official though you will still retain all your rights as explained in the information sheet.

Please sign the form below if you agree with the following statements

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethical Advisory Committee.

- I have read and understood the information sheet and this consent form.
- I have had an opportunity to ask questions about my participation.
- I understand that I am under no obligation to take part in the study.
- I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.
- I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless (under the statutory obligations of the agencies which the researchers are working with), it is judged that confidentiality will have to be breached for the safety of the volunteer or others.
- I understand that photos, video and other information about me will be checked with me before being used

I agree to participate in this study. I am happy to allow photographs and video to be taken with the above proviso.

Your name

Your signature

Signature of investigator

Date

Consent form Children

![Loughborough University logo]

Thank you for agreeing to help us do this research. Signing this form will make you an official part of the project though you will still keep all your rights as explained in the children's information sheet.

Please sign the form below if you agree with the following statements

The purpose and details of this study have been explained to me. I understand that this study is designed to discover scientific knowledge and that what is being done has been approved by the Loughborough University Ethical Advisory Committee.

- I understand what will happen in this research project.
- I have had a chance to ask questions.
- I know that I don't have to take part in the study.
- I understand that I can stop being part of the study whenever I want to and I don't have to explain this if I don't want to. This will not get me into trouble.
- I understand that any information about me will be collected and stored in such a way that no one will recognise or identify me.
- I understand that my safety is the most important thing in this research and so will tell someone if anything happens that makes me unhappy.
- I understand that photos, video and other information about me will be checked with me before being used

I agree to be part of this study. I am happy to allow photographs and video to be taken.

Your name   _____

Your signature   _____

Name of parent   _____

Signature of parent   _____

Signature of investigator   _____

Date   _____

Ethical Issues in this Research

Volunteers

The ethics process was concerned with who was to be recruited and what exclusion criteria would be applied. The volunteers in this study were of mixed age and gender, based in the UK and living in homes using electricity and so no exclusion criteria were applied per se. The aim was to access the broadest possible range of people as defined against the criterion of 'active occupancy'. Selection included the following considerations: which domestic settings might offer the greatest (and smallest) opportunities for shifting; whether particular demographic groups might be more or less prone to shifting; and what sort of shifting practices might offer fruitful paths for investigation as the research developed? Volunteers were personally known to researcher or introduced to her through the research. They were approached informally at first and then formally written to so as to clarify the purpose of the research and their involvement by means of the volunteer information sheet. It was also made clear that although they may knew the researcher this would not impinge on their rights as volunteers.

The ethics process was also concerned with how much time volunteers would be required to spend participating in the research. Initially this was estimated as two to four days depending on their level of involvement, involving an initial visit, a twenty-four hour observation and interview and then participation in three challenges. It had been expected volunteers would fill in diaries during the challenges but in the end they were interviewed afterwards instead. This means that most volunteers will have spent less than two days in the study. All of this was spent in their own homes and during most of it they were going about their normal business. Volunteers spent between one and four hours in interviews, depending on how much they had to say.

Also of ethical significance was whether people would be paid. Volunteers in this study received no incentives for their involvement though the researcher did contribute to food costs on the day she stayed over and bought a voucher or a gift valued at around £10 for each volunteer to thank them for allowing her to stay. Volunteers were offered an energy survey of their homes and an energy meter, though these extrinsic motivations did not seem to influence anyone's decision to participate. In the end no one took up the offer of a survey, though some were interested in receiving their energy data, and it was decided not to offer the energy meters because it became necessary to share them amongst volunteers. This meant data privacy would not have been assured because data is held by the energy monitor company in an online account related to the energy monitor rather than the energy user.

There were a couple of groups that were considered vulnerable under the ethics process, namely adults over sixty five and children under eighteen. It was felt that, as any older adults would be using energy in an independent domestic setting, they could be expected to be competent to make their own choices. The person concerned was known to the researcher who did not consider her to be vulnerable in the traditional sense or in relation to the subject under investigation. In addition, the information sheets (see **Appendix** One) given to every volunteer made it very clear that they had the right to withdraw from the study at any time and every volunteer (including children) signed a consent form (see **Appendix Two**).

Children were present in three of the households under study, though were not the focus of the research. They were invited to hear about the research when the researcher explained it (adapting

her explanation to the appropriate level and taking extra time to make sure any questions are answered) and signed their own willingness to participate forms (**Appendix Two**). The researcher undertook in advance to address the concerns or exclude any household where either a child or their parents expressed any reservations about the researcher being in the home. However, the children in the study either seemed to enjoy the researcher's presence or found it unremarkable. The researcher also undertook not to be alone with children or have unsupervised access to them and so it was not deemed necessary to undertake a CRB check. Special permission was to be gained if a child's electricity use practices be deemed particularly interesting or should they wish to get more involved in the research but in the end this was not necessary.

All photographs, but in particular those with children in them, have been screened by the volunteers concerned. Should any of them be required for work that is to be published, permission will be requested on each occasion. Volunteers have also given consent for their other data to be used by signing the consent forms. These are kept in a locked safe in the researcher's house. They were also asked in advance of all interviews for permission to record the interviews so that they could be transcribed and the record of the twenty-four hour observation was also shown to them to check that they agreed it was an accurate representation of the day that had been observed. As can be seen in the consent forms, volunteers' anonymity was guaranteed and this has been taken very seriously.

While most of the active work on ethics was done before the data collection was undertaken, there were issues to be addressed further on in the process too. During the data collection itself, there were issues around the privacy of volunteers (Robson 2002), especially as the researcher was entering people's houses. There were two aspects to dealing with volunteer privacy. In some cases, by unspoken agreement, access was restricted by volunteers to particular parts of the house or particular activities. More subtle, however, has been the researcher's need to make judgements about what to reveal about volunteers when confidences have been shared, but even more particularly because in certain cases she knows things about the volunteers from outside of the research context. In all cases the researcher has acted with respect to the wishes of the volunteers and in what she believes to be their best interests. Although there are issues of subjectivity in all data analysis, the researcher has also tried to treat all the volunteers' views as equally valid and although none of the information gathered was especially sensitive, and has written sympathetically about them (Finch 1993, Ezzy 2002).

Researcher

There were also some particular ethical issues that related to the researcher. As the volunteers were known to the researcher, though some not very well, before the research began, there was therefore a temptation to assume that the researcher would be safe. However, as the research involved going alone into people's homes and staying the night, it was important from a safety and insurance point of view to set up a protocol in case things went wrong.

In assessing the risk posed by visiting households, a number of factors were taken into account. The researcher had done a lot of work in communities that are considered somewhat unsafe both in the UK and in South Africa and felt comfortable assessing in various situations. The researcher knows some basic first aid and has informal reconciliation training so felt prepared for the task at hand. She was also visiting homes on 'ordinary' days when the people there were expected to be people she had met (rather than visitors) and so the risk seemed minimal. To assure any unexpected visitors, she carried her student card with her in case it was required for identification purposes and she made sure she introduced herself properly when she arrived, especially if children were in the house. In order to minimise the risk, she followed the guidelines recommended by (Gray 2009) and outlined in the university guidance notes for conducting interviews off campus and working alone

Data

The objective of all of this planning and recruitment was obviously to collect data. **Table 24** summarises the different types of data and how they were collected.

Table 24: Types of data collected and method of collection

Type of data	Method of collection
Personal data	Personal data was collected by the researcher in correspondence with volunteers
ID numbers	ID numbers were compiled by the researcher
Energy data	Energy meters were installed in the house
Observational data	Notes and timelines were collected by the researcher during the 24 hour observation period
Photographic data	Photographs were normally taken during the 24 hour observation period or on a subsequent visit to the household
Interview data	Interviews were recorded and notes made. Recorded interviews were transcribed and coded. These are available.

According to the university's procedures, extra care should be taken if the study involved observation, recordings or photographs. This study involved all three and so details of the capture and storage of data had to be provided:

- **Observation and audio recording** was done only with the volunteers' express, written permission, obtained by means of the volunteer consent form.
- Any **photography** initiated by the researcher will focus on the specific practices being carried out (such as cooking) and will not use volunteer's faces so they will not be identifiable from the pictures. In the end video was not used, partly for the purposes of confidentiality.
- It has been envisaged that **photography and video** might be undertaken by the volunteers themselves as recording packs were going to be devised (provision for this is outlined in the consent forms, which is why it is mentioned here). This would have complicated the issue of anonymity. In the end, however, interviews were deemed more efficient and more likely to provide the data required.

Any data collected was to be handled in the same way:

- In line with the university's own regulations, notes, transcriptions, completed questionnaires, images, audio and video recordings will be kept for ten years and then destroyed. This was discussed with the IT department and caused some surprise as no one had ever asked for such provision before, which was interesting.
- If the researcher leaves Loughborough and wishes to take the data for later use, she will get specific permission for this, in line with the university's regulations.
- The researcher agreed to keep clear records of the procedures followed (approvals, interim results, etc.) so that the research process can be traced if necessary

There are three main phases of data processing which it may be helpful to distinguish:

- **Raw data:** Data was necessarily attributable at this stage and so was stored absolutely securely to ensure volunteers' confidentiality is not compromised (see below for how different data formats will be stored). Only the researcher and her immediate project team (her supervisors) had access to the data in its raw form.
- **Anonymised data:** As soon as possible after the data reached the researcher and before being shared outside the project team it was anonymised so that volunteers cannot be recognised (volunteers could request that this happened before information is shared within the project team too if they wished but none did so). Anonymisation will consist of the production of two

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separate datasets that will not be merged: one contained volunteers' personal data (including name and contact details), and one represented volunteers by a unique ID number, as used in this thesis. This means that they will only be represented by an ID number and, after this ID has been assigned and their data shall no longer be linked with their personal details. This list of ID numbers and various other files was encrypted so that it will not be possible to relate a particular set of data back to any given volunteer. However, this caused problems with the files and so in the end the files were unencrypted again and just stored on a password protected computer kept securely, mostly in the researcher's home. This data might have been shared beyond the project team but in the event only the researcher herself spent any significant time with the raw or anonymised data. Volunteers were given the opportunity to read a final draft of this thesis if they wish though, somewhat unsurprisingly, none of them took this up!

- **Published data:** The anonymised data has been used to inform the original research being conducted in the pursuance of the researcher's PhD. As such it has been used for academic outputs including papers, internal reports and this final PhD thesis. This data is necessarily in the public domain and volunteers cannot be identified by means of any published data.

It is also worth distinguishing between different data formats:
- **Raw, paper-based data** has been and still is stored securely in a locked drawer or safe and will again be kept separately from any information that might identify volunteers personally.
- **Correspondence data** like emails are accessible only to the researcher on password protected laptop. Where information from emails needed to be stored the addresses were removed and they were stored in Word documents. When the research is complete they will be deleted from the inbox and deleted items folder.
- **Digital data** has been and is stored on a password protected computer with a back-up on an external hard drive kept in a safe in the researcher's home. As mentioned above, the intention was to encrypt the data but this almost resulted in the loss of all the data and so it was felt safer to keep it unencrypted. Should the data be backed up on the university's U drive, it is only accessible by the researcher and senior members of the IT department. Permission to access this drive without the researcher's express permission can only be obtained from the head of IT services in agreement with the Head of Department of Electrical Engineering. Digital data held on insecure devices like digital cameras and digital voice recorders was deleted once it had been saved in a secure location.

Before being used, the data has been checked with volunteers to ensure it is accurate and that they are happy for it to be used. Any data that relates to their identity, such as their name and address or the ID code that will be assigned to them, has been kept separately from data that relates to information about them, such as their energy usage or interviews. This means that no one has been able to link their data with them, so protecting their confidentiality and ensuring their anonymity. Also, although data has been anonymised as described above, volunteers were made aware that their energy data is ultimately held by Alert Me and that Loughborough University will store the rest of the data collected. Both organisations have strict data protection policies and procedures in place.

Finally, the researcher undertook to handle the data according to the eight Data Protection Principles and the Rights of Data Subjects under the Act and, even where exemptions to the Act are allowed for research purposes, to seek permission from volunteers should she want to depart from any of these principles or rights to any degree. In addition the volunteers were informed of their rights in relation to their data and how it is stored, used and processed as well as compensation should their rights or any provision of the Act be contravened.

Pilot done with Loughborough Students: Website Discussion

Turning Energy Use On Its Head!
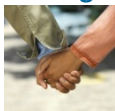
 Posted by MC on March 11, 2010 at 8:03pm in Events follow-up

Hi all,

It was great to see so many of you today at the event. I learnt very much from listening to each other; and had fun too. I hope you had a good time too guys! Anyway, this space is for YOU to add your thoughts about this event but also to keep the discussion going. Add your ideas, feedback, everything. Contribute as much as you can! Come on, take the challenge = 5 SLEUTH points + the chance to win a prize of your choice! PS. Don't miss the SWITCH ALL OFF FOR 3 HOURS Challenge to take place next Wednesday 17th. Details will follow.

Replies to This Discussion

 Reply by Sarah Higginson on March 12, 2010 at 10:56am

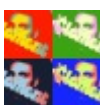Hi   Everyone

I also wanted to thank everyone for coming. It was really interesting to hear what you all had to say and I look forward to getting more of your thoughts here on SLEUTH. If any of you would like to keep in touch, please feel free to email me directly at S.L.Higginson@lboro.ac.uk.

Thanks also to G for speaking to us and to CM for setting the whole thing up.

Sarah

 Reply by CB on March 12, 2010 at 6:06pm

I want to publish something deeper about what I said yesterday, you know, the relation between liberty and energy.

I did not want to mean we should not restrict energy, but we cannot reduce the energy consumption by using drastic restriction. I feel free when I want to drink a coffee being able to make it, and if I cannot because of energy restriction, I will do feel frustration. Yesterday I took the example of "the internet": I felt frustrated when my internet was out of order. Carolina, this is for you: It does not mean my life depends of Internet, I am a slave, and internet restrict my liberty, not at all, but you must agree that when you need to send an important email, or you are waiting for an important one, it can be really frustrating. The same, if you do need to call someone (maybe because you are lost in a big forest), and your cell phone does not work, I am sure you will feel frustration.

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The world is built on these technologies, We cannot live without, and drastic restriction is a really bad solution. The use of internet is necessary for everything you want to do, above all in a university, with the use of Learn, or here with Sleuth, (I use Skype to keep in touch with my family as well)... You cannot change it quickly. I am sure I cannot cook without energy more than once or twice, because most of the food we buy has to be cooked before being eaten, and basically, cook require energy (ie: meat, eggs, pasta...)

Using energy is like using a part of our body! Cutting it, we will be at a disadvantage. (So if we do, it has to be slowly... but surely!)

By the way it was funny yesterday, and thanks Sarah and G for all the information (and the cakes...)

CB

Reply by MC on March 13, 2010 at 5:05pm

How do we make people change towards more energy efficient behaviours?

As we learnt on Thursday, how we use energy today is pretty much entirely up to our discretion - at least in rich economies. This will no longer be the case in the future as we run out of 'cheap' energy resources. How do we motivate people to change without making them feel frustrated, 'going backwards', or that they are 'loosing' something? ... some people believe that the answer lies on making "the 'right' choice, the easier choice".... what would make you make does changes *easy*? Ideas?
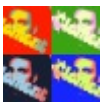
Reply by CB on March 15, 2010 at 12:34am

Well, I am not sure we can generalize an idea to change the behaviour of people, because everyone is different with their different idea, so everyone has his own thing that can attract him, getting him more environmental. For example, ME: Seriously, I am not someone environmental... Not at all, my kitchen light is turned on each night, even if this is useless. But I am about to change, why? Because of Sleuth. But, I have joined Sleuth for the competition at the beginning, not to get environmental, however, the result is here: I am getting environmental, step by step (now, I check f the light id off before going to bed). I mean, we cannot know what can attract people to the environmentalism.

But in Butler court, I cannot understand why the corridor is lighted every day and every night! I would be more environmental to put some detector in the corridor, so if someone enter a corridor, the light turns on in THIS corridor only.
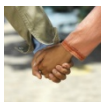
Reply by RD on March 17, 2010 at 1:15pm

A little long! Before I continue, I did enjoy this event as I was more involved than some of the others; we had a very proactive role in participation.

As Clement has said if you are expecting/needing to send an important e-mail or similar then only

being able to do this at certain times could be annoying. But why not send a letter? Everyone enjoys receiving post (bills excluded!)

It is also evident that almost everything we do today uses energy in some way, shape or form. This dependence does clearly need to be reduced. With the idea of controlling demand instead of satisfying it, although I believe this would work well in the long run, there is the ability of "installation". At first, with anything new, people may be either reluctant to accept it or not accept it at all and continue with their existing pattern, but there would be a point at which they will fall into line and comply. I expect I would find it hard to adjust myself, the kettle or laptop not being useable when I want.

To expand on something I mentioned at the event, about the use of renewable energies-solar and wind. The diagram of how energy is distributed throughout the country showed that where renewable sources entered was much lower down, just before domestic use. From this I believe that having energy provided purely from renewable sources may influence how we live. As one wind farm can only provide enough power for a certain number of houses, it would promote living in smaller communities. In these communities you would get to know everyone else and also nearby communities, so if at one time the wind isn't blowing in one region, a neighbouring community with another source may still have power.

 Reply by MC on March 17, 2010 at 2:16pm

Just some thoughts....perhaps the root of the issue lies in our current society's believe that everything must be quick and ready-to-use whenever we want. Our modern society craves instant gratification!
...maybe part of the solution to make people use energy in a different way, is to communicate and educate the users 'of the future' that we don't have to rush so much, that there is no need to live in a super fast forward mode. That there are benefits in many areas - environment, well-being, financial, social, etc - when we take time to enjoy life.

 Reply by MO on March 18, 2010 at 11:58am

I agree with what Carolina said about instant gratification. Everything should be now because the people said so... That is so not true!

If we understand that we are in the world to be part of it, and not to rule over it, maybe our thoughts can change... I learned so much since I moved to the UK... my life back home has been a mix of having energy and gadgets to use whenever I want to live in a farm where I had to wait for the fire to heat up the water that I'd take a shower. This made me realise that I have to be patient, to find something else productive to do, to organise myself to have time to do all that I want in the time that the nature provides me that. And I believe that is not too hard to change when you realise that the world does not revolve around you... and things flow very easily when you work together with it.

I know that people (including me) may need to contact people urgently, but i also believe that everything happens for a reason - you might not know why, but maybe if your internet is not working now can make you think better about what you have to say to that person, or to appreciate

more when the Internet is working again! Frustration is not good, so instead of controlling the 'energy source' to work for you every time, how about controlling your frustration?

Not sure if any of that make sense... but my life is much more stress-free now that I don't put myself first, but God - who creates the universe (that can lead to a big debate I know). We are here in His land, to use it and not to harm it, to contribute to it and not to suck from it... To be happy and not frustrated! :o)

Reply by MO on March 18, 2010 at 3:39pm

My comments about the 3 hours challenge:
Dear all,

I'm here to tell you about my last adventure. Basically, I took part in a project were the aim was to switch off any energy appliance that I had at home for 3 hours - between 6 and 9 in the evening of the 17th of March 2010.

At first, it sounded like a hard task, since 6pm is the time that we are all preparing our lovely dinner, made with food from all over the world (yea, who cares about buying locally?). However, since I've been influenced by a project called SLEUTH, I decided to buy food from the local market, and to make sure that I eat things produced locally (which some times can give you more options than you first thought!). So, I arrived from work at 5.20pm, and as I wasn't intending to cook, I decided to prepare a salad for me and my brother. We had lettuce, carrots, orange pepper, cucumber and radish. We added a bit of Olive oil, salt and vinegar. Result: nice refreshing salad. By this time was 5.40pm and we didn't have much time to eat before we have to leave the house (leaving the house was the only way not to use any energy we thought). So we had some cereal with milk and yogurt and off we went to Nottingham.

Ah, I almost forgot to mentioned that we switched EVERYTHING off in our flat, including all sockets, shower power, the telephone and the doorbell! The only reason that we didn't switch off the fridge/freezer is because we had some red meat on it, and it would go bad very quickly... but everything else was off. I felt quite good about it and I think I would be doing it more often.

The trip to Nottingham was done by car (unfortunately we didn't have time to get the train) and on there we went to the cinema. We decided to see Alice in the wonderland 3D (http://www.imdb.com/video/imdb/vi975438873/) and it was the best film so far this year. I advise you to watched it (and to switch everything of your flat off as well). I'm sure you will have a great time. Therefore folks, you can still change your behaviour in relation to things, and you also can still have the same fun as before. In this small things we can start saving a lot. Keep on SLEUTHing!!

Good bye for now, enough of computer for me! xx M :o)

Reply by MC on March 18, 2010 at 4:02pm

Great! I'm particularly interested in how you switched off the ring bell ;). It is interesting too that in order not to use energy, it was best to leave the house. This is - would not always be - easy to do, right? Food for thought: What, how, to 'accommodate' our routines without energy?!

 Reply by RD on March 18, 2010 at 4:24pm

As the "switch all off" was approaching I turned off my laptop phone and checked all other wall sockets were off as well as the lights. For about 3/4 of an hour I was able to read using the remaining light outside, after this I was trying out my PowerBall (and the dynamo powers 6 little LEDs, a little "free" light?) which I picked up earlier on in the day.

On Wednesday I had made sure there would be something to eat for tea: I had made a pasta salad. This to me says that you can prepare small things like that in advance, saving energy by cooking a one big amount than lots of little ones. Afterwards I simply slept until about 9-15! If I hadn't I don't know what I would have done. I then went down to the common room to join in with some of the St Patrick's Day celebrations where I met friends, had a bit of drink, played some games then we went to Hey Ewe foam Party!

This time of day is probably the most effective as many people will be getting home and turning on computers etc. By putting this off for another 3 hours, after possibly using a computer all day at work, shouldn't really matter. I guess this is to do with our dependence on energy/technology to communicate and keep us preoccupied. I will invariably have Facebook open and I nearly always have music on if I am on the computer.

 Reply by Sarah Higginson on March 19, 2010 at 12:42pm

Hi Guys

I'm just back from Glasgow where I've been talking to the people in the project that's funding my work. They are really interested in this sort of information so I'd encourage you to keep posting.

It sounds like you've really been thinking about all of this so my congratulations for that. It's great to hear from those who did manage to do the challenge - well done to you! - but it would also be nice to hear from those who couldn't do it. Perhaps you could let us know why it didn't work for you - did you just forget or was there some other reason that you couldn't participate?

Also, if you have any ideas at all about how changing WHEN you use energy might help you improve your life, do let me know. A reminder that you're all very welcome to contact me directly as I'd love to hear from you, even after the challenge is over. I think posting lasts until Wednesday next week so you still have time. Remember, the best poster gets a great prize :o)

Good luck with exams

Sarah

 Reply by CM on March 19, 2010 at 8:51pm

So, Last Wednesday, 3 hours without energy... This was very complicated.

First, between 6pm and 7pm it was quite easy, because to see clearly I could use the light outside,

but it was boring, because all my roommates was off... So alone in my room, I tried to study a bit, but after there was not enough light... So I stopped studying.

I was hungry, I decided to cook, but PROBLEM, all I can cook need some energy... Pasta, potatoes, meat, eggs... I ate a banana, in the darkness... So I decided to take my bike and go to the library until the end...

The conclusion is quite obvious: We depend of energy! The products we buy (even too cook) need energy to be use, and all the life is built on habits, such as using the light, watch a film when you are boring, even read or studying is impossible without light!!! If I want hot water to drink a tea I cannot without energy...

Before I did not realize how we depend of energy... So it is gonna be a tough task to reduce the consumption but the wasted energy (easier, reduce the wasted energy is only about awareness)

Appliance Use Diary

(Fill in for each use of the machines you use during the weekly challenge)

Name, date and time

1. Please indicate the which appliances you used and the settings you selected

Type of appliance	Settings used *(remember to include temperature, speed, etc. where these are adjustable)*

2. Consider **the main appliance** used for this task. Why did you select **this particular setting**? *(Tick ALL relevant boxes and add comment if possible)*

   a. It's the best for what I'm doing ☐ _____

   b. It's the one I always use ☐ _____

   c. It's the one I was told to use ☐ _____

   d. It's the default setting ☐ _____

   e. I don't know what the others do ☐ _____

   f. It's eco-friendly ☐ _____

   g. It's fast ☐ _____

   h. Other (state reason) ☐ _____

3. Please answer the following questions about your **selected appliance setting** if possible. *(Circle yes or no and/or fill in the answer. Then please indicate how you know the answer.)*

	Answer (Yes/ No and **How much**)	How do you know?
Do you know **how much energy** it uses? If yes, how much?	Yes/ no	
Do you know **how much time** it takes? If yes, how much?	Yes/ no	
Do you know **how much it cost**? If yes, how much?	Yes/ no	

4. Why are you doing this task (laundry, food preparation, personal hygiene, home care, work/ entertainment) **right now**?

5. Please let us know the impact of doing your this task **at a different time**.

	Positive Impacts	Negative Impacts
Bring forward		
Delay		

6. How will shifting this task change what you do **today**?

7. How will shifting this task change what you do **this week**?

8. Was there something unusual about this task or do you have any other comments about this particular 'session'?

Thanks for filling in this form! Please keep it safely and return to researcher

Post Observation Interview Schedule

This is a semi structured interview so I will ask these questions in different orders, sometimes not asking one of them at all, depending on the responses participants give me

Before starting

Check its okay to record	Make sure they have enough time to spend	Thank them.

Script

Thanks very much for allowing me to observe a 'normal' day in your life.

To start off with, please can you tell me whether this did seem like a normal day?

Do you have any comments about the last 24 hours?

Show them the Excel spreadsheet and ask them to pick up any inaccuracies

Rhythm, ordering, sequencing, timing

1. How would you say you organise your time?
   - Would you say that you have a fairly regular daily routine?
   - Would you say that you that your weeks are fairly structured?
2. Are there any other sorts of regular events that punctuate your normal life
   - A monthly activity or annual event that you rely on e.g. school or family holidays, particular administrative tasks (insurance), end of financial or academic year, etc. How long has this been going on?
3. Do you think the way you spend your time is more structured or flexible?
4. What are the main things around which you structure everything else?
   - What happens if these things have to shift?
5. Is it important to you that things happen in a particular order or at a particular time?
   - Can you say a bit more about this? What might be the consequences of not doing these things?)
6. Do you value routine?
   - If the routine in the house changes/ is disrupted, who is affected most by that?
7. I noticed that you didn't do some of the things I'm interested in.
   - Do you have a regular schedule for these things?
   - Can you show me how you might do these things?
     - Laundry
     - Work/ entertainment
     - Food storage and preparation
     - (Cleaning and DIY)
     - (Personal hygiene)

Flexibility

8. Thinking back over the last year to five years, are there any big changes that have led to you doing things differently? (Tell me about them. What were the positive and negative impacts of doing that thing differently?)
9. If someone else asked you, what sorts of things are you prepared to be flexible about?
10. From your point of view, what would make it worth being flexible in this sort of way?

Description of practices (for own reference)

- **Laundry:** care of clothes (washing, drying, ironing, putting away, etc.)
- **Personal hygiene** (showers, baths, washing hair, shaving, etc.)
- **Care of home** (cleaning, DIY, maintenance and gardening)
- **Food storage and preparation** (putting food into fridge/ freezer, etc. after purchase, preparing for cooking/ eating, cooking, eating, washing and putting away dishes, etc.)
- **Work and 'extra-curricular' activities** (work/ homework, TV, games, leisure, relaxing, entertainment, entertaining)

Food Challenge Interview Schedule

Note on all interview schedules: *This is a semi structured interview so I will ask these questions in different orders, sometimes not asking one of them at all, depending on the responses participants give me*

Note to self: *How much awareness will they show of what has gone on – will they, for example, be conscious of the energy the fridge is using even if they don't use the cooker, will they talk about the fact that the cooker is gas or if they go out will they talk about the energy use of their transport?*

Before starting: Check its okay to record. Make sure they have enough time to spend. Thank them.

Script
The challenge
Let's start by talking about the challenge.
1. Did you manage to carry out the challenge?
    - Tell me about it
    - How did you interpret food preparation in this challenge?
    - Did this mean you ate something different?
2. How did you find the experience?
    - Did it mean you had to complete some things earlier or do some things later that impacted on other parts of your day? Tell me about this.
3. What would you normally be doing at this time of the day?
    - What did you do instead?
    - What energy was being used in the house?
4. Were you alone?
    - What did the other people in the house do?
    - How did you explain the challenge to them?
    - How did they get on with the challenge do you think?
5. Did the challenge have a positive/ negative impact/ was it neutral?
6. Did it make you think about what you normally do?
    - What did you learn, if anything?
    - Did this give you any insight into what you normally do?
    - Might something about your normal routine change as a result?

After finishing: Turn of recorder. Discuss arrangements for next challenge. Check if they would like to see the transcription. Pass the time of day if they want to chat. Thank them. Transfer recording onto computer and transcribe.

Laundry Challenge Interview Schedule

Note to self: How much awareness will they show of what has gone on – will they, for example, be conscious of the energy implications of different settings and of different phases of the laundry? Will they talk about other aspects of the laundry apart from the washing machine?

Before starting: Check its okay to record. Make sure they have enough time to spend. Thank them.

Script
The challenge
Let's start by talking about the challenge.
1. Did you manage to carry out the challenge?
    - Tell me about it
    - How did you interpret 'laundry' in this challenge?
    - Did this mean you wore something different?
2. How did you find the experience?
    - Did it mean you had to complete some things earlier or do some things later that impacted on other parts of your day? Tell me about this.
3. What would you normally be doing at this time of the day?
    - What did you do instead?
    - What energy was being used in the house?
4. Were you alone?
    - What did the other people in the house do?
    - How did you explain the challenge to them?
    - How did they get on with the challenge do you think?
5. Did the challenge have a positive/ negative impact/ was it neutral?
6. Did it make you think about what you normally do?
    - What did you learn, if anything?
    - Did this give you any insight into what you normally do?
    - Might something about your normal routine change as a result?

What normally happens?
7. How is laundry normally done in your home?
    - Is there a time/ space/ activity that is particularly important?
    - How/ when/ where/ how do you normally prepare do the laundry?
    - What sorts of technology do you have in the house to 'support' your laundry practices?
    - How do you use this technology?
8. Do you think there are any cultural influences on how you do the laundry?
    - Friends, TV, UK, work culture, etc.?
9. Do you follow official instructions when doing your laundry (this could include user guidelines for washing machine, washing products, etc. but also instructions from your energy company or other 'officially sanctioned' information sources)?
    - Why does this information matter to you?
    - When would it be relevant to take it into account?
    - How did they/ would they need to tell you this information?
10. How do your values or opinions influence how you do the laundry (ideas about hygiene, environmental attitudes, attitude towards costs, etc?)
11. What normally makes you decide to do the laundry?
    - Weather, time of day, school/ work patterns, what others in the house are doing, etc.
12. What difference does it make if you're alone/ with others
    - Does it make a difference if they are family/ friends?

13. Do you have a washing machine? Is it a washer/ drier?
    - Model, make and efficiency rating
    - What programme do you normally use? Why?
    - Do you have a delay setting? Why do you use it?
    - Why do you have a washing machine?
    - Why do you have this make/ model?
    - Why do you use it this way?
    - When do you use your washing machine?
    - How do you use your washing machine?

14. Please rate the following. On a scale of 1-3 (where 1 is unimportant, 2 is neutral and 3 is important) how relevant are the following in deciding to do your laundry?
    - Weather
    - Exceptional (unusual/ emergency) washing demand
    - Price of electricity

15. Please also comment on the following:
    - In what way do work and/ or school attendance patterns influence how the laundry is done in your house?
    - In what way do your recreation patterns influence how the laundry is done in your house?
    - In what way does entertaining influence how the laundry is done in your house?
    - In what way do other domestic tasks influence how the laundry is done in your house?

After finishing: Turn of recorder. Discuss arrangements for next challenge. Check if they would like to see the transcription. Pass the time of day if they want to chat. Thank them. Transfer recording onto computer and transcribe.

Work and Relaxation Interview Schedule

Note to self: How much awareness will they show of what has gone on – will they, for example, be conscious of the energy the modem is using even if they don't use the internet, will they talk about the fact that the laptop is using a battery or will they talk about the energy use of other practices?

Before starting: Check its okay to record. Make sure they have enough time to spend. Thank them.

Script
The challenge
Let's start by talking about the challenge.
1. Did you manage to carry out the challenge?
   - Tell me about it
   - How did you interpret work and relaxation in this challenge?
   - Did this mean you did something different?
2. How did you find the experience?
   - Did it mean you had to complete some things earlier or do some things later that impacted on other parts of your day? Tell me about this.
3. What would you normally be doing at this time of the day?
   - What did you do instead?
   - What energy was being used in the house?
4. Were you alone?
   - What did the other people in the house do?
   - How did you explain the challenge to them?
   - How did they get on with the challenge do you think?
5. Did the challenge have a positive/ negative impact/ was it neutral?
6. Did it make you think about what you normally do?
   - What did you learn, if anything?
   - Did this give you any insight into what you normally do?
   - Might something about your normal routine change as a result?

What normally happens?
7. Do you normally work at home?
8. How are work and relaxation defined for you/ in your house?
   - Is there a time/ space/ activity that is particularly important?
   - How/ when/ where/ how do you normally relax?
   - What sorts of technology do you have in the house to 'support' your work and relaxation practices?
   - How do you use this technology?
9. Do you think there are any cultural influences on how you work or relax
   - Friends, TV, UK, work culture, etc.?
10. What normally makes you decide to work/ relax?
    - Weather, time of day, school/ work patterns, what others in the house are doing, etc.
11. What difference does it make if you're alone/ with others
    - Does it make a difference if they are family/ friends?

After finishing: Turn of recorder. Discuss arrangements for next challenge. Check if they would like to see the transcription. Pass the time of day if they want to chat. Thank them. Transfer recording onto computer and transcribe.

Practices by Household: Normal compared to Challenges

Household One

Two bedroom terraced house, courtyard garden in small city in the Midlands. Owned by single woman who lives alone. Second room used mainly as a spare room. Has large TV but only uses for films. Computer always on – uses for music, work, constant email activity (but not on FB or other new media). GCH and cooker - standard fittings (though badly wired and heating system needing maintenance). No large appliances apart from washing machine.

Food

Normal: She uses the Saturday Guardian as inspiration and makes a large portion of one main meal that lasts for the week. She then supplements this with 'standard' meals that she eats every week in between this. She eats early, having breakfast as soon as she wakes (which can be 4h30) and so this is followed by an early lunch and dinner, usually before 18h00 but triggered by hunger rather than convention.

Laundry

Normal: Has strict laundry schedule for big things like bedding (once a month on the first of the month) and towels (twice a month on the first and fifteenth) but the rest waits until there is a small load. She has favourite things that she wears continuously (sleeping and exercising in them as well as wearing them out) until they are dirty. However, these do not take up much space so the load may not be full. She thinks ironing is the devil's work.

Challenge: She came home from weekend in Bath and would normally have done it directly but delayed it. This required her to wear trousers she wouldn't usually have worn as her favourites were in the wash and also meant she had washing on the radiator on the Tuesday when she had guests which meant she did not feel very house proud but in spite of this she found it easy. She found the experience relatively neutral.

Work and relaxation

Normal: She goes to university to lecture (mostly in mornings) but then tends to return home and cooks before continuing work in afternoon. She volunteers for a group with gives free legal advice t people who have been wrongly imprisoned. She also reads a lot and feels her personal interests and work tie together seamlessly so that it is difficult to distinguish clearly between work and relaxation. Her computer is on all the time and she is always online, checking emails constantly. She also uses the computer for music and calls it her 'best friend'. She does several yoga classes a week and practices at home, sometimes teaching a class when cover is required. A friend uses the basement for painting on Tuesdays and another friend stays the night most Tuesdays. She quite frequently has people round for dinner. She visits her partner a couple of times a week but otherwise tends to be at home.

Challenge: She was mostly out, first visiting her partner and then going to a yoga class. While at home (17h00 to 19h00 and then after 21h20) she was reading, on the phone and also prepared and ate food. Her phone was on but her computer was off. She found the experience fairly neutral.

Household Two

Detached 3 bedroom house with flat below (rented out) in north London. Lots of gadgets but fairly standard – underfloor heating in living room not yet connected so need electric heater sometimes. TV entertainment centre but only one. Fairly large outside space (especially by London standards) with shed. Two laptops, one car, four bikes. Don't have kettle but make tea on stove. Two cats quite important

Food

Normal: She normally looks in fridge and prepares impromptu meals. In winter, however, she tends towards warm food. In summer the challenge would have been easier as they eat lots of salads and cold food.

Challenge: She prepared a large stew the night before for a friend who had a baby but made extra for her own family. Normally she would have 'nuked' it to warm it up. Instead she put potatoes in the oven to bake before going out to fetch the children from school. Her husband switched off the oven at 16h00 and the food was left in there to keep warm for an hour until they were ready to eat at 17h00. She found it a positive experience because it made her more organised.

Laundry

Normal: Although there is 'no norm' she would not normally do more than two loads especially in winter because she does not like laundry hanging about. She 'needs' to get laundry out of washing machine quickly so plans the timing of the laundry around this and how she will dry it (so sometimes the weather is important in her deciding to do laundry). If drying things in the house they will start on airers in sunny spots and then move onto radiators once they are less soggy. The fan light will be

on to create a movement of air round the house. In the summer she hangs it outside and that is easier. She does not iron and attributes some of her flexibility to this.

Challenge: She did three loads, so effectively bringing forward an extra load to test out drying extra laundry when all her normal drying places were full. This was successful. Previously drying washing inside caused condensation on the windows but with the new windows this no longer happens. She found it a generally positive experience because new windows coped with the damp and she realised it could be done for future reference. She also found that when she returned from holiday there was less laundry waiting to be done because she had brought some of it forward.

Work and relaxation

Normal: The couple are both self-employed, husband full-time, wife part-time at the moment. Both work very flexibly at home and in offices and 'on site' (as an architect and a trainer they need to be in and out of the office). They have two young girls (5 and 7 years old) and the woman was pregnant at the time of the study. They share childcare quite evenly. Both children are at school between 9h00 and 15h00. They have some regular afternoon activities like piano lessons and one of them plays football but the schedule for this was not discussed. They have a very busy social life as people often come to stay and they both go out regularly. Sometimes they go out separately so that one looks after the children. Otherwise they share childcare with friends and this helps them achieve their desired flexibility. There is no real pattern to their social life apart from a couple of things like church (weekly) and book club (monthly). They do not go to the gym but use cycling to places to keep them fit. Each person has a bicycle. Each adult has a laptop and a smart phone. The laptops are not always on but work is 'squeezed' into every available corner. The children have a laptop they've drawn on a piece of paper.

Challenge: An upset in their expected schedule meant that the wife needed to be at a training event and so was out. This caused them to forget about the challenge. The husband picked up the children and they practiced piano on an electric keyboard for ten minutes at start of it. They were then out for most of it. The husband went to fetch his wife because she was pregnant and the weather was bad. The traffic was so bad that they decided to go out for dinner and so by the time they brought the sleeping children into the house it was around 20h00. They then had a long catch up discussion about possible work opportunities and to reorganise the schedule thrown into disarray by the unexpected work appointment. After the catch up session the wife used her computer to send an email. She doesn't recall if it was plugged in or not. However, their phones and computers were on because they had forgotten about the challenge until seeing in in iCal the following day. Despite this, they effectively shifted their energy use throughout most of the period. The experience was neutral as they were unaware of it.

Household Three

Three bedroom semi-detached house in north London. Owner occupied but one room rented out all the time and the other rented out during the week. During the week owner sleeps in bunkbed in his office (which is what the third bedroom is used for). Garage (contains sports car, motorbike and freezer), front driveway (on which second car is kept) slightly larger than courtyard garden. Three TVs (reduced to 1 since study) and five computers (two desktops and three laptops). Standard house – GCH and cooker. Washing machine changed during study from washer drier to plain washing machine. Solar panels put on during study

Food

Normal: Three people in the house – homeowner, lodger (there for observation but not around for any of the challenges) and temporary lodger (not there for the observation but there for all of the challenges). The homeowner tends to eat his main meal at lunchtime with a light snack in the evening though he claims to have 'odd eating habits'. The temporary lodger is out at work all day. Normally he and she make food separately though they do also cook together quite regularly and would tend to get a takeaway once a week if they are both in. They tend to eat freshly cooked but quick to make things like pasta and stir fries.

Challenge: The homeowner was out to pick up a new motorbike and was tired so decided to pick up a pizza (2 for 1 deal) on his way home). His lodger had bought herself fish and chips on her way home and also had a slice of his pizza when he got home. He said this was good for his mental health so it was a neutral experience. She said it was unhealthy and expensive so it was a slightly negative experience.

Laundry

Normal: Homeowner had altered his laundry habits because he was washing the bed sheets for the temporary lodger. This had caused him to have a laundry day. Previously he waited until he had a full load and this was still important for him. Apart from his lodger's laundry he usually did a white load every two to three weeks and a coloured load once a week. He usually did the laundry at night because he has Economy 7. He would tend to turn this on before going to bed after midnight (no delay switch or timer) and would then hang it outside in the summer or around the house in the winter to dry it. He does a fair amount of ironing but does not iron everything. He does not iron every time he washes but leaves it to accumulate for two or three washes. The lodger normally washes her clothes separately. As she is so often away she sometimes does it at her mother's house. The temporary lodger does not do any of her own laundry in the house but does it at home at the weekends. However she generates laundry because the householder washes her sheets every week.

Challenge: The homeowner did the laundry in the morning (he normally does it overnight to save money) and did not wash the lodger's sheets because she had been there less than a full week. He discussed this with her and she was happy with this arrangement. Basically this meant he put back a load and cancelled a load. He had to cope with a slight backlog and the fact he was going away for four days so he needed to get ready for that. Normally he would have left himself two days to wash, dry and iron his clothes before going away but now he had only a day. However, he felt confident about getting it all done in time and felt this was a slightly positive experience.

Work and relaxation

Normal: Homeowner is a freelance photographer so works weekends and does not distinguish much between different days of the week in terms of work, relaxation and household chores. Each gets done as is required by the deadlines attached to it and so each day is arranged flexibly around that. He spends much of his time in front of a PC editing photographs and prides himself on working quickly to get back to customers and provide a good service. When working at home he may not see anyone for a couple of days and so spends a lot of time on the internet and using his phone. Being connected for his work and personal life is important. He has a very busy social life and also does sports once or twice a week and goes to the gym so is often out. He feels he does not spend any time relaxing, though occasionally he may watch a film on TV. His temporary lodger goes out to work at 7h00 and returns at 7h30. She would eat, bath and watch TV in the evening and finds this a good way to relax. At the weekends she goes home.

Challenge: The homeowner had organised a few 'trade' magazines to read during the challenge but in the end he went out on a date that had been organised at the last minute (his going out was not a response to the challenge) and was out for the entire time. He had agreed to keep his phone on during the challenge because he wanted to keep an eye on any work emails that might come in. His temporary lodger did the challenge. She only gets home at about 19h30. On this evening she had a bath, cooked food and read papers instead of watching TV. She turned on the TV at 22h15. For her this was a slightly negative experience as she had already read most of the papers whilst travelling to and from work and she felt that she was too tired to get much enjoyment from reading anyway.

Household Four

Four bedroom terraced house in small city in the Midlands. Garden at back with shed. Lives with teenage daughter who lives on third floor (with own bathroom and shower and no central heating). Computer hardly used. Laptop given as Christmas gift at end of study. Only one TV, apparently only sometimes used. House quite cold so rooms heated over and above gas central heating – PS's by electric heater and TV room by gas fire. Standard fittings but no kettle, dishwasher or microwave (kettle bought since study though not as a result). Do have tumble drier. Cat but not much impact

Food

Normal: The mum normally cooks when she gets home from work, a different meal each night, sometimes pre-prepared but sometimes cooked from scratch. Her daughter helps very occasionally. She finds this to be a pressurised and tiring arrangement. While the food is cooking she would tend to sit in the kitchen and read the paper. She sometimes watches TV to relax though she often does not turn on the TV. She may read or listen to music. Her daughter tends to listen to loud music and eat a snack when she comes home from school. She then does her homework in her room. At the time of the challenge she did not have a computer. She tends to listen to music to relax and only very seldom watches TV. The household is very different when the son is at home but he was away at university and so not around for the observation or any of the challenges.

Challenge: The mum had some chicken that needed to be eaten and would have gone off had she not cooked it. She had therefore cooked two meals the night before, bringing forward her food preparation. On the day of the challenge she did warm up what she'd cooked the night before using the gas oven and used a toastie maker to warm up the tortillas. She found it a very positive experience because it gave her extra time on the second evening and also allowed her to be more creative with her cooking on that evening. She said she might do it again in the future. The daughter's evening was unaffected by the challenge.

Laundry

Normal: The mum worked Monday to Thursday and so tried to get all jobs done on a Friday and Saturday so that she could relax on a Sunday and have proper free time. The daughter liked to get her washing done on a Saturday so she could get the ironing done on Sunday, ready for school.

Challenge: This family had intended to do the challenge and so put on a load of laundry on the Friday night (effectively bringing it forward) but then they had not finished the laundry and rather than delaying the rest of it until Sunday, they decided not to do the challenge. She and her daughter felt they liked their laundry the way it was. They might have been induced to change if they had felt part of bigger initiative or if they could have seen the point. It would have been a negative experience if they had completed the challenge but as they did not do it, the experience was neutral.

Work and relaxation

Normal: Mum only watches TV occasionally, daughter only seldom. Tend to eat dinner together and then relax separately, daughter in her room listening to music and using phone and mum either reading, watching TV or maybe also listening to music whilst sorting out house.

Challenge: Memory of the challenge day was not good (as the interview was unavoidably delayed) but they thought they had not done anything particularly different to a normal day. Mum got home late and by the time cooking and cleaning up had been done it was 22h00. Daughter did do school work work but at time did not have a computer so this did not involve energy. She could not remember if she had played music or not. A neutral experience as it appears not to have altered their normal routine.

Household Five

Four bedroom house owned by couple with two young children in small market town in the Midlands. Three computers (2 laptops both used by same person), one TV. Fairly standard fittings – GCH and cooker, dishwasher. Small back garden with courtyard and chickens. Small front garden with flowers and veggies. Carport used for washing and storing things. Two cars on front driveway.

Food

Normal: Normally the family eat together if possible at around 17h30 or 18h00. The parents share the cooking but the wife does more of it, particularly as the man works away from home during the week.

Challenge: The family were going out to a local Christmas tree festival and so bought a fish and chips takeaway. Everybody was apparently happy with this arrangement. The wife had planned to make a soup in the slow cooker to cook beforehand and then keep warm but in the end the husband was late home from work and suggested picking up a takeaway on his way home. In fact, given they were going out to the festival, they said they might have decided on this option even without the challenge. This was considered a positive experience.

Laundry

Normal: Normally the laundry is done at night to take advantage of Economy 7. They have a large washing machine (11kg) of which they are very proud and which they only use when they have a full load but even so it is used several times a week. There would be about one white wash a week and then two or three other washes depending on whether the sheets are being done (they are done every second week before the cleaner comes). Typically a wash would be done on a Friday night when the man came home from being away from work. This allows him time to get his work clothes dried and ironed in good time for going away early on a Tuesday morning. However he admits to doing less than 5% of the laundry. She says she 'does it better'. More laundry is done over the weekend, particularly because the family goes to the gym at the weekend and this generates an immediate need to do the laundry. Similarly, the mum and her girls go swimming during the week and this generates a bath for the children and laundry to wash the chlorinated towels.

Challenge: Two interviews were done on the laundry in this household, one interviewing the man and the other his wife. On the day of the challenge (a Friday evening) it was the man's birthday anyway and so it was not difficult to delay the laundry as they were going out to a fun fair anyway. This meant that it had to be done at a more expensive time of day. It also meant the shirts were not dry and had to be ironed dry (by the wife) and put on hangers to be ready for the man to go to London at 4h30 on Tuesday morning. He admitted that he could have taken other shirts but these were his favourites. This was a slightly negative experience because of the amount of hassle in getting the clothes dry in time.

Work and relaxation

Normal: The woman in the couple works for herself as a gardener. She therefore does most of her work out of the house but has administrative tasks which she does at home. The man in the couple works part time at a local university and part time in London as an IT consultant. He occasionally works from home when he needs to share in childcare arrangements but is normally away from home for work. Both members of the couple relax by exercising and have occasional social activities. The man also relaxes by 'messing around' on the computer, accessing music for example, and he also plays the guitar. The woman sometimes watches TV but will tend to spend spare time during the week doing 'jobs' so that she can relax when her husband is at home. Relaxing is normally done when the children are in bed. Both children go to school until 15h00 when their mum (usually) picks them up. They have a variety of after school activities. Normally they would relax for a short while in front of the TV when they get home from work. Sometimes they use the computer to practice maths problems. One of them in particular likes listening to music on the CD player.

Challenge: Right after school the girls went home and did puzzles instead of TV. They did not mind this apparently but did mind that they were not allowed to listen to music or turn on the Christmas lights. However, they were prepared to accept this for the day because they remembered the researcher coming to stay and understood that this was part of the same project. They had an early dinner and then the older child went to karate whilst the younger one had a short nap because they were going to be out late. The man in the couple missed being on the internet and mentioned this a couple of times. Once the oldest child returned from karate the family went out together at 19h00 to see the school nativity play. When they got home they put the children to bed and chatted instead of putting on the TV.

Household Six

Two bedroom terraced house, rented, with courtyard garden in small city in Midlands. One couple who share a room. One single person in his own room. Electric cooker, no washing machine, TV or other large appliances. Everyone has a laptop, they have a record player in one bedroom. GCH.

Food

Normal: This household has an electric hob. Normally the single housemate and the couple prepare food separately. The single man is diabetic and so is quite careful about what and when he eats. The couple are vegetarian so often do not use energy to prepare food anyway. She felt that if she was part of a larger initiative she would be happy to make quite significant changes to how she used energy. They do not have a particular set time to eat because the man of the couple often works in the evenings and might be asked to do so at the last minute. This means they are used to disruption. The woman takes responsibility for the decisions around meals though her partner sometimes helps prepare them. She describes what they do as 'going with the flow'.

Challenge: The single housemate was out for the challenge. The couple completed it. Originally the intention had been for the man of the couple to cook and they had planned to prepare the food and eat after 20h00. However, the woman was out for lunch with a friend and the man forgot to eat lunch because he was working. This meant he was really hungry so they got a takeaway. They got something cheap and healthy (humus on pita with salad from the kebab shop) and so were happy with the meal. She felt some of the decision-making she usually had to do around mealtimes had been taken away which was a relief. It was a neutral experience.

Laundry

Normal: There is no washing machine in this house. The single man uses the laundrette around the corner. This means he has to be around, though he does sometimes pop home and do things like cleaning while he is waiting. He dries his clothes on airers in the front room of the house. The couple do their washing at the woman's parents' house. She tends to take the washing and usually combines it with a visit. However, she would leave the washing there to get dry. Both of them wash about once a week though this might vary depending on what they have on. Neither of them does ironing under normal circumstances.

Challenge: The single man did his laundry on a Wednesday rather than a Tuesday, so putting it back 24 hours, but this did not make much difference. Due to the time this freed up, he managed to see his sister on the Tuesday. As he was unemployed during the challenges he was able to fit things in but claimed that he would have been able to manage even had he been working. The woman in the couple had been planning to do her laundry on the Sunday after meeting her parents to see a film. Responding to the challenge she decided to put it off until the Monday but ended up putting it back a week because she was revising for exams and her partner was busy at work. By then they had lots of washing, some of which she thought she may do at the laundrette to save overwhelming her parents. The dirty laundry drawer was very full but had not yet run out of clothes (partly because she had been busy revising and so had not needed lots of new changes of clothes). For the single man the experience made no difference. For the couple one day would have made no difference. A week was possible but it was going to take a bit of work to catch up so it was slightly negative.

Work and relaxation

Normal: The single man used to work as a croupier at the local casino but had broken his wrist and so had lost his job and was unemployed at the time of the challenges. When he was working he had afternoon and evening shifts. At the time of the challenges he spent a lot of time at home and online, usually in his bedroom. He had a fairly active social life. The woman in the couple was a full time student at the time of the challenges and worked part time as an estate agent. Her partner was working part time as a journalist and part time in a pub. They spend quite a lot of time at home. One way they relax is to 'do watching' which is when they watch something relaxing on the computer, usually while eating. The house did not have a TV. They also have an old fashioned record player and they also made music together quite regularly.

Challenge: The single man was away but not as a reaction to the challenge. He was not interviewed about it therefore. The couple had not done the challenge because she had suddenly become quite ill and they had needed to look up her symptoms on the internet and then call NHS direct. In addition they had an unexpected guest staying and they did not want to ask him not to use energy. The experience was neutral because they did not do it.

Household Seven

Two bedroom terraced house with loft conversion in large city in the north of England (accessed by loft ladder and used for guests). Small front garden with flowers. Small back garden with shed, herbs, flowers, a couple of veg. Kettle but hardly used. Gas cooker but never used (eat raw vegan diet). Have other kitchen gadgets like dehydrator. GCH. Two dogs important

Food

Normal: This couple are both raw vegans, meaning they eat no animal products and do not cook their food in a conventional way. They do use appliances like a fridge, blender and dehydrator (which heats food up to less than 40° Celsius so as not to kill the enzymes present in raw food) but they would use a lot less energy than normal to prepare food. Their dogs are also fed with vegan food which is sometimes prepared using a food processor.

Challenge: This household actually forgot about the challenge but had already had a smoothie before 16h00 and were having hand pressed orange juice and a salad for dinner so they did not need to use any energy anyway. They did put the dog's food onto the dehydrator but remembered a short way into the challenge that they should not be using energy and turned it off. They do not normally use the dehydrator for the dogs' food so said that had they remembered they could easily have done the challenge all the way through. The found the experience positive because it made them think about their energy use and realise they did not really need much energy to prepare their food.

Laundry

Normal: This couple normally does their laundry on a Saturday and they try to do as much of it on one day as they can because their energy tariff means that they get discounts over a certain number

of units in a day. In the winter they use a tumble drier and so this is even more important. They also usually do cleaning on same day as the laundry.

Challenge: They did the challenge and their cleaning on Sunday instead of Saturday, effectively swapping schedules (though actually some of the cleaning spread across the two days as the husband did some of it on Saturday because the wife was working on job application. The implication is that this cost them their free time on the Sunday though they may not have had this free time anyway given the job application needed to be done.

Work and relaxation

Normal: Normally this couple work until the end of the working day, though this is quite flexible, especially for the husband, who is self-employed. The rest of the time would be spent walking the dogs, possibly going for a run or doing yoga, preparing and eating dinner, possibly whilst watching something on television (often a DVD such as the Dog Whisperer) and probably having another fruit meal as well. This would be followed by cleaning up, and maybe something else on television. They might also listen to music which they found a very important part of their daily lives and which they used to relax, sing, dance and energise themselves. Their appliances included a TV, DVD player, a Virgin box, a digibox with a hard drive, an iPod with speakers, a computer, a work laptop, a printer and a video camera (which they had not yet used)

Challenge: They only started the challenge at 18h00 because she had a job application with an immanent deadline and he was working on Green Movies, a new enterprise they were trying to set up. They had planned to do the challenge and she was going to go into office to cover work part of it but at last minute decided to do job application so stayed home. Both were working on computers and had music on the iPod with little speakers to drown out noise of neighbours. Once they had finished work they continued with the challenge as specified. They had dinner and watched a seminar on an unplugged laptop. They then went to bed early, at which point they turned on their white noise machine, again to deal with the noisy neighbours.

Household Eight

Six bedroom detached farmhouse on about 200 acres of land in central England. A couple of outbuildings (mobile home office, old hangar, ex stables) and a substantial vegetable growing area, formal garden, some managed land and some more or less left alone (solar farm and truffle woodland being planned on this). Lives alone but entertains a great deal and also rents out the whole house as holiday let, during which time he moves out. Entertainment centre in living room and TV in kitchen. Two computers – laptop and one used for security. Security equipment. Standard though high spec fittings and high energy usage. Septic tank but otherwise normally connected to water and electricity. Not gas connected – uses oil to heat water and gas bottles for cooker. Two cats but not much impact

Food

Normal: When alone he would normally have breakfast and dinner at around 19h00. Depending on what he has for breakfast and what he is doing he may not eat lunch. Much of the time, however, he is entertaining and then there can be up to ten people in the house all of whom will eat at least three meals a day. He also sometimes entertains fewer people but again would then eat at least three times a day. He is a vegetarian and estimates he produces about 50% of his own food from the garden.

Challenge: During the food challenge he cooked chick peas earlier in day. When he was ready to eat, he gathered leaves and things from the garden to make a salad for dinner. He was going out anyway at 19h00 for a lecture and so the challenge did not have a broader influence on how he spent his

evening. Although he brought his food preparation forwards, it only took a short time and so did not materially affect his time earlier in the day either.

Laundry

Normal: For his own laundry he does about one load a week. If just at home or going out he will wear clothes up to five or seven times before considering them dirty. On some occasions, however, such as when 'lumberjacking' or doing maintenance of some kind he will get sweaty or covered in grease and sawdust and on those occasions he will wash the clothes more quickly. He is clear that he washes clothes before they smell and is as efficient as possible with his laundry. However, he also does a lot of laundry because of houseguests, both paying and non-paying. Bedding and towels will be washed every time someone comes to stay even if they have only stayed one night. His own bedding and towels will be washed every two to three weeks. He tends to wash on quite a high temperature, at least 60°C for clothes, particularly 'smalls' and up to 90°C for bedding and towels, especially if they are stained. He uses environmentally friendly products for sensitive skin that will not damage his septic tank. Laundry is dried on the rack in the laundry room, the boiler cupboard or outside on the line.

Challenge: For the challenge, he delayed doing the laundry after his last guests left. As there was no urgent need to get it done, it was delayed for a couple of days. He would have preferred to get it done straight away (referring to himself as a "clean house fetishist") but he claimed that doing it later did not change anything.

Work and relaxation

Normal: He does not have a regular routine as he works for himself and is often away or has friends staying. However, as far as a regular schedule does exist, he would wake up naturally, normally between 6h00 and 8h00 and eat breakfast. He would normally work in the morning, deal with maintenance issues in the afternoon and be in by about 18h00 when he might relax in a bath or meditate. He would then cook and probably watch the Channel 4 news at 19h00. He might listen to music, watch something on TV or read in the evening.

Challenge: During the challenge he worked in the morning and then went out some time in the afternoon to his woodlands and was "lumberjacking" until 18h00. When he came in he had a bath and then made and ate dinner, read for a while and wrote a couple of letters. At 22h00 he sent the researcher a text to say that he had most missed music and so had put some on though he later said he could just as easily have gone to bed.

Household Nine

Five bedroom detached house in the countryside outside small market town in the southwest with about 10 acres of land (mostly rented out to local sheep farmer but does have large garden and a couple of outbuildings, ex stables). Older woman who lives alone. Used to entertain a lot but no longer. Sometimes family or others to stay but less than in past. Aga but otherwise fairly standard fittings. Uses Aga and conservatory for heat management. Has lots of gadgets (laptop, Kindle, digital radio, iPad) but only one of each.

Food

Normal: She tries to eat something raw every day. She usually eats dinner at about 19h00-19h30 in the evening. Sometimes, if she is going out, which she quite often does in the evenings as she attends local meetings, she would prepare high tea, leaving something in the Aga to have when she gets back in.

Challenge: The woman in this household prepared in advance for the challenge. She made tea before 16h00 and filled a thermos with hot water in case she wanted more tea (though in the end she did not need it and subsequently used the water for washing up). She put a 'nasty pre-prepared Shepherd's pie' in the bottom of the Aga at 16h00 which warms it up slowly. While she did not see this as preparing food, it could be argued that this was cheating. Then, just before 20h00 she prepared the vegetables and put them on at 20h00 to eat shortly afterwards once they were ready.

She found it easy though she was hungry by 20h00 as she usually eats at 19h00 or 19h30. However, she would not always find it easy as when she goes out, which she does at least a couple of times a week, she wants to eat an early dinner before she goes.

Laundry

Normal: She would normally do about one load of washing a week comprising her nightwear, underwear, vests in winter and a couple of shirts in summer (she would tend to wear them for two or three days). She would add a towel, dish cloths, a sheet or washing left over from when people stayed over to fill up the wash. She does quite a lot of hand washing – jumpers and roll necks, which she wears in the winter, cannot go into the machine. She tends to wear expensive clothes that she wants to last a long time so she washes them carefully. The main thing that determines when she does her laundry is the weather as she likes to hang things outside.

Challenge: She delayed the laundry 24 hours and was happy to find that the day she swapped to was as nice as the day she swapped away from as the weather was an important catalyst for her washing which tended to be dictated by the weather rather than a particular day or even a full load (she might wait until she had several full loads). As before, she found the challenge easy.

Work and relaxation

Normal: She has a to do list and a schedule and tries to stick to it. She works for the family in various ways and does lots of voluntary work. She starts work at 9h00 and does a couple of hours. She may then do some domestic chores or have someone coming in (such as someone to help with typing, do cleaning or tidy the garden). After lunch she may relax and try not to fall asleep. She would then work through until about 18h00. She may watch the six o'clock news to see her son (who is a presenter) or might listen to the radio. Dinner is usually around 19h30. She watches about three to five TV programmes a week – wildlife, Paxman and possibly some opera. This might be done on her computer in the kitchen, especially in winter when she stays near the Aga but she does have a 'combi' TV/ video/ DVD player which she also might use in the living room. In the summer she may work and relax in the conservatory. She has two laptops, one mainly used for travelling and the other used for watching iPlayer and listening to music as well as work and Skyping, and quite a number of gadgets, including a Kindle, which she may use to read the paper or to read in bed, a DVD/ video 'combi' machine, an old TV, a microphone and speakers for the computer, a dictaphone, a mobile phone mainly for when she travels (at home she almost exclusively uses the landline and Skype), a CD player and a radio. She has or has had a number of hobbies, sewing, gardening and opera being the main ways she relaxes. She goes out to meetings related to local issues or the Parish Council a couple of times a week though she is less involved these days. She makes sure she goes out regularly to see friends or to visit her family. She spends quite a lot of time on Skype to her four sons in London, Newcastle, Australia and South Africa. She finds relaxing 'quite a problem'.

Challenge: She went out to see a film and returned at about 17h00. She was conducting an interview the following day in London so had dinner, had a bath and washed her hair to pass the time. She had planned ahead again and 'stoked up' her gadgets in advance (Kindle, digital radio and laptop). Despite this she got distressed at about 21h30 when she was preparing for the interview on her laptop (which was unplugged) and realised she needed to print some documents but could not do so because she could not use electricity. However, she got the documents ready and printed them at 22h00 so the problem was short-lived.

Household Ten

Two bedroom flat with balcony owned by married couple in large city in the southwest. All electrical fittings, including cooker and heating. One laptop and sometimes brings one home from work. No TV (fish tank substitute). Washing machine and fridge freezer but no other large appliances.

Food

Normal: Although the challenge was not contingent on the type of energy used for cooking, this house was actually fully electrified so that their heating and cooking was done using electricity. Normally this couple share the cooking and would eat dinner at around 19h00. On a Wednesday they cook something experimental.

Challenge: This household did the challenge on a Wednesday which is their 'experimental' cooking evening, when they usually try out new recipes. They still did this on the challenge night but because they could not use energy this meant they did not eat until 21h00 so they were hungry. The husband in particular needed to eat some uncooked snacks before dinner to keep going. His wife, however, found the challenge okay despite this and reported that her cooking was a bit more organised as a result: she pre-prepared everything up in advance so it was ready to go at 20h00.

Laundry

Normal: The laundry in this house is normally done on a Saturday morning. The wash basket equates to a full load so it is easy to see when the laundry needs to be done. It more or less works out to one coloured load a week and one white load every two weeks. The bedding is washed first thing on a Saturday so that it can be dried and put on the bed again by evening.

Challenge: The researcher had set it up so that the challenge in this household would be done on a Wednesday because the volunteers did voluntary work out of the house on Tuesdays and Thursdays. In the event there was not enough laundry for a load on Wednesday however and so the volunteer waited until later in the week. So, instead of doing it on Saturday she did it on Friday (bringing it forward 24 hours in other words). She found it straightforward though the interview does not reveal

how she fitted it around work. She does report that because the washing was dry by the weekend and could be put away it was nice not to have the washing hanging around.

Work and relaxation

Normal: This couple tend to spend an hour relaxing when they get home at 18h00. They do not have a TV but watch quite a lot of DVDs and things on iPlayer. They both volunteer on Tuesday and Thursday nights and quite often go to the pub to listen to live music. The wife also does a lot of voluntary work for an NGO that supports young engineers visiting and working in the global south. She is doing a PhD and her husband works for a company that deals on the stock exchange. When the weather is nice they will often go out at the weekend. They quite often travel to 'exotic' locations. They consider themselves to have relaxing lives and do not bring work home.

Challenge: The couple in this household left work at the normal time, met up and went to a music gig in the pub down the road. They out straight from work so walked around town a bit and then ate dinner before going to the pub. They got home after 22h00 and went straight to bed.

Household Eleven

Semi-detached four bedroom house in small city in the Midlands (4th a loft conversion) with three bedrooms rented out and owner living in house. One TV, four laptops, otherwise fairly standard fittings. GCH and gas cooker. Dishwasher doesn't work. No tumble drier. Small garden, three sheds and bike shed. No gadgets for owner (though one housemate has iPad and Kindle and all housemates have iPods). Two cats important

Food

Normal: The first volunteer is a vegetarian and cooks most of her food from scratch. She would normally have her main meal at lunchtime though this varies. The second housemate normally cooks her main meal when she gets in between 18h30 and 19h00 and cooks a mixture of ready meals and meals from scratch. The third housemate also cooks at around 19h00 and cooks from scratch, normally cooking twice a week and freezing or saving the leftovers, which she then microwaves on subsequent evenings. The forth housemate eats his main meal at the university at lunchtime. He

then eats a light meal (normally ready-made soup heated in the microwave) at about 22h00 when he gets home from the gym.

Challenge: One volunteer tea beforehand and boiled water to fill a flask. She then went out to a yoga and stayed out so as not return before the end of challenge (going to the supermarket to pick up food on her way back from yoga). A second householder cooked her main meal at lunch time and then had fruit and crisps for dinner. She made pancakes for Pancake Day after 20h00, leaving a couple for other housemates to have when they got home. A third householder had cooked extra food the night before (as she often did) so she had thought she would just heat something up at the end of the challenge. In the end, however, she went to friend's house for pancake evening so only returned after 20h00 anyway. She then warmed up her pre-prepared food heated in microwave. The final housemate was at home but, as is usual for him, did not eat until late in the evening after returning from the gym so his evening was no different from normal. He did want a coffee during the challenge but had a glass of wine instead.

Laundry

Normal: The first housemate does two full loads of laundry every two to three weeks, one coloured and one white. She will re-wear things many times before putting into the wash. She uses eco washing products. The second housemate will re-wear certain things but has a tendency to change items that go on the top half of her body more frequently. She also washes a couple of loads every two to three weeks but uses the cheapest products she can find. Both of these housemates will wait until the weather is nice and hang laundry outside if possible, even in winter. The third housemate does laundry every two days. She only wears things once before washing, with the possible exception of jumpers that she wears at home. She is afraid her clothes will be contaminated in the laboratory where she works and is generally worried about dirt. She has sensitive skin and so has to dry her clothes indoors. She uses a washing product called Fairy which agrees with her skin. The final housemate washes every week or two depending on how many shirts and how much underwear he has left, though he seldom does a full load. Every month or so he washes his sheets as well. Some of his laundry is done at home at the weekends.

Challenge: The first housemate forgot. The second delayed by a day which meant she swapped from a good weather to a bad weather day and was really annoyed as she likes to hang her washing outside. The third housemate put hers back a day which she said did not affect her but, as she normally does her laundry every two days this was actually a big shift for her. The load was still full. The final housemate brought his laundry forward to the Wednesday (as he would usually do it on a Thursday) which meant he did not have a full load (in fact he seldom has a full load anyway as a week of washing is just a couple of shirts and a bit of underwear).

Work and relaxation

Normal: Three of the housemates are working on PhDs. The first works mainly from home from where she also works part-time for a charity, the second partly from home and sometimes at the university and the third keeps office hours in her laboratory. The forth housemate works at the university and keeps office hours, though he tends to leave early and come back late because he lives away at the weekends so starts late on a Monday and finishes early on a Friday. The first housemate has no regular schedule. She organises her time around yoga classes. She spends quite a lot of time socialising. The second housemate spends a lot of her evenings on the phone or watching something on iPlayer and is generally away at the weekends. The third housemate also does not work in the evenings and also is on Skype or watching something on the computer, while at weekends she is also mostly away. The third housemate goes to the gym most evenings and will also spend some time running his own business and on the phone helping his daughter with homework. He goes home every weekend.

Challenge: The first volunteer stopped at 15h00 and turned off her phone and computer which gave her huge relief. She hurried to the tip, then returned and changed before meeting a friend for coffee. They decided to go to vegan talk together later so came home for tea and then went out again until after end of challenge (they were hungry so stayed to eat some snacks at end of the talk). The second housemate had a 15h00 deadline on an assignment. This meant she had to do 10 minutes on the computer using her battery but then she sent it and turned off her computer. She went out to deliver her expenses on campus and then wandered around aimlessly for a bit. She misinterpreted challenge and thought she was not allowed to use any energy. As a result she had eaten an early lunch and thought she was not allowed to prepare food or drink during the challenge. Not knowing what else to do, she went home and complained to the other housemates while they were doing cleaning. She then found out she was allowed to eat so had some tea and a snack dinner. She then had a bath, chatted on the cordless landline phone and also went on iPlayer on her laptop, using the batteries. She found it difficult but said she would normally have found it easy as she loves reading. However, having just finished her assignment she did not feel like reading anything, even for pleasure. The third housemate came home a bit later than normal (between 18h30-19h00) because of the challenge. She cleaned hallway, had a shower and did some cooking. She watched something on her laptop (using the battery) while she ate and then read some papers for work which she had brought home specifically. At about 21h30 she decided she had enough battery to last until the end of the challenge and so turned on her laptop again and Skyped until after the end of the challenge. The final housemate came home earlier than normal so that he would be at home for the challenge. He spent some time reading and relaxing in his room. He also misunderstood the challenge and thought he could not use the vacuum cleaner. Again he was told by another housemate that cleaning was okay and so he vacuumed the kitchen. Later it was too dark to read so he switched on his iPad (thinking that turning on the light to read was using electricity for entertainment but thinking that it would be okay to access the twelve hours of battery life on his iPad. He went to gym about 20h45 (later than normal) and returned just before the challenge ended at about 22h45, at which time he heated up some food for dinner.

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