

Time, Practices and Energy Demand: implications for flexibility

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Elizabeth Shove and Noel Cass

Abstract

The timing of energy demand is increasingly important given the pressure to decarbonise energy systems, accommodate more intermittent forms of renewable energy supply and reduce peak load. In the transport sector, rush hours and periods of congestion present problems of their own also related to the synchronisation and the sequencing of social practices. This document brings together DEMAND research on the social-temporal ordering of what people do and considers the implications of this work for ‘demand management’ and for efforts to develop more flexible energy systems.

Introduction

The timing of energy and especially electricity demand (and therefore supply) is increasingly significant for energy policy and for utilities and providers alike (Geller, Harrington et al. 2006, Anable, Anderson et al. 2014, Torriti, Hanna et al. 2015). There are several reasons for this. One relates to the challenge of accommodating supply from more intermittent renewable sources, and of coping with seasonal variations especially in the demand for heat. Another is that the fuels used to produce electricity at peak times are especially carbon intensive. In the transport sector, peaks in the timing of travel enable some forms of public transport to run at a profit but also generate congestion, increased carbon emissions and air pollution. Together, these concerns call for better understanding of the social and temporal rhythms that underpin present peaks and troughs in energy use and travel, and of how these might be changed or modified.

The challenge of coping with uneven patterns of demand is not new. Demand for gas is much greater in the winter and in the electricity sector, consumption rises and falls daily, weekly, and over the course of the year. Since electricity is difficult to store, provision and generation are organised to match these fluctuations. Historically, and at a national scale, the strategy has been to expand supply in order to meet maximum demand, whenever that occurs (Torriti, Hanna et al. 2015: 891-2). In practice, this means building enough additional generation to top up ‘baseload’ to meet peak demand and to ‘keep the lights on’ at all times (ENWL 2016). This response is complicated by new commitments to decarbonising the energy system and increasing the proportion of renewables in the supply mix (National Grid 2014, Energy UK 2016).

As a result, there is now growing interest in methods of reducing rather than always meeting peak demand, and in techniques known as Demand Side Management (DSM) or Demand Side Response (DSR). DSM and DSR generally target individual business or households and use real-time pricing (or information, for example in the form of smart metering) to encourage consumers to shift the timing of what they do. Time of use tariffs (Torriti and Grunewald 2014, Strengers 2018), ‘Smart’ meters and grids are used for this purpose along with ‘smart’ controls capable of switching certain loads on and off in response to real-time data on the relation between supply and demand. Whilst some forms of DSM take place behind the scenes (for instance automatic switching of freezers or heating and cooling systems), many depend on persuading individual consumers to change their routines: for example, to run the washing machine at

night or modify journeys to avoid the rush. To date, smart-metering feedback and current forms of real time pricing (in the domestic setting) have had only modest effect. Meta-studies of household smart metering feedback trials show reductions in demand of e.g. 3-5% (McKerracher and Torriti 2013, Torriti and Grunewald 2014). One plausible reason for this is that people are *not* free to re-arrange the timing of energy demand at will.

Instead, and as discussed below, daily and weekly schedules are defined by collective social and temporal rhythms, not by individual choice. In taking this idea further, we suggest that peaks and troughs in demand relate to the synchronisation and sequencing of practices that entail mobility and/or other forms of energy consumption. We go on to argue that these arrangements are, in turn, significant for understanding and conceptualising the extent and character of 'flexibility. The conclusion that different forms of flexibility (for instance, of individual practices, or of people) are outcomes of how sets of social practices intersect over time has practical implications for those who seek to modify the timing and the location of energy demand.

The timing of energy demanding practices

The temporal patterning of daily life is an established theme across the social sciences. Writers such as Pred (1981), Parkes and Thrift (1979) and Hägerstrand (Hägerstrand 1970) in geography; Schatzki (2009) and Lefebvre (1992, 2004) in philosophy, and Adam (2008) and Southerton (2003, 2006, 2012) in sociology, to name just a few, provide important insights into the development and detail of social-temporal order. Many of these analyses highlight the physical (day and night), biological (eating and sleeping) and essentially social (work, meals and leisure) organisation of what people do (Zerubavel 1981, 1982). This literature is crucial for energy research and policy in that peak loads, in travel and in energy demand, arise from situations in which many people do the same or different energy-demanding activities at the same time (Mattioli, Shove et al. 2014). Inspired by these ideas, projects within DEMAND (Torriti, Anderson, Mattioli) have used time-use data, qualitative research and methods of sequence analysis to investigate the *synchronisation* of practices (with each other and at specific times), and their *sequencing*, and to show how temporal rhythms vary over time. In combination these studies show how practices become anchored to specific times (and places) in ways that constitute peak loads (Anderson 2016) and that determine the scope for re-scheduling and adjustment (Mattioli, Shove et al. 2014, Carlsson-Hyslop, Kuijjer et al. 2015, Torriti and McGraw 2016, Anderson and Torriti 2017).

In understanding these and other features of the timing of energy demand, the first step is to discover what people are actually doing when energy (and especially electricity) demand is at its peak. Exactly which activities constitute morning and evening peaks, and do these change during the week or vary between week-days and week-ends? One way of finding out is to combine data on domestic electricity use with information about the timing of activities like those relating to ICT, cooking, heating or lighting.

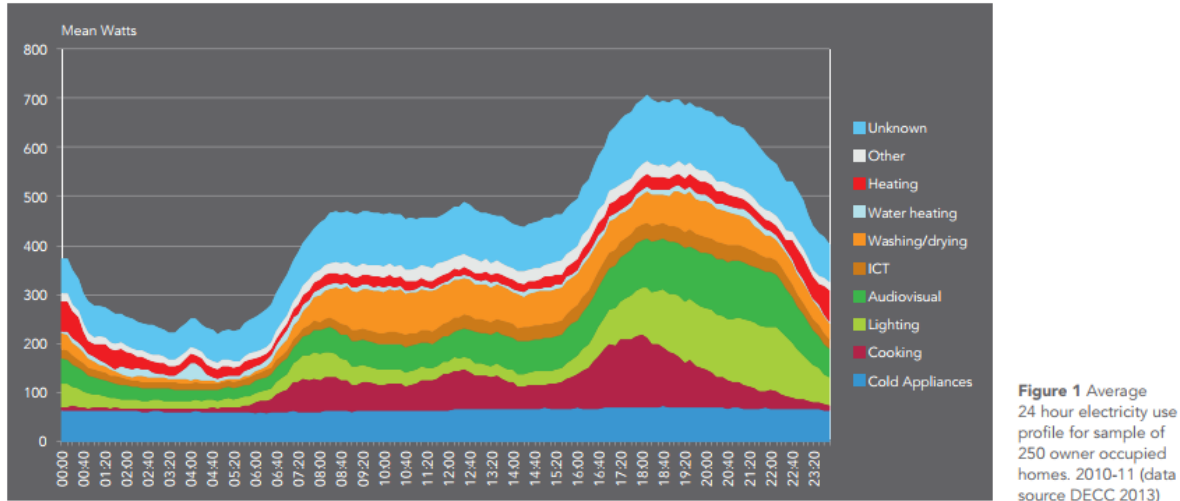


Figure 1: Average 24 hour electricity use profile for sample of 250 owner occupied homes. 2010-11 (data source DECC 2013: taken from Anderson 2016c:3)

As Figure 1 shows, and as one might expect, meal times are associated with an increase in electricity demand especially for cooking; and more energy is used for lighting when people are at home in the evening. Averaged figures like these can be compared with data from other countries (Durand –Daubin 2016), and used to reveal changes over time. It is also possible to compare the time profiles of different sectors of the population, or of week-ends and week days. Within DEMAND, researchers have used these and other techniques to identify and investigate the *forms* of coordination on which patterns of demand depend.

For instance, some peaks arise when many households do the *same* electricity-demanding activities at the same times. Large numbers of households simultaneously engaging in *different* energy-demanding practices at the same time also create peaks in overall demand. In aggregate, post-dinner peaks in washing/drying, lighting, and using audio-visual equipment coincide. Similarly, peak periods of traffic include the morning commute, when many people travel to work, but also Saturday mornings, when lots of people are on the move but for very different reasons. Equally, some societally synchronised arrangements, such as sleeping at night, result in lower demand. Figure 2 summarises four possible combinations of synchronisation and energy demand.

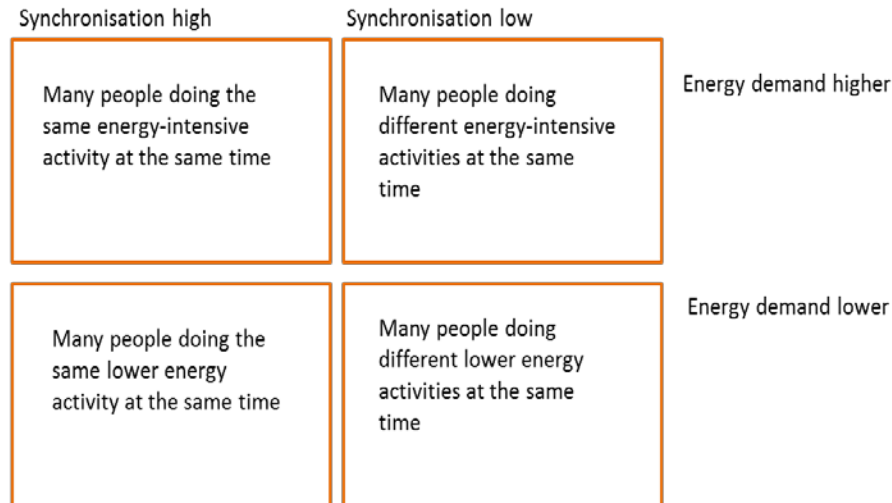


Figure 2: Synchronisation and energy demands

To understand the ebb and flow of energy demand (or traffic), we need to know more about exactly which practices are ‘synchronised’, and when, and we need to know how these arrangements develop historically and vary from one country to another.

Time use studies show that in France more people sit down to lunch at the same time than is the case in the UK. They also show that in the UK, lunchtimes were more strongly synchronised forty years ago than they are today (Durand-Daubin 2016). In general, there is some evidence to suggest that the extent of societal synchronisation is reducing. For example, in the UK, practices like those of commuting to work, taking summer holidays, or eating together at home are less synchronised (Gershuny 2011), and thus less ‘peaky’, than they have been in the previous few decades. Figure 3 uses successive waves of time use data to give a more detailed picture of how the timing and location of selected activities has changed in the UK between 1974 and 2014. During this period the timing of ‘food’ (shown in orange on the left) has become less ‘peaky’ whilst the timing of travel has become more concentrated in the morning (shown in pink, on the right).

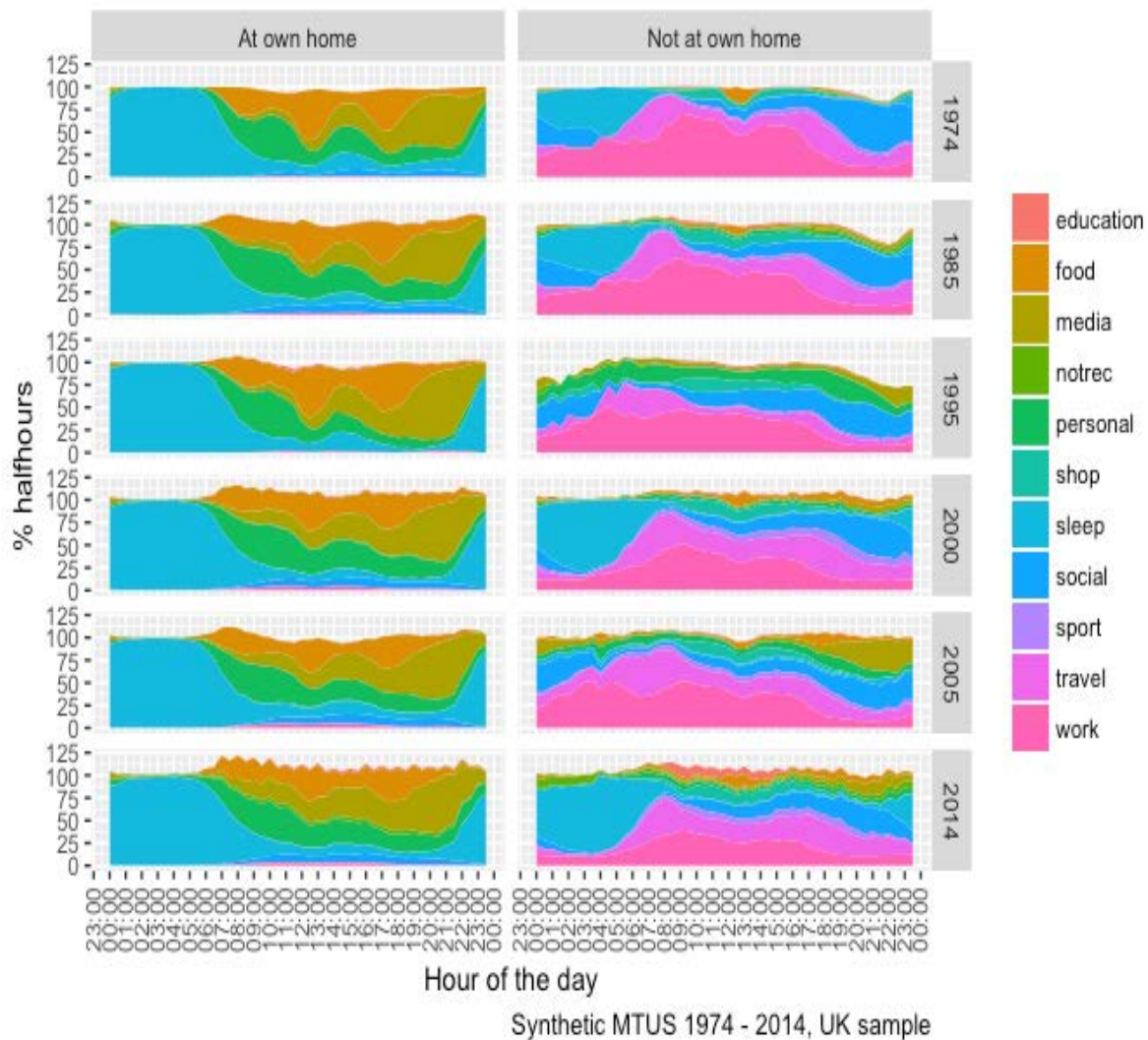


Figure 3: Anderson and Torriti, based on UK time-use data time-mapped in half-hour segments for home and other locations (data sources MTUS 1974-2014).

Figure 4 presents the same data but in a form that shows how the timings of specific activities recorded in 2014 have shifted from the 1974 baseline. Movement up or down from the zero point indicates percentage increases or decreases in the number of people reporting each activity at specific times of day. For example, changes in the green line show that there is now less 'food' related activity recorded at 12.00 but more at 19.00. This is in keeping with other evidence suggesting that meal times are becoming less rigid and that people are eating at different times of day (Hitchings 2011, Warde 2013, Yates and Warde 2015, Warde and Yates 2017).

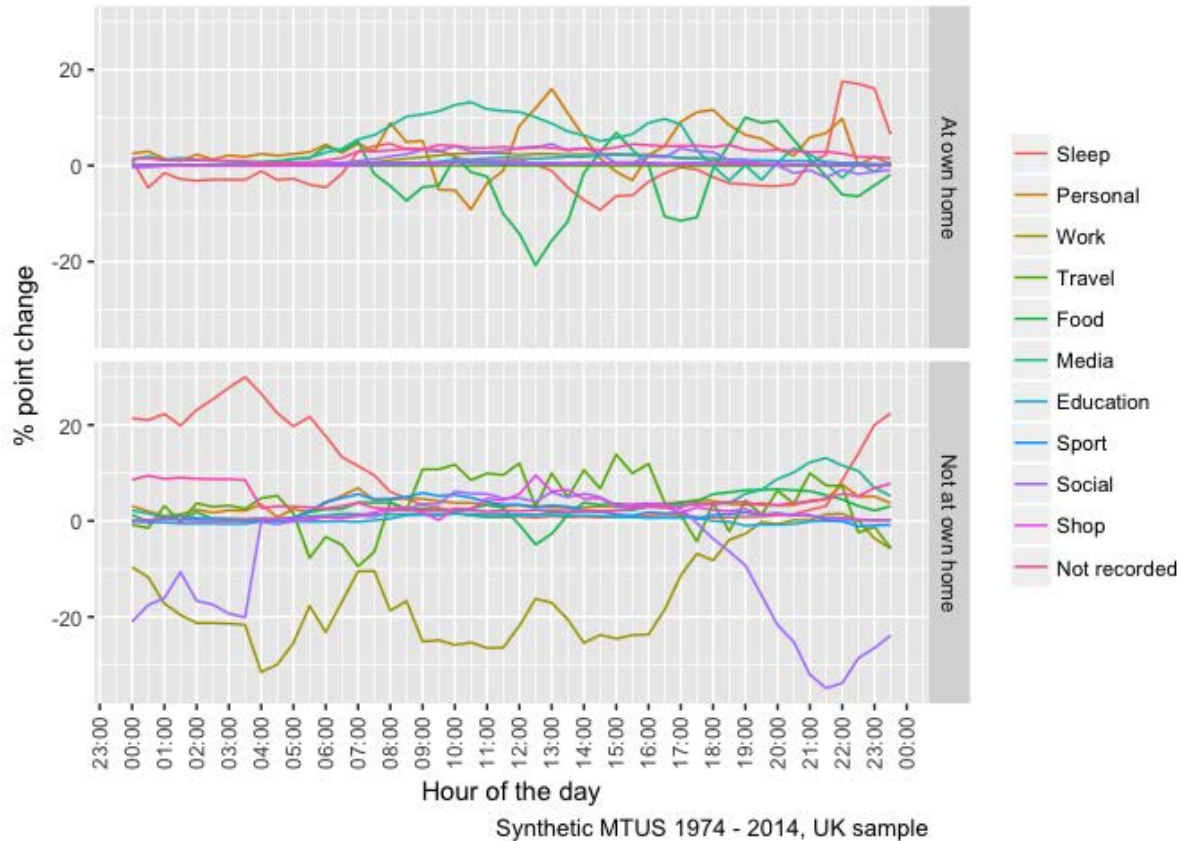


Figure 4: Anderson and Torriti. Percentage point changes in time-uses in half-hour periods at home and elsewhere in the UK (data source MTUS 1974-2014).

Trends like those of eating later in the evening and of having shorter lunch times are not outcomes of energy policy, but they directly affect the details of demand.

To learn more about how these and other such patterns evolve and whether they can be deliberately modified – for example, to reduce peak load or adjust demand to better match renewable supply – we need to say more about the forms of synchronisation and sequencing of which socio-temporal rhythms are made, and about the various forms of flexibility that follow.

Synchronisation

Situations in which similar practices occur at the same time are not merely happenstance; they are to different degrees, outcomes of collective forms of *societal synchronisation* (Shove, Trentmann et al. 2009). As already mentioned, some explanations of why different people do similar things at similar times highlight natural, biological or physiological rhythms, not as independent forces, but as mediated by social conventions, technologies and institutions (Zerubavel 1981, Zerubavel 1982).

The practicalities of coordination are also important. As Parkes and Thrift explain methods of temporal organisation, like those that involve the use of clocks and calendars, have arguably enabled forms of synchronisation that would have been difficult, and perhaps impossible to achieve in any other way. For example, train services that run to a timetable depend on the collective discipline of clock time. As such

they represent one amongst other forms of ‘pace making’ associated with timekeeping technologies and with the conventions of measuring and representing time in minutes and hours (Parkes and Thrift 1979).

Whether resolved with reference to clock time or not, practices often have what Hägerstrand calls ‘coupling constraints’ – meaning that they require the presence of other people or objects at set times (Hägerstrand 1970: 12-14). This is important in understanding why people and things move around as they do. Building on these ideas, Urry identifies various situations in which co-presence is important in daily life (Urry 2002). Being present at performances or collective events is one example; valuing face-to-face meetings with family members or work colleagues is another. Exactly how such ‘requirements’ play out depends, in part, on the range of different activities that people undertake; on related temporal features (such as duration, tempo and periodicity); and on how practices are linked across the day, week or year.

Forms of institutional timing – such as working and opening hours, school times and terms, and forms of leisure provision have a key role in defining the extent and character of societal synchronisation (Hui, Shove et al. 2013, Cass and Faulconbridge 2016, Anable, Cass et al. 2017, Blue 2017). The rush hour is a paradigmatic example of how institutional arrangements create peaks in demand. The convention of a 9am-5pm working day and that fact that this coincides with school times means that large numbers of people are mobile at the same time (Cass and Faulconbridge 2016). The early evening peak in electricity demand is similarly an outcome of many people returning home from work, and then making and eating a meal. Patterns of employment and education represent critical ‘orchestrating’ forces, but as the structuring of TV schedules and the notion of ‘prime time’ viewing demonstrates many organisations are involved in ‘making’ times when specific practices dominate and when other activities are temporarily set aside.

As these examples indicate, seemingly ‘private’ household routines are connected to the routines of others and shaped by distinctive arrays of practices some of which are anchored to fixed times and spaces (Hui 2017). Daily rhythms are a product of these arrangements, and of the fact that some practices have to take place before others.

Sequencing

What happens when, and the potential for rearranging daily schedules depends on how different practices connect to each other, and on the sequences or chains of action involved. As with forms of synchronisation, sequences relate to different kinds of material ‘necessity’, social convention and institutional ordering.

Many practices depend on the existence or ready availability of material ‘elements’ including objects, tools, appliances and infrastructures (Shove, Pantzar et al. 2012: 84-87, Shove 2016, Wiig 2016). Getting these materials together in the right place at the right time often involves some form of preparation: for example, doing the laundry depends on gathering dirty clothes, putting them in the machine, adding soap powder etc. Meanwhile, ironing requires a supply of washed but crumpled garments. These activities are linked in that ‘inputs to one practice are transformed into outputs that may become inputs of another practice’ (Hui 2017: 62). The scheduling of many other domestic practices, including shopping, cooking and dishwashing is to an extent defined by sequences of this kind.

Sequences of practice are also important for when and whether journeys are made by car. Mattioli and Anable (2016) applied sequence-analysis to time-use data to identify practices that precede and follow driving. Their research showed that driving was typically embedded in chains of activity that involved the movement of people or things. Better understanding of this 'cargo' function is hugely important for understanding when trips are made by car and for the viability (or not) of using other modes, such as cycling or public transport. Analysing car driving not as an isolated activity but within and as part of a sequence of practices provided a more differentiated picture of 'car use' and of the timing of driving as a consequence of the specific practices in which it is embedded. This is not a natural or inevitable phenomenon. The existence of sequences in which driving is an essential part is relatively new and is, to an extent, an outcome of the possibilities afforded by what Urry describes as a system of automobility (Urry 2004), and of the forms of connectivity, speed and 'convenience' this enables. In other words, sequences change and evolve along with the practices they connect, and of which they are comprised.

This is also the case for sequences that are more obviously defined by cultural conventions, including those associated with eating, sleeping and cleaning. In contemporary Western societies, breakfast, lunch and dinner are very different sorts of meals shaped by understandings of when they should occur and what it is socially appropriate and 'normal' to eat on each occasion (Durand-Daubin 2016). Exactly what is consumed (particularly, cold or hot, home or restaurant cooked, frozen or fresh) at different times of day is relevant for the energy demand that follows and for when and where this occurs. Other contemporary habits, like those of sleeping 7-8 hours a night, or of taking a daily shower (usually in the morning) also have the dual effect of structuring the time-scape of the day and reproducing shared interpretations of temporal propriety.

Finally, institutional procedures and working practices are clearly relevant for the order in which things happen, and for how sequences (and thus timings) are established and changed. In his study of institutional rhythms and energy demand, Stanley Blue (2017) shows that the timing of peak loads in hospital energy consumption and patient transport is an outcome of the interplay of job-roles, shift patterns, organisational and/or medical protocols and the 'time sovereignty' (Breedveld 1998) of more and less influential members of staff. These arrangements intersect with patient centred sequences of sleeping, eating and medication in ways that generate different peaks and troughs in hospital life. One consequence is that discharge procedures (which consist of a series of precisely defined steps and stages) are such that although patients arrive in hospital at all times of day and night, most of them leave between the hours of 3 and 5pm.

In hospitals and in other settings, institutional arrangements are aligned around what Pred describes as 'dominant projects' (Pred 1981). Dominant projects include things like delivering health care, organising family life, or achieving work-related goals. In any one society there are many such projects, all of which have effect on the scheduling, the synchronisation and, collectively, the sequencing of practices in ways that are more or less entangled and thus more or less amenable to change. These are not the only processes that matter but all are important in thinking about what it is that makes some practices, some people, and some relations between practices more flexible than others.

Conceptualising, measuring and influencing flexibility

Energy and climate change policy makers, and utilities, have an interest in developing energy systems in which consumption adjusts to the ebb and flow of supply, and in which activities are re-scheduled to avoid peak times. Not surprisingly, there are different views on how much scope there is for 'flexibility' of this

kind, and how it might be achieved. For example, some contend that the timing of energy use is inherently flexible, and can be manipulated by setting appropriate real-time prices (Mohsenian-Rad and Leon-Garcia 2010). Others argue that such measures are unlikely to persuade consumers to change their ways, and that the best option is to develop methods of demand management that are 'invisible' at the point of use. Examples include automatically switching off devices (refrigerators, heating or cooling systems) at peak times but not for so long that consumers/occupants notice the difference (Hamidi et al. 2009, Di Giorgio and Pimpinella 2012, Finn et al. 2013). These analyses situate 'flexibility' either as a matter of consumer choice or as something that suppliers can achieve, behind the scenes. DEMAND research points towards other ways of conceptualizing and influencing the timing of demand. For example, and as discussed in more detail below, certain practices are likely to be more 'flexible' than others depending on how they are positioned in relation to other practices. Second, some people (or groups of people) are likely to be more 'flexible' than others, depending on the range of practices with which they are engaged. Third, flexibility in both these senses appears to be an outcome of how entire complexes of social practices are configured in space and time.

Flexible practices

If we define flexibility as the converse of closely-coupled sequencing and/or rigid synchronisation, more flexible practices are those that are relatively detached (they are not tied to specific times or places); decoupled (not requiring the co-presence of other things or people), or capable of being interrupted, restarted and broken into smaller parts (Shove 2009, Zhai, Cao et al. 2016). Figures 3 and 4 suggest that in general, and in the UK, social practices might be acquiring more of these features. For example, and as Southerton notes, there are now fewer 'institutionally timed events' than in the past (Southerton 2006) and so-called 'convenience' technologies have changed the time-profiles of various activities (cooking, laundry etc.) (Shove 2003). There is also some evidence that mobile technologies and smartphones (Lord, Hazas et al. 2015) are reconfiguring the temporal characteristics of activities like shopping and film/TV watching, and that they are also creating opportunities to work in small fragments of time or when on the move. It is also important to notice that certain practices, like working from home, appear to have the effect of reducing forms of synchronisation and of enabling greater variation in when other activities occur.

These observations suggest that energy and transport policy makers would do well to 'target' seemingly flexible practices: for example, focusing more on the timing of laundry and leisure than on eating or commuting. However, they also point to less obvious forms of intervention. For instance, non-energy policies that promote 'flexible' working might have long term, cumulative consequences for the timing of demand.

Flexible people

Whether people are affected by such trends or not depends on the range of practices in which they are involved. For example, people in both the highest and lowest income groups tend to spend more time at work than others, and may therefore have less scope to modify the timing of other activities. In addition, and as Breedveld (1998) and others have argued, flexibilities for some people or organisations arguably produce and come at the cost of rigidities for others. More ordinarily some people engage in practices that are highly synchronised or sequenced, whereas others do not. For example, those who are retired are not tied to routines of employment. Similarly the forms of coordination that occur in families are not the same as those that characterise the lives of people who live alone. According to Torriti, home-workers

display ‘the highest level of flexibility, because their practices are associated with high active home occupancy, low spatial mobility, long duration of a small set of activities mainly not shared with others and low synchronisation with the rest of the population.’ (Torriti, 2015: 909). This conclusion is based on analysis using what Torriti describes as a flexibility index composed of ‘a set of component indices on synchronisation, variation, sharing and mobility [that...] feed into ... an indication of the potential to shift demand’ (2015). Torriti’s index makes it possible to identify specific *practices* (e.g. laundry) that appear to be more flexible than others (e.g. eating meals). It also makes it possible to identify people (or groups of people) who engage in complexes of more and less closely-coupled, sequenced or synchronised practices. Amongst other things, use of the index enables Torriti and colleagues to show that lone and childless households are generally more time-flexible than those which include partners and children (2015: 891-904). However, a critical feature of this work is that flexibility is not treated as a *fixed* characteristic of any one practice, or of any one set of people. Instead it is conceptualised as something that is situated and variable, depending, as it does, on how specific practices are positioned in relation to others. From this point of view, the index can be used distinguish between the forms of flexibility (defined by specific relations between practices) such as those that (in general) characterise morning as opposed to evening peaks, or peaks during week-days compared with week-ends.

In the short term, this leads to the important insight that flexibility is itself ‘flexible’. In other words, the ‘flexibility to shift activities var[ies] throughout the day” (Torriti et al 2015: 891-2). More abstractly this approach builds on the idea that flexibility (of people, of practices, and of social systems) is an outcome of synchronisation and sequencing, and an emergent feature that is itself important for how future sequences and forms of synchronisation are established and enacted.

This work has different practical implications. At one level it argues for more differentiated forms of intervention. Rather than the blanket approach associated with real time pricing, it suggests that it might be more effective to identify, and in a sense ‘target’, people who are in a position to respond flexibly. It also supports the view that strategies of this kind only scratch the surface of what is in fact a much more systemic challenge.

Flexible societies?

The apparent flexibility both of individual people, or of individual practices is itself an expression of broader trends in how practices relate to each other on a societal scale. From this point of view, the fact that specific practices might be less tightly bound in time and space does not mean that there is greater flexibility, overall. If we define flexibility not as a quality of an individual practice (as it stands in relation to others), but as a feature of the socio-temporal ordering of society, other considerations come into view. These include questions about how multiple practices become more and less tightly coupled in relation to each other, and about the relative significance of collective priorities and ‘orchestrating’ projects.

By implication, promoting ‘flexibility’ in this more systemic sense is in essence, a matter of changing the ways in which daily lives are coordinated and the practices of which they are made. This is a more daunting, but also more promising prospect. In thinking about what is at stake it is important to notice that societal rhythms are never fixed: as mentioned above, systems of automobility, convenience technologies, supply chains and modes of provision and storage continue to transform the social-temporal landscape. In the UK today, a number of current trends appear to be softening or at least changing the ways in which people, things and practices intersect in space and time. For example, and as other DEMAND research has shown, online shopping is modifying both the meaning and the timing of activities

such as browsing, payment, product trial and crucially delivery. This affects the temporal organisation of the activities of providing as well as of shopping and may also reduce energy and travel demands (Zhai, Cao et al. 2016, Cass and Shove 2018). This is not an isolated case. As Cox et al. note, many areas of public policy (including policies relating to health, education or employment), have immediate and obvious impacts on the scheduling of a host of interdependent activities (Cox, Royston et al. 2016, Royston 2016).

In conclusion, the ambition of reducing peaks and adapting demand to the rhythms of more intermittent sources of supply calls for potentially significant changes in when different activities take place. Engendering social-temporal rhythms that are compatible with reduced and/or renewable energy consequently depends on much more than pricing, behind-the-scenes technology 'fixing' or individual persuasion. Instead, the possibilities for change on a societal scale depend on how social practices are arranged in relation to each other, and on the forms of flexibility (or not) that follow. Such arrangements are not fixed for all time, nor are they immune to the influences of business and policy. In fact there is some evidence to suggest that for various reasons certain patterns of work, of eating and of travel are 'flexing' and becoming more complicated and also more fragmented than in previous decades. Although not 'driven' by energy policy, trends like these are important for the design and operation of future energy systems (for instance, for investment in new forms of storage, for judgements about how much energy we 'need', and for assessments of the scale of provision). At a minimum, this argues for folding discussions of collective social-temporal rhythm into discussions of energy and transport policy, and for analysing and learning from past as well as present regimes of 'flexibility' in different sectors and at different scales.

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