

A briefing report for the Department for Business, Energy & Industrial Strategy
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Energy use, flexibility and domestic food practices: implications for policy and intervention

Reshaping the domestic nexus

engaging policy understandings of kitchen practices and how they change



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This report is part of a research project bringing new ideas and evidence to bear on policy concerned with water, energy and food consumption. *Reshaping the Domestic Nexus* is a collaboration between research teams at the Universities of Sheffield and Manchester, in partnership with Defra, BEIS, Food Standards Agency and Waterwise. It is funded by the ESRC *Nexus Network*.

More on the project at nexusathome.wordpress.com

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REPORT SUMMARY

This report introduces a new approach to understanding the role of everyday household practices in domestic resource consumption and addressing the policy challenges this presents. To demonstrate this ‘change points’ approach we focus on one such topic: **tackling energy use in the provision of food at home**. Providing food in the home uses large quantities of energy, with 30-40% of the evening peak in electricity demand in the UK accounted for by food practices. In light of societal concerns over energy, reducing total energy use in domestic food provisioning, or shifting that energy use away from peak electricity demand, are worthwhile objectives.

Existing key approaches [p6] to tackling energy use in home food provisioning have focused on the appliances involved. Regulation, certification and technological development mean contemporary appliances have grown substantially more efficient over recent decades, reducing total energy demand for provision of a given level of service. More recently, smart technologies have had increasing prominence, including refrigeration and dishwashing appliances, as means to shift energy demand from the peak. In addition to appliances, information campaigns and price incentives have been used as more direct means of reshaping what people do and when, to affect energy use in the kitchen as elsewhere.

Here we present a new approach, tracing numerous ‘change points’ that occur in the process of carrying out routine household tasks (e.g. cooking, cleaning, laundry): moments in which energy and other resources end up being used, and waste is produced. In seeking to understand what influences these change points, and hence what successful intervention might entail, we draw on insights from **social practice theory**. This shifts attention from individual attitudes and behaviours to a systematic consideration of the multiple social, cultural and material factors that shape what people routinely do.

Our aim is to better mobilise this established body of academic work for practical use. In particular, we bring together evidence from what we term the **‘home practices’ literature**: recent empirical research applying social practice theory, and related social science approaches, to the study of household sustainability issues. This provides a distinctive but complementary addition to existing responses to domestic energy use, emphasising connections between everyday sequences of activity and wider cultural, political, technological and infrastructural factors.

Crucially, energy use does not just happen because of decisions at the fridge door or in front of the cooker. Rather, actions throughout the stages of food provisioning – including shopping, storage, food preparation, cooking, dealing with leftovers, and clearing up [p9] – are implicated in generating demand for energy. Insights into what shapes what people do at these change points [p12] lead to a range of implications and recommendations for policies and intervention [p17].

Key implications of the report are that policies for intervention should seek to:

1. *Understand household routines and rhythms of everyday life*, ensuring interventions and innovations fit into those rhythms or look to take advantage of moments of change
2. *Think about kitchen design and the use of domestic technologies*, especially how these can complement and help bring about changes in routine practices
3. *Appreciate diversity within and between households*, learning from existing household responses while anticipating any limits to transferability of successful initiatives
4. *Work with shared social norms* as well as individual knowledge and attitudes
5. *Recognise that kitchen practices are shaped by wider systems* – particularly systems of food provisioning (supply chains, retailers, etc.)

THE ISSUE

Providing food in the home uses large quantities of energy. This energy use is problematic in two ways:

1. *Total energy used.* Energy use occurs throughout the food provisioning process, right from the energy embodied in food from primary production, processing or manufacturing, distribution and retail through grocery shopping and transport, to cleaning up after the meal, in heating water or powering an automatic dishwasher and downstream in the management of waste. Food provisioning therefore accounts for a substantial share of energy demands and their consequences for climate change and energy security.
2. *When electricity is used.*
 - a. Energy use peaks in the evening, prompted by the preparation and consumption of many people's main meal, in parallel with a number of other routine household activities. This presents a challenge of ensuring that electricity generation capacity is sufficient during peak times.
 - b. Issues of timing get potentially more complex in light of moves towards renewable energy provision, given the relative unpredictability of supply in general and, more specifically, the mismatch of solar electricity production (during the day) and the evening peak.

Consequently, it is worth looking for opportunities for change in domestic food provisioning which can reduce energy use, and/or enable energy use to be shifted in time. Our focus is on direct energy use in the home, so we do not consider the embodied energy of different foods.

This report draws together ideas and evidence from recent research which shares an understanding of how both energy use and food provisioning are embedded in shared routines and seemingly entrenched patterns of practices. However, this work enables understanding of *change* and of *diversity* in practices. The aim is to understand the potential for *flexibility* in energy use for domestic food provisioning, and hence to draw out implications for intervention which could exploit this flexibility to enable a reduction, or a temporal shifting, of energy use for food provisioning.

OUR APPROACH

This report provides new evidence and ideas for tackling issues of energy use in home kitchens. It does so by presenting a new ‘change points’ approach. As will become clear in this section, the approach develops academic insights from social practice theory – and a broader body of empirical work that we term ‘home practices’ research – for practical application in policy settings. It is based on a synthesis of evidence from extensive existing research into everyday practices around food provisioning, and other aspects of resource consumption in domestic kitchens. An emphasis on ‘change points’ provides a distinctive addition to existing understandings and approaches being applied to domestic energy use.

Focus on practices and change points

Current and recent research highlights that people seldom consciously ‘demand’ resources like energy and water but rather require those resources to do practices – such as cooking or cleaning. This project explores how evidence about these domestic practices can inform policy addressing water, energy and food consumption in homes. This report gathers together relevant ideas and evidence from this field of research in relation to tackling energy use around food preparation in UK home kitchens.

Our approach begins by charting the sequence of very ordinary things that people do in the course of buying, preparing, eating and disposing of food. We characterise the moments that these activities are carried out as **change points**, in that they are moments in which multiple possible courses of action could be pursued, each with different direct or indirect consequences in terms of using up energy and other resources (as well as producing different forms of waste). Change points are therefore potential targets for intervention to change prevailing food practices.

We then draw together existing research evidence on domestic practices, from across the domains of water, energy and food consumption, to explore the factors that shape change points: what makes currently prevalent courses of action more likely than others and how might this plausibly change? This lets us draw out insights on the (potential) flexibility of food provisioning practices in relation to energy use. We do so through a focus upon the practices of food provisioning, with a particular concern for those of meal preparation.

However, this focus on practices means recognising that what goes on with food in the home is inseparable from broader systems. It is important to distinguish between the causes and locations of energy use: there are many important factors *outside* the household – most obviously in broader systems of food supply – which help shape practices *within* it.

Placing energy in the nexus of water, food and energy: The case of food provisioning

The ways that resources like food, water and energy are used are closely linked. Intervening in how one resource is used is likely to impact on the others. Any attempt to change domestic eating practices is likely to affect all three. Recognising how the issue of energy use is situated in this nexus of resource relations – in home kitchens as well as throughout systems of food provision and disposal – is vital. Doing so helps to identify more holistic opportunities for intervention and also to anticipate trade-offs between different courses of action.

Work on the nexus of water, energy and food has typically focused on interdependencies in these resources' supply systems. This project focuses on practices performed in UK households' kitchens to explore the demand for these resources. As exemplified by the domestic kitchen, we argue that the water, energy, food nexus is present as much in people's homes and everyday lives as in sites of production.

The distinctiveness of the approach

Focusing on practices and change points, and paying attention to the interdependency of water, energy and food together allow our understanding of enduring policy problems – such as energy use – to be reframed, with important implications for intervention strategies.

Our approach is distinctive from other models of conceptualising and responding to such issues, in a number of ways:

1. Systematically tracing a sequence of distinct yet interrelated **change points** in the process of food provisioning broadens the view of the direct and indirect causes of energy use, multiplying the possibilities for potential intervention.
2. Starting from the practices that take place at these change points immediately draws attention to connections and overlaps between different policy concerns relating to use of water, energy and food. Intervening in any of these change points is likely to have implications across policy domains and objectives.
3. The approach brings a distinctive understanding of what shapes the activities undertaken at these change points.
 - Conventional behaviour change approaches characteristically seek to provide better information or incentivise particular courses of action in order to allow individuals to make more appropriate decisions.
 - Behavioural insights approaches draw on recent developments in social psychology and behavioural economics, demonstrating that much of what people do on a daily basis is 'automatic', habitual and unthinking, rather than deliberative. They look to change behaviour by either capitalising on these automated responses to stimuli or targeting particular periods of disruption to instil new routine patterns of behaviour.
 - **Social practice approaches** go further, recognising the routinised nature of everyday practice but also looking outside the individual to the multiple social, cultural and material factors that shape what people do. These 'external' influences are continually reproduced in how people carry out everyday practices, but systemic change happens 'if enough people do enough things differently enough' (Watson, 2012: 488).

Thinking in terms of social practices implies a different, but complementary, approach to intervention, compared with those based on behavioural insights. Rather than focusing on small measurable changes to particular tightly defined behaviours, it emphasises connections between small-scale everyday activities and wider cultural, political, technological and infrastructural developments. The key imperative that follows is to think systematically about the different factors that can shape everyday kitchen practices, the interactions and interdependencies between these factors, and how intervening in one type of activity might have knock-on effects elsewhere.

Synthesising evidence

This report – and our ‘change points’ approach – is based on a thorough critical review of the burgeoning body of literature providing insight into domestic practices and their consequences for resource consumption. Several key fields of work are brought together in our review, especially those concerned with the dynamics of social practices (Shove et al, 2012) and household sustainability (Gorman-Murray & Lane, 2012; Gibson et al, 2013). What makes this ‘home practices’ literature distinctive is its shift of attention from purely economic drivers or individual attitudes and behaviours to examining socially, culturally and materially constituted practices. This shift in emphasis informs the development of our ‘change points’ approach.

By emphasising the importance of social norms, meanings, rhythms, routines, materials and technologies, as well as inter-personal relations within the home, contributions to this literature together provide new framings of how resources are consumed and wastes produced as part of accomplishing the practices that make up everyday life.

In addition to the broad-ranging insights from this body of literature on domestic practices and resource consumption, the analysis in this report draws especially on three related applications of the ‘home practices’ perspective. The first body of work considers the temporality of food practices, how their timings have changed historically and how they vary from place to place (Mestdag, 2005; Cheng et al, 2007; Warde et al, 2007; Southerton, 2009; Southerton et al, 2012). The second combines this approach with analysis of domestic energy use to explore the relationship between routine food practices and daily patterns of energy demand (Isaksson and Ellegård, 2015; Anderson, 2016; Durand-Daubin, 2016; Durand-Daubin and Anderson, in press). The third looks in detail at the practices that constitute an evening peak of domestic activity, to better understand how these patterns of activity are shaped and where there might be opportunities for change (Higginson et al, 2014; Powells et al, 2014; Nicholls and Strengers, 2015). These are complemented by a wider literature on the energy consumption associated with different aspects of food provisioning practices.

EXISTING RESPONSES

The approach we develop in this report offers ways to build upon and develop from existing approaches to reshaping energy demand in home kitchens.

Energy efficient appliances

Probably the most progress towards making food practices less energy intensive to date through deliberate intervention has been in introducing and encouraging the uptake of kitchen appliances that use less energy. Fridges, freezers, cookers and dishwashers have been progressively replaced with more energy efficient models. Particular progress has been made with cold storage appliances, with the average energy consumption of new fridges and freezers in 2015 around 40 per cent of what it was in 1990 (BEIS, 2016). There is still potential for future improvement over the coming decade – even without further advancements in energy efficient design – due to the large stock of older appliances to be replaced. It is estimated that it will take until 2030 for all pre-2010 refrigerators in the UK to be replaced with newer models (DECC, 2014). As recently as 2014, while 98 per cent of new fridges sold across the EU were rated A+ or better for efficiency, only a quarter were in the two higher rated categories A++ (21 per cent) or A+++ (4 per cent). Respectively these are thought to use 21 per cent and 41 per cent less electricity than A+ rated

models (Michel et al, 2015). Given that replacement occurs on average every 12.5 years (DECC, 2014), it will take time for these savings to be realised.

Energy efficiency information, certification and regulation

Technological approaches to reducing energy consumption in the kitchen are only likely to be successful if the technologies are not only taken into use, but are also used in energy efficient ways in the course of daily life. Differences in the way kitchen appliances are used can impact on the energy required for storage, cooking and cleaning. For example, waiting for food to cool before refrigerating, using lids on pots and pans, or only using the dishwasher when there is enough for a full load, are all associated with reductions in energy use. Advice on these and other measures is often communicated online or in print by NGOs (Energy Saving Trust, n.d.), consumer organisations (Which?, n.d.), and energy companies (OVO Energy, n.d.). While there has been little evaluation of such initiatives, information campaigns more generally have tended to be limited in their success, in isolation at least, at producing sustained changes in routine activities.

Another common strategy to influence consumer decision making is to provide information demonstrating the advantages of one choice over another. Alongside the development of more efficient appliances, households have been encouraged to invest in them through provision of standardised information on each model's expected energy consumption (POST, 2017). Energy labels have been mandatory for many appliances since the early 1990s. In general, practice-oriented research has highlighted the ineffectiveness of information campaigns as a means to bring about change in routine everyday practices. However, the 'occasional' purchase of durable domestic appliances arguably represents a different type of activity, more amenable to deliberation (Lavelle et al, 2015). Evidence from market research suggests that energy efficiency is a key factor reported as influencing consumer choice of new refrigeration appliances (Mintel, cited in DECC, 2014). However, the trend towards lower energy use appears to have been accelerated by EU regulations, most recently through the introduction of Minimum Energy Performance Standards (MEPS) for certain appliances (Michel et al, 2015). From 2010 all new fridges and freezers introduced to the market were required to have an energy efficiency rating of A or higher; since 2012 the minimum standard has been increased to A+.

This approach to developing more efficient appliances effectively means replacing like for like: from a user's perspective there is little difference between an A+ rated fridge and a comparable A+++ rated fridge, other than the prices of purchase and of running. However, the efficiency rating of an appliance is not the only factor impacting on the amount of energy it will use. Efficiency ratings are relative to the class of product so a very large American style fridge can have a higher rating than a small fridge despite using much more energy in use. Critiques of technological efficiency as a path to reducing total demand include well recognised 'rebound effects' of efficiency in increasing demand for services; but also more fundamental claims that the pursuit of efficiency, in perpetuating and extending expectations of service and in promising to provide a technological solution, can be help to produce the problems of high energy demand (Shove 2017).

Smart appliances

Ambitions for reshaping domestic energy demand – particularly in relation to shifting the timing of energy use to reduce total peak electricity consumption – increasingly include hopes for the contribution of 'smart' technologies: appliances that responsively adjust their energy use in line with information about wider demand on the grid. In relation to food practices, this includes fridges and freezers that are able to temporarily disable their cooling function during periods of peak demand (provided that the temperature remains below a pre-determined level), shifting their energy use to other times.

Evidence on the likely uptake of smart appliances, which to date mostly consists of survey data on their perceived advantages and disadvantages, suggests ambivalence among consumers. The potential to save energy and money with little effort required is widely seen as a worthwhile benefit (Wilson et al, 2017). This is especially the case for appliances (such as fridges and freezers) where no discernible disruption to existing kitchen practices is expected (Paetz et al, 2012).

However, respondents also expressed a number of concerns: fear about the technology failing, with appliances being switched on or off at inappropriate times; worries about loss of control or risks around data security; and lack of trust in energy companies and their motivations for controlling energy use (Balta-Ozkan et al, 2013). There is also some evidence of social differentiation in these perceptions – with younger people seemingly more optimistic about smart technologies and less likely to express concerns (Stragier et al, 2013) – as well as international variation (Balta-Ozkan et al, 2014). Research has tended to focus on smart appliances in general, rather than specifically on cold storage.

Financial incentives to time shift practices

Alongside technological innovations, another approach to encouraging households to shift the timing of their energy-consuming practices is with differential pricing structures, known as time-of-use (ToU) tariffs. These charge more for electricity use within peak demand periods and thus incentivise moving such practices to other times. Pilots of ToU tariffs have tended to demonstrate positive effects on both moving electricity use out of the evening peak period and reducing overall levels of consumption (Chan et al, 2014). However, some practices appear more resistant to shifting than others. Evidence suggests that when people eat is among the least flexible of all; on the other hand, the introduction of a ToU tariff appears to have an impact on dish washing (Powells et al, 2014; Nicholls and Strengers, 2015). This difference reflects both the complex shared societal meanings and conventions that underpin eating and the evening meal, and the fact that eating together requires the coordination of multiple people's availability, each shaped by the wider organisation of work, education and leisure. Neither of these factors affect dish washing to the same extent.

Economic incentives and disincentives are not necessarily enough to shift practices. Current prevailing practices are a result of careful coordination between competing needs and priorities, involving different household members (especially in families with children). In the moment of juggling multiple priorities, concerns about energy bills tend to be secondary (Nicholls and Strengers, 2015). Interestingly, the influence of the economic rationale for ToU tariffs again seems to differ between practices. For cooking and eating, the strength of conventions around the normality of the evening meal seem to be more keenly felt than those around saving money. For dish washing, however, which is less strongly ordered by such expectations and anxieties, conventional understandings about the importance of using resources wisely are more prominent, making the changing of timing of dish washing seem 'obvious and uncontroversial' (Powells et al, 2014: 49).

It is clear that approaches of technological development, information provision and financial incentives do have some effect. However, more efficient or smart technologies, or messages from information campaigns, have to be assimilated to householders' kitchens and everyday lives. Increasingly, processes of innovation and communication are developed with detailed understanding of those lives. Information campaigns increasingly engage contemporary behavioural science approaches to inform messaging. The approach we articulate below builds on this engagement, adding understanding of the broader range of shared social, cultural and material factors shaping what people do to inform future interventions. It is worth considering other potential innovations, and sites of intervention – as yet less well developed – that might help to further reduce energy consumption through changes to food practices themselves.

ENERGY USE AND DOMESTIC FOOD PRACTICES

This section of the report articulates what is distinctive about a 'change points' approach to home energy use in relation to food provisioning.

Energy is used in the course of carrying out routine practices. In order to understand energy use and how to intervene in it we need to better understand food practices, how they are shaped and how they change.

How food practices constitute demand for energy

In the course of acquiring, using and disposing of food, households engage in a series of different activities: shopping, storage and managing stock, food preparation, eating, dealing with leftovers, and cleaning up. Actions and decisions at each of these moments can have consequences for overall energy use as well as consumption of other resources. Each stage can be seen as a key **change point**, a moment where numerous possible courses of action could plausibly be pursued. Different courses of action have different implications for what energy is used and when, as well as for other policy concerns relating to food (e.g. healthy eating, waste and food safety) and the conservation of water.

Shopping

Many householders use energy in travelling to and from the shops to collect their groceries. The institution of the big weekly shopping trip – in a mutually reinforcing relationship with the prevalence of out-of-town supermarkets and increased car ownership – has helped make car travel the predominant mode for food shopping in the UK (Watson, 2012). 95 per cent of households use large supermarkets and 86 per cent use them for their 'main' shop, not including online shopping for home delivery (FSA, 2017). In England 66 per cent of shopping trips (food and non-food) are carried out by private car (DfT, 2016). Transport is likely to impact more directly on home energy use, and could potentially contribute to periods of peak demand, if uptake of electric vehicles becomes more widespread (Palmer and Terry, 2014).

Walking or cycling to more local shops would mean less energy used in transport, at least directly by households, although some of the benefit might be offset by the higher energy intensity associated with smaller retail outlets (Hoolohan et al, 2016). Energy savings may also arise from the growth of online food shopping, due to the overall reduction in vehicle journeys that this implies (Siikavirta et al, 2002; Cairns, 2005; Wygonik and Goodchild, 2012). However, these reductions depend on the number of households covered by a delivery, the distances that would otherwise be travelled by customers to do their shopping (Coley et al, 2009) and the volume and type of goods purchased; well-used public transport might offer similar benefits (Edwards et al, 2010).

Less direct impacts of shopping on subsequent energy consumption include the type and quantity of food that is bought, with implications for how it is stored and cooked. These impacts are considered below.



STAGES IN THE
FLOW OF FOOD

Storage

Refrigerators and freezers account for around 15 per cent of UK total electricity consumption by domestic appliances, including lighting but excluding electric heating (BEIS, 2016). The amount of energy used varies depending on both the characteristics of the appliance and how it is used. Like other domestic appliances, fridges and freezers are rated by energy efficiency on a scale of A+++ to G, although since 2012 all new cold storage appliances have to be rated A+ or higher. All other things being equal, a higher rated appliance will use less energy. Size is also important, with smaller fridges and freezers consuming less. Since the efficiency rating is calculated relative to the size of the appliance, a small A rated fridge may use less energy than a large A+ rated fridge (Energy Saving Trust, n.d.). As will be discussed later, the size of cold appliances (and hence the energy they use) is both a product of, and helps to sustain, current prevailing approaches to buying, preparing and eating food, as well as the way kitchens are designed (Shove and Southerton, 2000).

Alongside the efficiency ratings under test conditions, the energy performance of cold storage appliances is also highly sensitive to how they are used and the circumstances they are used in. Factors including the ambient temperature in the room, the chosen internal thermostat setting, the temperature of items placed in the appliance and the opening of doors all impact on energy consumption (Geppert and Stamminger, 2013). Users are advised to locate fridges and freezers away from other heat sources, keep them set to recommended temperatures, allow hot food to cool before placing inside, and keep door opening to a minimum (Energy Saving Trust, n.d.).

The energy use of cold storage appliances remains at a similar level throughout the day (Palmer and Terry, 2014), reflecting their continuous operation. However, there is some evidence of a contribution to evening peak demand – an increase in energy consumption during times of meal preparation – due to the more frequent opening of doors, allowing warm air inside (EA Technology, 2011).

Food preparation and cooking

Preparing food often involves washing and/or peeling ingredients, especially vegetables. Choosing between washing and peeling can involve a trade-off between food waste and using other resources. On the one hand, peeling is likely to produce more solid waste and may have nutritional disadvantages. On the other hand, washing requires water and, if warm water is used, then energy is also consumed in heating.

Electrical cooking appliances, including ovens, hobs, microwaves and kettles, are responsible for 17 per cent of UK total electricity consumption by domestic appliances, including lighting but excluding electric heating. Cooking also accounts for 2 per cent of natural gas consumption in the home, with the vast majority used for space heating and water heating (BEIS, 2016). Furthermore, cooking tends to be relatively synchronised across society and is a key contributor to the evening peak in energy demand (Palmer and Terry, 2014; Durand-Daubin, 2016; Durand-Daubin and Anderson, in press; Southerton et al, 2012).

As with cold storage, the energy required in cooking varies a great deal according to the heat source, appliance efficiency and especially the specifics of the cooking techniques used (Hoolohan et al, 2016). Although definitive comparisons are difficult based on the number of factors involved, electrical appliances generally have better end-use efficiency than gas, but gas is currently more efficient in production and transfer, so has greater overall efficiency. This may change with increased use of renewable sources in electricity generation. Surface cooking (i.e. on a hob) typically uses less energy than an oven. Microwave cooking tends to use less energy than a hob, although this depends on the quantity (microwaves are more suited to smaller portions) and composition of the food being heated. Purpose-

specific appliances, including coffee percolators, electric rice cookers and egg cookers often use less energy in heating, although raise questions about the embedded energy of having multiple appliances that are relatively rarely used. While less well researched, there is also evidence that pressure cookers use less energy than conventional stove top cooking and that slow cookers are more efficient than ovens (Hager and Morawicki, 2013).

The way people cook is especially important in its impact on the amount of energy used. Cooking in greater quantities is more efficient. Batch cooking may therefore be beneficial to overall energy use, but only if additional portions end up being eaten, pointing to the significance of measures to reduce food waste. Other energy saving measures include ensuring lids are used on pots and pans when cooking on a hob and regulating temperature during cooking, for example turning down to a simmer when water has boiled (Oberascher et al, 2011; Energy Saving Trust, n.d.).

The variability of energy use in cooking also highlights the importance of choices, conventions and routines in shopping and meal planning: different ingredients have their own particular ways of being cooked, reflecting both their material properties and cultural conventions.

Eating

In itself the act of eating has limited immediate effects on energy use. Eating can require space heating, cooling and lighting but as these demands are close to demands of other practices at home, flexibility in eating and its timing would have little net effect. However, eating is the fundamental orchestrating moment in the chains of action covered in the other stages. Fixed meal times – a consequence of metabolic as well as social processes of timing – help account for difficulties in shifting when energy is used in cooking. Culturally embedded norms and expectations of what constitutes a meal shape both shopping and the particular processes of cooking. Meanwhile the challenges of coordinating a guaranteed sufficiency of food for everyone around the table can be one cause of food waste generation, representing the wasting of energy invested in food preparation in the home as well as the embodied energy and other resources going into the food's production and distribution. Changes to eating itself could meaningfully be a target for interventions aimed at energy demand reduction and flexibility. However, abundant research demonstrates how deeply entrenched are patterns of eating how those patterns are intractable to purposive attempts to change them.

Cleaning up

Finally, substantial quantities of both energy and water are used in cleaning up after a meal. Like other kitchen appliances, the design of new dishwashers has become increasingly energy and water efficient in recent years. Once again, however, efficient performance is dependent on how the appliance is used. Pre-rinsing dishes, running the dishwasher when not fully loaded, and choosing higher temperature settings are all associated with greater water and/or energy consumption. Underfilling dishwashers and using high temperature programmes appear to be particularly prevalent in the UK, whereas pre-treatment is much less common (Richter, 2011).

In general, using an automated dishwasher saves both water and energy compared with hand washing of dishes (Berkholz et al, 2010). Despite this, adopting 'best practice' in hand washing dishes has been shown to reduce water and energy use. Advice includes reducing the amount of water in the washing up bowl by half, rinsing in another bowl instead of under running water, and soaking more heavily soiled dishes in the bottom of the bowl while washing the rest (Fuss et al, 2011).

These food-related activities necessarily have to happen in coordination with each other. Appreciating the relations between different food provisioning practices is fundamental to recognising many aspects

of flexibility discussed below. Practices directly related to food provisioning also relate to a range of other household activities such as watching television, taking a bath, heating a room, or doing the laundry. The various demands on household schedules are instructive for understanding the evening peak of electricity demand.

What shapes what happens at change points?

This section presents understanding of what shapes food practices and their timings. For instance it asks why particular patterns of practices (of food storage, food preparation, or eating, for example) tend to be more prevalent among some groups than others, why they can be slow to change, and where attempts to intervene might find some traction.

The key message here is that although energy is used in specific moments of domestic food provisioning, the causes (and therefore potential points of intervention) may well be elsewhere: in the complexities of daily routines, in relationships and the division of labour within the home, in social norms and cultural conventions, in the configuration of kitchens and the material properties of food, in the systems of provision and of disposal.

Invisible infrastructure and unconscious routines

For the most part, households consume resources and create demand for services in the course of carrying out mundane everyday practices. These resources – and the infrastructures that provide them – are instrumental in activities such as cooking, cleaning and doing the laundry, yet they go largely unnoticed. The invisibility of energy services reflects their consistency and reliability: they tend to come into focus only when they are interrupted in some way, for example by a power cut. As such, the impacts of appealing to people's attitudes about energy in trying to change how and when they cook and eat are likely to be limited.

More generally, much of what people do on a day-to-day basis is a matter of routine. What are often understood as rational consumer decisions – e.g. what people buy and cook – tend to follow stable patterns and in normal circumstances involve little conscious reflection. For many households, especially families with young children, the early evening presents a period of considerable pressure, a short window of opportunity for carrying out numerous different caring and provisioning tasks. Well-rehearsed routines are an essential part of coping with this stress and are also seen by parents as providing children with highly valued stability and security. Campaigns that aim to encourage behaviour change through providing information and advice aimed at changing these routines may only have limited success, especially if this is the only method pursued. However engaged someone is by the campaign, translating their new knowledge into practical action will always be difficult.

Daily rhythms

In the context of busy lives, often with competing employment and caring responsibilities, householders find ways of managing domestic life that *work* for them and minimise disruption elsewhere. The activities that people routinely carry out in the home cannot be considered in isolation from what they do elsewhere and at other times. Grocery shopping, for instance, is particularly routinized, as exemplified by 'the big shop' that takes place at fixed intervals. Food preparation, cooking and eating follow similarly routine patterns. Many have a repertoire of 'tried and tested' meals that suit the needs and tastes of household members and fit well into the normal rhythms of daily life.

Unsurprisingly, these rhythms also shape when food practices occur. For many people, energy-consuming domestic practices such as cooking, laundry and watching TV happen in the evening partly because that is when they are at home, with other times of the day allocated to work, school, social commitments or sleep. Conversely, attempts to shift activities outside of the evening peak may impact on what they already do at other times. Eating a main meal in the day time instead of the evening, for example, might require changes to the structure of the working day, when breaks are taken and for how long.

Working hours, the school day and the regular timings of social and leisure commitments are often outside the control of individuals. The schedules and sequencing of people's days – and by extension the activities that need to fit into the evening – are to a large extent shaped by these social institutions.

Managing multiple priorities

Preparing and eating food often happens alongside a wide range of other activities. The process of cooking an evening meal, for example, might be interspersed with other tasks such as feeding pets, emptying bins, washing up, answering the phone or helping children with homework. The particular ways that activities are coordinated – whether simultaneously or in sequence – can help with managing this especially busy period. For example, parents might take advantage of TV and other media as a means to occupy children's attention while preparing a meal, before using the time the children are eating to run a bath.

Evidence suggests that this impulse to fit multiple activities into a short period of time – often coinciding with the early evening peak in electricity demand – may be a response to feeling time pressured and the need to protect 'downtime' or 'quality time' with others, highly valued for both personal wellbeing and maintenance of interpersonal relationships. Concentrating numerous tasks into 'hot spots' of activity in turn serves to free up corresponding 'cold spots' for rest and spending time with loved ones.

If any changes in how people carry out food provisioning are to take hold, they need to represent a good fit with the wider rhythms of daily life. Eating different food, using different cooking methods, adding further stages to cleaning up processes, or changing the timings of these practices may threaten to disrupt the careful balance of competing priorities, even while they may offer means to resolve competing demands.

Collective coordination within the household

Often, households are not singular units, but are comprised of relationships between different people, sometimes with differing needs, priorities, routines and roles. Repertoires of meals are often constrained by the frequently narrow range of foods that some family members are willing to eat, as well as by the complex scheduling of many family lives. The requirement to balance the conflicting needs of different household members represents a potential barrier to changing what is bought, cooked and eaten.

Aspects of food provisioning – especially the evening meal – commonly involve some degree of coordination between household members, even if this does not take the shape of the 'traditional' family meal. This can mean cooking and eating is scheduled to accommodate all household members' varying daily rhythms, potentially squeezing the available time for these activities into a narrower window still. Dish washing and laundry, by comparison, are often less communal activities than eating, meaning that they do not necessarily require the presence of multiple household members and hence can be more amenable to being shifted outside of the early evening peak period. However, another consideration is that many parents encourage children to engage in household chores, considered to be an important part of their development. Again, this means that tasks such as dish washing might need to be performed while children are home but before bedtime.

Responsibilities for negotiating competing demands within and outside the home fall disproportionately on women. Where these responsibilities are heavily concentrated in one household member's hands, this is likely to exacerbate the aforementioned pressures of managing multiple priorities and further limit the likelihood of disrupting well-rehearsed routines.

Social norms and cultural conventions

How people go about and make sense of their domestic activities is not merely a matter of personal preferences or individual habits. Instead, kitchen practices are shaped by shared understandings – and associated desires and anxieties – around food. These conventions circulate and are reproduced within a given society or amongst particular subgroups of the population. They change over time and vary geographically and culturally, but they can be difficult to intervene in, at least in predictable and controllable ways.

The idea that it is normal to eat a cooked meal in the evening is widespread in the UK. Similarly, imperatives to eat collectively as a family and to eat 'proper food' are prevalent and influential. In today's context in the UK, 'proper food' tends to mean serving a variety of *home cooked meals*, using *fresh* and *healthy* ingredients, prepared *from scratch* and eaten *together*. Conventions around acceptable bed times for children are also important in shaping the timing of evening activities. By contrast, other practices such as dish washing appear to be less strongly shaped by shared meanings and so might be less resistant to change and potentially more flexible in when and how they are performed.

Shared understandings are difficult to shift; however, sustained campaigning on multiple fronts – including the influence of high profile intermediaries (e.g. celebrity chefs) – could yield results.

Materials and technologies

The material properties of the kitchen, including the technologies used for storing, preparing and cooking food also play an instrumental role in shaping kitchen practices. At the simplest level, food practices can be made less energy intensive by the replacement of existing appliances – e.g. fridges, freezers and ovens – with more efficient models or in some cases with smaller models more suited to the needs of the household. The layout and standardised units and design of the conventional fitted kitchen are also important in ensuring the continued popularity of existing appliances and potentially in encouraging or discouraging the normalisation of new or different technologies.

Knowledge, know-how and competence

Furthermore, the adoption of different technologies for food storage and preparation is likely to require new culinary repertoires and procedures for household management. Smaller fridges and freezers, for example, might require different strategies for meal planning and restocking the kitchen more responsively than the prevailing model of the 'big shop'. Moving towards lower energy cooking appliances, such as microwaves or slow cookers, not only implies an impact on the temporal coordination of the day, but may also require different recipes and acquiring new competences in preparation of ingredients and appliance operation.

Systems of provision

The way food is sold ultimately impacts on the types of meals that are prepared and the energy used in doing so. The variety of food available to buy, and the quantities or sizes it comes in, can help dictate what people cook and eat. If only large quantities are available then it becomes easier for food that has

been bought to become surplus to requirements, demanding more fridge or freezer space and potentially going to waste.

Questions of where and when energy is used in the preparation of food is also significant to energy use in home kitchens. Reheating a ready meal in a microwave clearly takes a fraction of the energy and water that would be used to prepare the same meal from scratch in the same kitchen. Whether at a societal level this approach to getting a meal on the table represents an overall reduction in total energy demand, or a useful shifting of when electricity is being demanded, depends on a wide range of factors in relation to production, packaging, cold storage, distribution, retail and shopping travel through to packaging and demands of cold storage in the home. Nevertheless, there are clear grounds for looking for energy use reduction, or changing time use, through different configurations of systems of provision, including those which could enable food preparation to happen at a collective level.

Understanding variation and change

Practices are not uniform. They vary in how they are performed in different places and by different groups of people, and change over time. Identifying variation implies that practices are contingent on particular contextual factors; existing arrangements are thus provisional and subject to change.

Variation between places

International research reveals important differences between countries. While meal times in Britain show some degree of synchronisation, as discussed above, they are less synchronised than in some other European countries. In France, for instance, 60 per cent of the population eats lunch in the half hour between 12:30pm and 1pm, and 42 per cent eats an evening meal between 8pm and 8:30pm. In Britain, by contrast, there is never more than 23 per cent eating at any one time (Durand-Daubin and Anderson, in press). Similar comparisons can be made between Spain and Britain (Southerton et al, 2012). On the other hand, in Finland eating is spread much more evenly through the day (Shove, 2009).

Evening meals tend to be eaten earlier in Britain than in either France or Spain (Durand-Daubin and Anderson, in press; Southerton et al, 2012). In France, as in Britain, cooking appears to coincide with the evening peak in electricity demand. Furthermore, regional analysis within France suggests both variation in when people cook and eat in different parts of the country and a significant correlation between these timings and when peak demand occurs in each place: in regions where cooking peaks earlier, so does demand for electricity (Durand-Daubin, 2016).

Variation between households

In addition to national and regional differences, food practices also differ at a more local level. It is important to recognise diversity between households: they are composed in different ways, with different combinations of people at different life stages, and with different characteristics and preferences. Acknowledging variation between households is important for three reasons:

First, as noted above, variation provides insight into the different possible ways of performing a given practice; wider change can emerge from policies that encourage the development of one (more desirable) variety over another. Differences in the timing and location of cooking and eating can be observed between age groups, income groups and those with different levels of education (Cheng et al, 2007; Durand-Daubin and Anderson, in press).

Second, the amount of energy used in food practices varies between household types, suggesting targeted and tailored intervention to be important. For example, single person households use

approximately the same amount of energy in cooking as do three- and four-person households – considerably more energy per person – reflecting the greater efficiency of cooking in bulk (Energy Saving Trust, 2012).

Third, responses to energy use need to be sensitive to these different circumstances: interventions that have traction in one household type might not work in others.

Change over time

With a little historical perspective, it is clear that neither contemporary energy intensive forms of food provisioning nor currently prevalent timings of cooking and eating are inevitable or fixed. They have changed across multiple dimensions in the past and they will change again, albeit not in easily predictable or controllable directions. Some examples of profound change over time include:

Changes to when the main meal happens

In Britain, the proportion of people reporting eating lunch (as a primary activity) decreased dramatically between 1974 and 2005 (Durand-Daubin and Anderson, in press). Taking a longer view, comparison of diaries from 1937 with 2000 shows that in the 1930s lunch was commonly the main meal of the day, with only lighter meals taken later in the day; by contrast, the evening meal typically constituted the main meal of the day in 2000 (Southerton, 2009).

Meals themselves change in timing. Between 1974 and 2005 the peak time of day for eating the evening meal shifted to around an hour later (Durand-Daubin and Anderson, in press). Between 1975 and 2000 the overall amount of time spent cooking and eating decreased, but there was an increase in time spent eating out (Warde et al, 2007).

Changes to foods, technologies and systems of supply

Recent decades have seen radical changes in the foods consumed in the UK, with culturally entrenched staples of mid-20th century culinary culture displaced. How that food ends up as a meal has also changed and diversified, such as the rise of convenience foods and ready meals, in concert with changes already discussed including uptake of freezers and microwaves as well as reconfiguration of food supply systems. Some of these changes have the potential to reduce demand for energy in home food preparation, and potentially to reduce overall demand for food provision, including through the commercial collectivisation for food preparation through ready meals. Increasing reliance on ready meals and takeaway food for some people, at least in certain stages of life, have led to suggestions that increasingly homes could be provided without a fully functional kitchen.

Changes to shopping

There is emerging evidence that routine ways of shopping in the UK are currently in the process of shifting, from the weekly big supermarket shop towards both increasing home delivery, and towards buying little and often at 'convenience stores'. These emerging patterns might represent a site of traction for encouraging further changes in how people go about household provisioning, including popularisation of smaller fridges and freezers.

These and other dimensions of change – such as indications of gradual change in deeply gendered division of labour around food provisioning in the UK – demonstrate first that relatively fundamental change does happen, and there is no reason to expect processes of change to stop. Some such changes clearly have the potential to reduce energy use for food provisioning in the home, and perhaps also to reduce energy over the entire system of provision, from processing to disposal. This is encouraging for hopes of reducing energy demand for food preparation. However, processes of change such as those discussed here are clearly multi-dimensional and deeply challenging to seek to steer by governing interventions.

IMPLICATIONS FOR INTERVENTIONS TO RESHAPE HOME ENERGY USE

As discussed in the *Existing Responses* section, there are several existing approaches to the challenge of reshaping domestic energy use. Some of these follow a *service provision* model, requiring no real change in what householders do. Examples include encouraging and regulating the provision of more efficient appliances. Other approaches appeal to *consumer decision making* such as through information campaigns that draw attention to the issue and/or suggest tips for changing behaviours in response. Specific initiatives can include a mixture of the two above models – service provision and targeting consumer decision making – for example promoting the purchase of more energy efficient appliances through labelling regimes.

On the basis of the evidence we present above, we argue that initiatives like these could be further advanced by an approach rooted in understandings of everyday activities in a given household as enactments of wider social practices. The key imperative that follows is to **think systematically** about the different factors that can shape everyday kitchen practices, the interactions and interdependencies between these factors, and how intervening in one type of activity might have knock-on effects elsewhere. Traditional approaches often focus on a particular policy problem, assuming that broader contexts stay largely the same, whereas the ‘change points’ approach assumes that all aspects are potentially able to change.

From the synthesis of work above, we can identify a number of recommendations. Below these are differentiated between those that focus on the everyday lives of householders and how they negotiate competing priorities; and those that entail technological change and the associated development of householders’ knowledge and competences.

Changing practices in the kitchen directly

A focus on practices taking place at key change points enables a holistic understanding of the situations that lead to energy demand, and appreciation of the range of factors influencing those situations. In so doing, it shows different potential targets for intervention, as well as a fuller basis for anticipating challenges and trade-offs.

Alongside disrupting and intervening in individual routines, which some of the more developed behaviour change programmes in this field already seek to do, there is a need to intervene in the multiple other factors that shape what people do in their kitchens. This means **distinguishing between the cause and location of energy use**, recognising the important factors outside the household which help shape the use of energy within it.

Key implications for intervention that follow from the discussion above include:

- **Understanding household routines and rhythms of everyday life**, paying attention to the ways in which people achieve balance between competing priorities. Interventions need to fit into those rhythms, but might also exploit moments of change. For example, it is clear that shifting shared social patterns of work, school and home life are implicated in the focusing of cooking activity and therefore energy use during the evening peak period. Emerging changes – flexible working, buying less food more frequently, ordering online for home delivery – may provide opportunities to innovate, promote and normalise new patterns of food provisioning.
- **Appreciating diversity** within and between households can enable:
 - Anticipation of the challenges of transplanting initiatives that have been successful in one situation to another.

- Identification of specific opportunities for targeted intervention, for example reflecting the particular cooking practices and conventions within subgroups of the population.
- Recognition of, and sensitivity to, the dynamics within households and the disproportionate burden on particular household members (especially female partners and mothers). There are risks that the pursuit of good environmental outcomes may inadvertently exacerbate existing inequalities such as gendered divisions of labour.
- **Working with shared social norms** as well as individual knowledge and attitudes:
 - Cultural conventions around 'proper' food – being fresh, varied and prepared from scratch – help shape energy use in home kitchens. Working with retailers to promote good quality, healthy versions of convenience food, including mixed packs of pre-prepared vegetables, sauces and even well-designed ready meals, could reduce home energy use (although any trade-offs in terms of processing, packaging and distribution would clearly need to be considered).

Changing social norms? Relocating the main meal of the day in Finland

Historical precedents of change and contemporary variation in practices both suggest that the temporal structure of food practices is possible to shift. For example, in the early twentieth century it was much more common for the main meal to be eaten in the middle of the day, and it is still more common in some other European countries than it is in the UK. It is plausible, then, that this trend could be reversible. This would be likely to require major changes in a number of areas, for example: provision of affordable meals at workplaces; changes to working schedules to accommodate a lengthier and more structured break; and changing societal understandings around the importance of the shared meal occasion. Experience in Finland highlights the success of subsidised workplace canteens (Raulio et al, 2005), something with potential to reduce total energy use through collectivisation of provision, as well as moving food preparation away from the evening peak. While the context differs – in Finland eating hot lunches is very common (Gronow and Jääskeläinen, 2001) – and there is no guarantee that the model would be transferrable to the UK, this provides a working example of an approach which merits further investigation.

Changing technologies to shift kitchen practices

Technological innovations, and interventions to promote their uptake, can be more effective in reshaping energy use when their broader effects on what people do in kitchens are considered.

Smaller appliances

The size of an appliance is an important factor in its energy use. Smaller fridges, freezers and ovens use less energy than their larger counterparts within the same energy rating bracket. Between 2004 and 2011, for example, the average energy consumption of A+ rated fridges increased by 21 per cent, reflecting a corresponding increase in average volume (Michel et al, 2015). In fact, small appliances can sometimes use less energy than a larger appliance with a better energy efficiency rating (Energy Saving Trust, n.d.).

There is little research evidence directly on attempts to introduce smaller kitchen appliances, but helpful insights can be taken from what is known about the factors that shape existing domestic food practices, as discussed earlier. This suggests that encouraging the adoption of smaller appliances is likely to be challenging, but it also highlights the multiple fronts on which such an intervention might best focus.

For example, domestic ovens are designed to be big enough to accommodate cooking for special occasions – such as catering for Christmas dinner – leaving them oversized for many households' day-to-day use (Morley and Shove, 2014). Here oven design, and hence energy use, is inseparable from cultural conventions about what constitutes a celebratory family meal, in this case a large roast dinner.

The dimensions of fridges and freezers, meanwhile, are closely bound up with prevailing retail and shopping practices, where householders stock up on food during a regular 'big shop' at the supermarket. There is emerging evidence, though, of tentative shifts in these patterns, towards both home delivery and buying 'little and often' at convenience stores. This could represent a site of traction for encouraging further changes in how people go about household provisioning and, in turn, the cold storage space required in the home.

Finally, the design of kitchen appliances is also in part determined by the size and layout of commercially available kitchens and especially the composition of fitted and integrated kitchens (Shove and Southerton, 2000). The adoption of smaller appliances would be further encouraged by changes in kitchen design that straightforwardly accommodate them. In summary, then, promoting smaller appliances is likely to require working closely with a broad range of partners, including supermarkets, appliance manufacturers and retailers, interior designers and suppliers of fitted kitchens.

Time shifting appliances

In addition to reducing the amount of energy used in food practices, technologies have a potential role to play in changing when and where energy is used, helping move this out of the evening peak period. They do this chiefly by decoupling the energy consuming tasks carried out by the appliance from the human input required. The clearest example in relation to food practices is the inclusion of a timer on a dishwasher so it can be set in advance to run overnight. Evidence from trials of time-of-use tariffs (see above) suggests that householders find it relatively straightforward to make this adjustment, compared with changing other aspects of their daily routine (Powells et al, 2014). Smart appliances offer to automate this shifting of energy use. It is possible that the timing of cooking be shifted in a similar way, without requiring a change in when people eat, by using a slow cooker (Palmer et al, 2014) or smart oven. However, this is likely to require greater adjustment both to the timing of when cooking activity happens and to routines of what gets eaten, which may pose a challenge to being widely adopted. In particular, it might mean having to develop new repertoires of 'go-to' meals, a possible source of anxiety in some households – especially those with children – where there is a limited set of recipes that all household members are willing to eat.

Two other major precedents for time shifting appliances are the freezer and microwave, especially working in combination (Shove and Southerton, 2000). Together they allow food prepared at one point in time to be eaten at another. In the case of shop-bought convenience food, such as ready meals, they also shift the *location* of some of the energy used in food preparation. Like all such innovative appliances, when first appropriated to home use freezers and microwaves impose demands on user competence as established routines are disrupted, new controls and reasons to control need to be learned. This is made most evident through formal efforts to enable new technologies to be normalised to practice, such as cookery books specific to pressure cookers or microwave ovens. Efforts to introduce and encourage the use of programmable and smart appliances should not exist in isolation from development of the

appropriate corresponding products (foodstuffs, crockery and utensils) and sharing of the knowledge and skills required to smooth their adoption into real life food provisioning practices.

Alternative heat sources

Future opportunities for reducing the environmental impact of food provision might come from the substitution of existing sources of heat for cooking. Anticipation of how readily new sources of heating in cooking might be assimilated to food provisioning practice can be informed by studies into existing and past innovations in heat sources.

Current efforts to introduce new means of cooking in locations in the global south can demonstrate the challenge of new heat sources being accepted as part of existing routines and norms. For example, recent research in Nepal explored why rice cookers, introduced following the provision of electricity in rural communities, were often left idle or repurposed as containers (Cameron, 2017). Electric rice cookers promised to displace cooking of rice on wood fires and stoves, which cause both indoor air pollution and much labour in the collection and processing of wood fuel. Research revealed how the cooking of rice on wood fires is embedded in everyday life, from the details of taste of the rice through to gendered divisions of labour in the household. Introduction of other cooking technologies to displace wood fired cooking in other locations can find similar unanticipated cultural resistance.

New sources of cooking in the global north similarly have to be assimilated to existing patterns of practice. The implications of this are dependent on the type of innovation:

1. Substitution of fuel
Some means for introducing new sources of heat might make no real difference to the practices of cooking. For example, uptake of locally produced biogas could substitute mains natural gas smoothly in the kitchen (while of course implying a range of changes and disruptions in the system of supply of biogas).
2. Changing how and when heat is delivered
As discussed above, a number of technologies have enabled shifting of different aspects of food preparation, whether in the daily routines of the household (such as the slow cooker), or across systems of food supply (such as the microwave). New technologies, such as smart cookers, will face related opportunities and challenges to reconfigure practices in a way which make meaningful differences.
3. New means of heating food
While now normalised, the new means of heating food that enables the microwave oven to reconfigure practice was a very radical innovation. Heating food with microwave rather than heat energy was a fundamental departure, and one which required people to learn new competencies (in timing, use of controls) and rules (such as around the novel ways plastics or metals could or could not be used). Disruption of norms and expectations of cooking, together with anxieties over this new and highly technological way of heating food, were part of the contestation of the microwave as it became part of home kitchens. Any future possibilities for new means of heating food is likely to face similar challenges to being appropriated to practice.

Collaboration and locating responses in the Nexus

Designing and implementing interventions that consider multiple infrastructural and resource implications requires collaborative working across policy domains. For example, as already observed, energy savings through the adoption of smaller appliances are likely to require concerted, coordinated action involving not only appliance manufacturers, but also kitchen designers, food retailers and cultural intermediaries responsible for influencing shared understandings around normal patterns of shopping and cooking. The same is likely to be true for adopting alternative cooking technologies.

Here we focus on one further example of the potential benefits of cross-sector collaboration – reducing food waste – pointing to the potential synergies between different policy concerns. For further discussion and analysis on intervention in this area please see our parallel report, *Household food waste and kitchen practices: implications for policy and intervention*.

Reducing food waste

Campaigns to reduce household food waste have risen to prominence in the UK over the past decade, especially through the work of the Waste and Resources Action Programme (WRAP). This work ranges from brokering largescale voluntary agreements between public and private sector bodies, to targeting consumers directly through the Love Food Hate Waste campaign. The latter provides online information, as well as supporting localised programmes of events and hands-on activities and providing 'cascade training' to groups of volunteers.

Food waste clearly impacts on other resource use, including the energy and water used in agriculture and food production (WRAP/WWF, 2011). It also contributes to energy and water use within the home kitchen. When food is discarded the proportion of energy used in shopping and storage for that item is effectively wasted. Cooked leftovers thrown away without being eaten account for further energy and water use in preparation, cooking and washing up. Ensuring that better use is made of this food, or preventing oversupply in the first place, will be beneficial for reducing energy use. In addition, some measures to reduce food waste are likely to be synergistic with those to reduce energy use in kitchen practices. For example, shopping little and often, combined with having a smaller fridge, might mean surplus food is less likely to become hidden and subsequently forgotten, reducing the amount of food that eventually goes to waste, as well as the energy used in powering the fridge. In sum, there are potential mutual gains to be made from stakeholders in the energy, food and waste sectors – including representatives of BEIS and Defra – combining resources and co-producing strategies to effectively tackle both sets of concerns.

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References

- Anderson, B (2016) DEMANDING Times, Paper prepared for DEMAND Centre Conference, Lancaster, 13-15 April 2016.
- Balta-Ozkan, N., Amerighi, O. and Boteler, B. (2014) A comparison of consumer perceptions towards smart homes in the UK, Germany and Italy: reflections for policy and future research, *Technology Analysis & Strategic Management*, 26, pp.1176-1195.
- Balta-Ozkan, N., Davidson, R., Bicket, M. and Whitmarsh, L. (2013) Social barriers to the adoption of smart homes, *Energy Policy*, 63, pp.363-374.
- BEIS (2016) Energy Consumption in the UK.
- Berkholz, P., Stamminger, R., Wnuk, G., Owens, J. and Bernarde, S. (2010) Manual dishwashing habits: an empirical analysis of UK consumers, *International Journal of Consumer Studies*, 34(2), pp.235-242.
- Cairns, S. (2005) Delivering supermarket shopping: more or less traffic?, *Transport Reviews*, 25(1), pp.51-84.
- Cameron, L. (2017) *Energy 'access' for sustainable development: Enabling modern energy practices in rural communities* PhD thesis, University of Sheffield.
- Chan, A., Garcia Moreno, J. and Hughes, M. (2014) Further Analysis of Data from the Household Electricity Usage Study: Electricity Price Signals and Demand Response.
- Cheng, S., Olsen, W., Southerton, D. and Warde, A. (2007) The changing practice of eating: evidence from UK time diaries, 1975 and 2000, *British Journal of Sociology*, 58(1), pp.39-61.
- Coley, D., Howard, M. and Winter, M. (2009) Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches, *Food Policy*, 34(2), pp.150-155.
- DECC (2014) Energy efficient products - helping us cut energy use.
- DfT (2016) Road Use Statistics Great Britain 2016.
- Durand-Daubin, M. (2016) Cooking in the night: peak electricity demand and people's activity in France and Great Britain, Paper prepared for DEMAND Centre Conference, Lancaster, 13-15 April 2016.
- Durand-Daubin, M. and Anderson, B. (in press) Changing Eating Practices in France and Great Britain: Evidence from Time Use Data and Implications for Direct Energy Demand, in Hui, A., Day, R. and Walker, G. (eds.) *Demanding energy: spaces, temporalities and change*. Palgrave.
- EA Technology (2011) Delivering the Benefits of Smart Appliances.
- Edwards, J.B., McKinnon, A.C. and Cullinane, S.L. (2010) Comparative analysis of the carbon footprints of conventional and online retailing: A "last mile" perspective, *International Journal of Physical Distribution & Logistics Management*, 40(1/2), pp.103-123.
- Energy Saving Trust (n.d.) Products and appliances, online at: <http://tools.energysavingtrust.org.uk/Electricity/Products-and-appliances>
- Energy Saving Trust (n.d.) Energy-saving tips for the kitchen, online at: <http://tools.energysavingtrust.org.uk/Take-action/Energy-saving-top-tips/Changing-your-habits-room-by-room/Energy-saving-tips-for-the-kitchen>

- Energy Saving Trust (2012) Powering the Nation: Household electricity-using habits revealed.
- FSA (2017) The Food & You Survey: Combined Report for England, Wales and Northern Ireland.
- Fuss, N., Bornkessel, S., Mattern, T. and Stamminger, R. (2011) Are resource savings in manual dishwashing possible? Consumers applying Best Practice Tips, *International Journal of Consumer Studies*, 35(2), pp.194-200.
- Geppert, J. and Stamminger, R. (2013) Analysis of effecting factors on domestic refrigerators' energy consumption in use, *Energy Conversion and Management*, 76, pp.794-800.
- Gibson, Chris, et al. Household sustainability: challenges and dilemmas in everyday life. Edward Elgar Publishing, 2013.
- Gorman-Murray, Andrew, and Ruth Lane, eds. *Material geographies of household sustainability*. Ashgate Publishing, Ltd., 2012.
- Gronow, J. and Jääskeläinen, A. (2001) The Daily Rhythm of Eating, in Kjærnes, U. (ed.) *Eating Patterns: A Day in the Lives of Nordic Peoples*, National Institute for Consumer Research, pp.91-123.
- Hager, T.J. and Morawicki, R. (2013) Energy consumption during cooking in the residential sector of developed nations: A review, *Food Policy*, 40, pp.54-63.
- Higginson, S., Thomson, M. and Bhamra, T. (2014) "For the times they are a-changin'": the impact of shifting energy-use practices in time and space, *Local Environment*, 19(5), pp.520-538.
- Hoolohan, C., McLachlan, C. and Mander, S. (2016) Trends and drivers of end-use energy demand and the implications for managing energy in food supply chains: Synthesising insights from the social sciences, *Sustainable Production and Consumption*, 8, pp.1-17.
- Isaksson, C. and Ellegård, K. (2015) Dividing or sharing? A time-geographical examination of eating, labour, and energy consumption in Sweden, *Energy Research & Social Science*, 10, pp.180-191.
- Lavelle, M.J., Rau, H. and Fahy, F. (2015) Different shades of green? Unpacking habitual and occasional pro-environmental behavior, *Global Environmental Change*, 35, pp.368-378.
- Mestdag, I. (2005) Disappearance of the traditional meal: Temporal, social and spatial deconstruction, *Appetite*, pp.62-74.
- Michel, A. (2015) Energy efficiency of White Goods in Europe: monitoring the market with sales data.
- Morley, J. and Shove, E. (2014) Size is everything at Christmas and your oven is no exception, *The Conversation*, online at: <http://theconversation.com/size-is-everything-at-christmas-and-your-oven-is-no-exception-35689>
- Nicholls, L. and Strengers, Y. (2015) Peak demand and the 'family peak' period in Australia: Understanding practice (in)flexibility in households with children, *Energy Research & Social Science*, 9, pp.116-124.
- Oberascher, C., Stamminger, R. and Pakula, C. (2011) Energy efficiency in daily food preparation, *International Journal of Consumer Studies*, 35(2), pp.201-211.
- OVO Energy (n.d.) Energy-efficient fridges and freezers, online at: <https://www.ovoenergy.com/guides/energy-guides/energy-efficient-fridges-and-freezers.html>
- Paetz, A., Dütschke, E. and Fichtner, W. (2012) Smart Homes as a Means to Sustainable Energy Consumption: A Study of Consumer Perceptions, *Journal of Consumer Policy*, 35(1), pp.23-41.
- Palmer, J. and Terry, N. (2014) Powering the Nation 2: Electricity use in homes, and how to reduce it.
- Palmer, J., Terry, N., Firth, S., Kane, T., Godoy-Shimizu, D. and Pope, P. (2014) *Energy use at home: models, labels and unusual appliances*.
- POST (2017) Future Energy Efficiency Policy, POSTNOTE no.550, online at: <http://researchbriefings.files.parliament.uk/documents/POST-PN-0550/POST-PN-0550.pdf>
- Powells, G., Bulkeley, H., Bell, S. and Judson, E. (2014) Peak electricity demand and the flexibility of everyday life, *Geoforum*, 55, pp.43-52.

- Raulio, S., Roos, E., Rahkonen, O. and Prättälä, R. (2005) Twenty-year trends of workplace lunches in Finland, *Food Service Technology*, 5, pp.57-66.
- Richter, C.P. (2011) Usage of dishwashers: observation of consumer habits in the domestic environment, *International Journal of Consumer Studies*, 35(2), pp.180-186.
- Shove, E. (2009) Everyday practice and the production and consumption of time, in Shove, E., Trentmann, F. and Wilk, R. (eds.) *Time, Consumption and Everyday Life: Practice, Materiality and Culture*, Oxford: Berg, pp.17-33.
- Shove, E., Pantzar, M. and Watson, M. (2012) *The dynamics of social practice: Everyday life and how it changes*. London: Sage.
- Shove, E. and Southerton, D. (2000) Defrosting the freezer: from novelty to convenience: A narrative of normalization, *Journal of Material Culture*, 5(3), pp.301-319.
- Siikavirta, H., Punakivi, M., Kärkkäinen, M. and Linnanen, L. (2002) Effects of E-Commerce on Greenhouse Gas Emissions: A Case Study of Grocery Home Delivery in Finland, *Journal of Industrial Ecology*, 6(2), pp.83-97.
- Southerton, D. (2009) Re-ordering temporal rhythms: Coordinating daily practices in the UK in 1937 and 2000, in Shove, E., Trentmann, F. and Wilk, R. (eds.) *Time, Consumption and Everyday Life: Practice, Materiality and Culture*, Oxford: Berg, pp.49-63.
- Southerton, D., Díaz-Méndez, C. and Warde, A. (2012) Behavioural Change and the Temporal Ordering of Eating Practices: A UK–Spain Comparison, *International Journal of Sociology of Agriculture & Food*, 19(1), pp. 19–36.
- Stragier, J., Hautekeete, L., De Marez, L. and Claessens, S. (2013) Towards More Energy Efficient Domestic Appliances? Measuring the Perception of Households on Smart Appliances, *Energy & Environment*, 24(5), pp.689-700.
- Warde, A., Cheng, S., Olsen, W. and Southerton, D. (2007) Changes in the practice of eating: A comparative analysis of time-use, *Acta Sociologica*, 50(4), pp.363-385.
- Watson, M. (2012) How theories of practice can inform transition to a decarbonised transport system, *Journal of Transport Geography*, 24, pp.488-496.
- Which? (n.d.) Dishwasher energy saving tips, online at: <http://www.which.co.uk/reviews/dishwashers/article/dishwasher-energy-saving-tips>
- Wilson, C., Hargreaves, T. and Hauxwell-Baldwin, R. (2017) Benefits and risks of smart home technologies, *Energy Policy*, 103, pp.72-83.
- WRAP/WWF (2011) *The water and carbon footprint of household food and drink waste in the UK*.
- Wygonik, E. and Goodchild, A. (2012) Evaluating the Efficacy of Shared-use Vehicles for Reducing Greenhouse Gas Emissions: A U.S. Case Study of Grocery Delivery, *Journal of the Transportation Research Forum*, 51(2), pp.111-126.