DEMANDing Times

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Introduction

Given that only about 35% of the variation in domestic energy use can be attributed to physical building attributes (Huebner et al. 2015), if we are to achieve the UK policy goal of reducing energy consumption by 20% (DECC 2014) then it appears axiomatic that we need to understand the factors that drive the 'missing' 65%. This can only come from improving our understanding of what people *actually do* with energy (Janda 2011), why they do it and how the current state of play came to be. Only then can policies or commercial strategies apply interventions at the most effective points in a local, regional or national socio-technical energy ecosystem.

This paper's approach to this challenge begins from first principles, arguing that people use energy as part of accomplishing social practices (Reckwitz 2002; Warde 2005) of one kind or another and it is the variation in the performances of these practices that drives much of the 'missing' 65%. From this it follows that understanding energy demand depends, above all, on understanding the timing, location, context and materiality of a range of inter-connected social practices (Elizabeth Shove 2012; E. Shove and Walker 2014). In addition, examining the changing temporal distribution of these performances may generate new insights into the way demand for energy has changed and may evolve in the future (Elizabeth Shove, Pantzar, and Watson 2012). That these patterns of activities, and thus their consequential energy demands, change over time is perhaps self-evident if apparently rarely seriously considered in strategic energy policy development (DECC 2014).

This paper responds to this need by attempting to demonstrate the value of using general-purpose time use diary data to interrogate the changing patterns of everyday life in the UK from 1974 to 2005[1]. The paper will outline the national time-use survey datasets from the 1960s to the present that have been made available by the Multinational Time Use Study (Gershuny et al. 2012) and will describe the harmonisation process that has been to attempt to support both cross-national and temporal comparative analysis. The paper then presents analysis of trends in the timing of specific energy demanding practices (or their proxies), and indeed of practices that have come to demand energy to understand, conceptualise and describe the changing nature of the social activities that drive changes in domestic and mobility related energy demand in UK society.

It does this by focusing on three specific aspects of everyday life – food preparation, laundry and car use which provided three different lenses on evolving demand for energy. On the one hand they represent end uses that are relatively constant – sustenance, cleanliness and mobility – and on the other they represent activities whose material infrastructures and normative arrangements have changed substantially over the last 30 years. As such they provide a range of insights into the changing nature of emergent domestic energy demand. In so doing the paper will highlight the evolving configuration of energy demanding practices across a range of social dimensions in direct contrast to the apparent UK policy presumption of static (and immutable) demand. The paper will present largely descriptive analysis and will highlight how changing configurations of, especially, labour market constraints and participation are revealed.

The paper will then describe an example of the way in which time-use diary data can be used to explore potential near future scenarios by adapting the analysis of car use to the need to anticipate additional power network loading as a result of electric vehicle charging at the population level. The paper will conclude by summarising the way in which time-use data can be used to highlight the

[1] Analysis conducted to date includes the most recent national UK time use survey which was conducted in 2005. However a new dataset collected in 2014/15 may soon be available which would enable substantial updating of the results.

significance of 'non-energy energy' policies and it's potential value in tracking the evolution of energy demand practices.

The Timing of Energy Demand

Whilst the most recent call for improved evidence for policy development in the area of energy demand notes that not enough is known about 'how the use of homes and workplaces by people affects patterns of energy demand' (DECC 2014, 14), any developments in this knowledge are to be recruited in the surmounting of barriers to 'techno-adoption' rather than to the evolution of new, sustainable practices. Whilst the restructuring of domestic practices might appear to be off the UK public policy agenda in favour of delivering current practices through more energy efficient and/or low carbon technologies, this seems a sizeable missed opportunity. As Higginson et al emphasise (2013), to assume that practices are inviolable is to claim that they never change. Yet there is substantial empirical evidence that all social practices evolve, albeit at differing rates and with different trajectories (Elizabeth Shove, Pantzar, and Watson 2012; Elizabeth Shove 2003; Cheng et al. 2007). If practices *have* changed then they are in principle *changeable*, whether or not there is political appetite to explicitly incentivise change, and this inevitably begs the question of how such practices came to be.

With these challenges in mind, a review of the energy demand literature suggests that with a few notable exceptions, there is a vacuum in both knowledge and data that can be mobilised for this purpose. Current studies of domestic energy demand tend to concentrate on overall consumption or appliance use measurement using small scale studies and imputed stochastic models. Notable exceptions that have attempted to take account of aspects of the timing and nature of specific practices more directly. Recent work deducing carbon footprint information from time-use diary data (Druckman et al. 2012) is one approach which focuses on overall consumption but of more direct relevance here are studies using time-diary data as the basis for modelling energy demand (Torriti 2012; Ellegård and Palm 2011; Palm and Ellegård 2011; Widén, Lundh, and Vassileva 2009; McKenna and Thomson 2016). Here, energy demand patterns are ascribed to the range of activities recorded using a variety of average/appliance use approaches. As Palm and Ellegard's work makes clear, not only can the use of such data provide empirically grounded models of demand but they can also help to make plain the variation in temporal demand that derives from the different performances of different sequences of practices by different people. Notably missing from the perspective of this paper however is significant analysis of substantive variation between (and within) individuals and groups and any analysis of how energy-using activities may have changed over time.

Overall then, not only is there little data on variation and change in energy-demanding practices but with a few notable exceptions there is also very little consideration of variation in the extent and timing of the practices that underpin or constitute energy demand. Such variation appears generally to be seen as a 'problem' to be averaged out (Sofoulis 2011) or modelled away as an error term rather than a key feature of the way energy is used. This is unfortunate as it seems likely that considering such variation can offer a critical tool for identifying loci of potential intervention and change (Pullinger et al. 2014). In the next section we build on the few studies that have engaged with the underlying activities or practices that shape the variation in energy demand (e.g. Palm et al (2011)) to consider the value of UK time use data in tracking the recent trajectories of change in these practices.

Data

It will be clear from the preceding discussions that historical time-use survey data may be able to provide information on the sequencing, synchronisation, timing, location and performance of a range of social practices across the population of interest and over time. One such resource is the recently developed Multinational Time Use Study (Gershuny et al. 2012) which includes detailed activity sequences with 'harmonised' activity codes from nationally representative UK time use diary surveys carried out in 1974, 1983, 1987, 2000 and 2005. This historical record of social practices is, inevitably, incomplete and comparative analysis over time must take into account changes in coding schemes, data collection methods, sampling and response details (see Table 1 and also (Anable et al. 2014; Anderson Under review)). As can be seen, earlier time use surveys collected data from each respondent on each day of the week whilst later ones only asked for a diary to be kept on one or two days but with appropriate randomisation to ensure a full week was covered by the sample as a whole. In addition earlier diaries used longer (30 or 15 minute) activity recording slots whilst later surveys used 10 minutes meaning that direct comparison of the recorded number of episodes of a particular activity is not a robust method of analysing change over time. Furthermore the diaries of 1983 and 1987 were only recorded in specific months (c.f. Table 1) and so are usually pooled to form a full year '1985' whilst the diaries for 1995 were only completed in May and so are rarely used.

Table 2 shows the general form of the harmonised time-use diary episode data and highlights that the diaries had different reporting periods and differing analytic opportunities with respect to additional contextual data. Table 3 to Table 5 shows the detailed derivation of the harmonised codes for the activities on which this paper concentrates. Thus Table 3 shows that food preparation has been coded in almost identical ways over the sequence of time-use diaries that comprise the MTUS and therefore provides the opportunity to analyse change over a thirty-year period from 1974 to 2005. In contrast laundry has not been consistently coded over time (Table 4) with the harmonisation for 1974 and 1995 particularly unclear. As a result analysis can only cover the twenty years from '1985' to 2005 and needs also to take into account that other clothing related practices might be included. Similarly, car use is also not consistently coded across the various surveys with the data for 1974 being difficult to use in comparative studies as it only coded car use for travel to or from work/school (Table 5) and car use in 1995 was not coded at all. As a result the following analysis of car use also uses data from only '1985', 2000 and 2005.

However despite these constraints and the variability in coding and methods described above it should be clear that the data allows the identification of sequences of activities which may be taken as indicators of specific practices. In addition the coding of travel mode and the ability to infer purpose of travel means that the relationship between energy demand for travel and for other purposes can be directly observed.

Overall, despite the deplorable lack of a more recent UK national time-use survey (Fisher and Gershuny 2013), the ability to construct a thirty year history of the timing, sequencing and, in some surveys, the location of activities provides a substantial basis for empirical analysis of changing practices over time. It should be noted however that the paper does not claim to be able to identify all facets of the materiality or meaning of practices from such data. Instead it follows Browne et al (2013) by claiming to analyse what might be termed *traces of* or *proxies for* practices. Thus whilst we are unable to explore the detailed contingencies or interconnected networks of materiality and meaning that are part and parcel of the moment by moment performance of practices (Warde 2005), we are nevertheless able to describe and analyse the variation in the temporal structure of the activities that represent the footprints of the these performances.

Table 1: Key features of the MTUS (World 6) UK time use surveys

Survey	Sample	Sample size (individuals) and period	Time interval	Notes
1974	All 5+ in representative household sample	2,598 February, March, August, September	30 minutes	7 diary days, primary & secondary activities (73 codes), location known, co-presence unknown
1983	Representative sample 14+	1,350 January, February, September, November, December	15 minutes	7 diary days, primary & secondary activities (188 codes), location known, co-presence of others known
1987	Representative sample 14+	1,586 March-June	15 minutes	7 diary days, primary & secondary activities (190 codes), location known, co-presence of others known
1995	Representative sample 16+	1,962 May	15 minutes	1 diary day, primary activities only (31 codes), location & co-presence of others unknown
2000	All 8+ in representative household sample	8,688 All months	10 minutes	7 diary days (weekday & weekend), primary & secondary activities (265 codes), location known, co-presence of others known
2005	Representative sample 16+	4,854 March, June, September, November	10 minutes	1 diary day, primary & secondary activities (30 codes), location known, co-presence of others unknown
MTUS Harmonised	**18+**	**As above**	**As above**	**1 – 7 diary days as available, primary & secondary activities (69 harmonised codes), location and co-presence as available**

Table 2: Example time-use data (MTUS, 1974 and 2000 samples)

1974											
	ID	Date	Day of week	Episode start	Episode end	Main	Secondary	Location	Mode of travel	Child present	Partner present
1	301279	14-Aug-74	Wednesday	04:00	05:30	sleep and naps	no recorded act	at own home	not travelling	could not be coded	could not be coded
2	301279	14-Aug-74	Wednesday	05:30	06:00	wash, dress	no recorded act	at own home	not travelling	could not be coded	could not be coded
3	301279	14-Aug-74	Wednesday	06:00	06:30	wash, dress	listen to radio	at own home	not travelling	could not be coded	could not be coded
4	301279	14-Aug-74	Wednesday	06:30	07:00	meals or drinks	listen to radio	at own home	not travelling	could not be coded	could not be coded
5	301279	14-Aug-74	Wednesday	07:00	07:30	travel to work	no recorded act	travelling	other/unknown	could not be coded	could not be coded
6	301279	14-Aug-74	Wednesday	07:30	10:00	paid work	no recorded act	at workplace	not travelling	could not be coded	could not be coded
7	301279	14-Aug-74	Wednesday	10:00	10:30	meals at work	no recorded act	at workplace	not travelling	could not be coded	could not be coded
8	301279	14-Aug-74	Wednesday	10:30	13:30	paid work	no recorded act	at workplace	not travelling	could not be coded	could not be coded
9	301279	14-Aug-74	Wednesday	13:30	14:00	meals at work	no recorded act	at workplace	not travelling	could not be coded	could not be coded
10	301279	14-Aug-74	Wednesday	14:00	16:30	paid work	no recorded act	at workplace	not travelling	could not be coded	could not be coded
2005											
	ID	Date	Day of week	Episode start	Episode end	Main	Secondary	Location	Mode of travel	Child present	Partner present
1	338122	25-Jun-00	Sunday	04:00	08:00	sleep and naps	no recorded act	at own home	not travelling	no	no
2	338122	25-Jun-00	Sunday	08:00	08:20	wash, dress	no recorded act	at own home	not travelling	no	yes
3	338122	25-Jun-00	Sunday	08:20	08:30	pet care	no recorded act	at own home	not travelling	no	yes
4	338122	25-Jun-00	Sunday	08:30	08:40	food prep	conversation	at own home	not travelling	no	yes
5	338122	25-Jun-00	Sunday	08:40	09:10	food prep	no recorded act	at own home	not travelling	no	yes
6	338122	25-Jun-00	Sunday	09:10	09:20	meals or drinking	conversation	at own home	not travelling	no	yes
7	338122	25-Jun-00	Sunday	09:20	09:50	meals or drinking	no recorded act	at own home	not travelling	no	yes
8	338122	25-Jun-00	Sunday	09:50	10:00	Set/clear table	no recorded act	at own home	not travelling	no	yes
9	338122	25-Jun-00	Sunday	10:00	10:20	Voluntary	no recorded act	travelling	walk / other	no	yes
10	338122	25-Jun-00	Sunday	10:20	11:20	Worship	no recorded act	at place of worship	not travelling	no	yes

Table 3: MTUS code 18: Food preparation, cook

	Coding
1974	53 Prepare meals or snacks
1983-87	0601 Food preparation 0602 Bake, freeze foods, make jams, pickles, preserves, dry herbs 0604 Make a cup of tea, coffee
1995	3 Cooking
2000	3100 Unspecified food management 3110 Food preparation 3120 Baking 3140 Preserving
2005	Pact=5 (preparing food)

Table 4: MTUS code 21: Laundry, ironing, clothing repair

	Coding
1974	50 Other essential domestic work
1983-87	0701 Wash clothes, hang out / bring in washing 0702 Iron clothes 0801 Repair, upkeep of clothes
1995	14 Clothes
2000	3300 Unspecified making and care for textiles 3310 Laundry 3320 Ironing 3390 Other specified making and care for textiles
2005	Pact=7 (washing clothes)

Table 5: MTUS coding of car travel

	Travel	Label	Notes
1974	Mtrav = 1	Car, motorcycle, taxi	45 Travel to work/school by car
1985	MTRAV = 1	Car, motorcycle, taxi	36 Car, motorcycle (includes taxi)
1995	MTRAV	Any	Not possible to create
2000	Mtrav = 1	Car, motorcycle, taxi	Wher=11 (unspecified private transport) Wher=14 (moped, motorcycle, motor boat) Wher=15 (drive car) Wher=16 (passenger in car) Wher=17 (car, not sure if driving) Wher=18 (lorry or tractor) Wher=19 (van) Wher=20 (other specified private motor transport) Wher=22 (taxi)
2005	Mtrav = 1	Car, motorcycle, taxi	Pact / Sact = 41 to 45 (travel by car)

Analytic approach

This paper takes a relatively basic approach to the analysis of the data described in Table 1 and especially Table 2. Thus, whilst it would be possible to include secondary activities, the rate of recording of secondary acts varies substantially between surveys with 30% of episodes having a reported secondary activity in 1985 but only 16% in 2005. As the reasons for this difference could be any combination of the design of the diary instrument, the method of respondent diary completion and the proclivity to record secondary acts as well as the level of 'multi-tasking' itself, the paper focuses solely on primary activities.

In addition to counteract the problem of differing diary activity recording durations, the data have been converted from episodes (c.f. Table 2) to a sampled form where at least one instance of the particular activity of interest in a given half hour is taken as an activity indicator (Anderson Under review). Although imperfect as it is unable to represent the duration of activities, this approach enables meaningful comparisons across time to be made and, in addition, has the benefit of mapping on to the half hour 'settlement periods' which both domestic gas and electricity billing are tending towards (Darby 2010). In the mainly descriptive analysis presented below this indicator is used to illustrate the level of reporting of the activities of interest and the relative temporal distribution of that reporting during the day and days of the week within different survey years.

As will become clear, change over time is then generally represented as a percentage point change in this relative within-year temporal distribution. This approach highlights apparent shifts in the distribution of the activities over time of day and/or days of the week but does not enable analysis of absolute change over time in terms of duration or prevalence.

Changing times: food preparation and laundry

As might be expected from the longer duration diary slots, Figure 1 (absolute reporting rate) suggests that reported food preparation decreased from 1974 onwards and this is especially noticeable at breakfast and lunch times with an additional shifting of 'peak evening' food preparation from 17:00 to slightly later. Overall substantial change may have taken place between 1974 and 1985 but with a slower rate of change thereafter confirming Cheng et al's results for the reduction in total time spent preparing food in the UK between 1974 and 2000 (Cheng et al. 2007, 46). As above, to offset the influence of reporting methods the relative distribution of reported food preparation within years can also be considered (Figure 2). To some extent this confirms the trends in absolute reporting of food preparation described above but also highlights the disappearance of late evening food preparation which may have been associated with preparing food for the next day or for a late 'supper' (Cheng et al. 2007).

However Figure 3, which considers the percentage point change from 1974 to 2005 by day of the week, clearly shows a reduction in the proportion of food preparation that was reported in late mornings on and lunchtimes on Sunday. As an example, the percentage point reduction of 0.4% at 13:30 on Sunday corresponds to a 48% decrease in the rate of reporting of this activity. In contrast the proportion of food preparation reported on Sunday mornings and evenings increased between 1974 and 2005 while a similar pattern of change can be seen for Saturdays and weekdays albeit with a much lower magnitude.

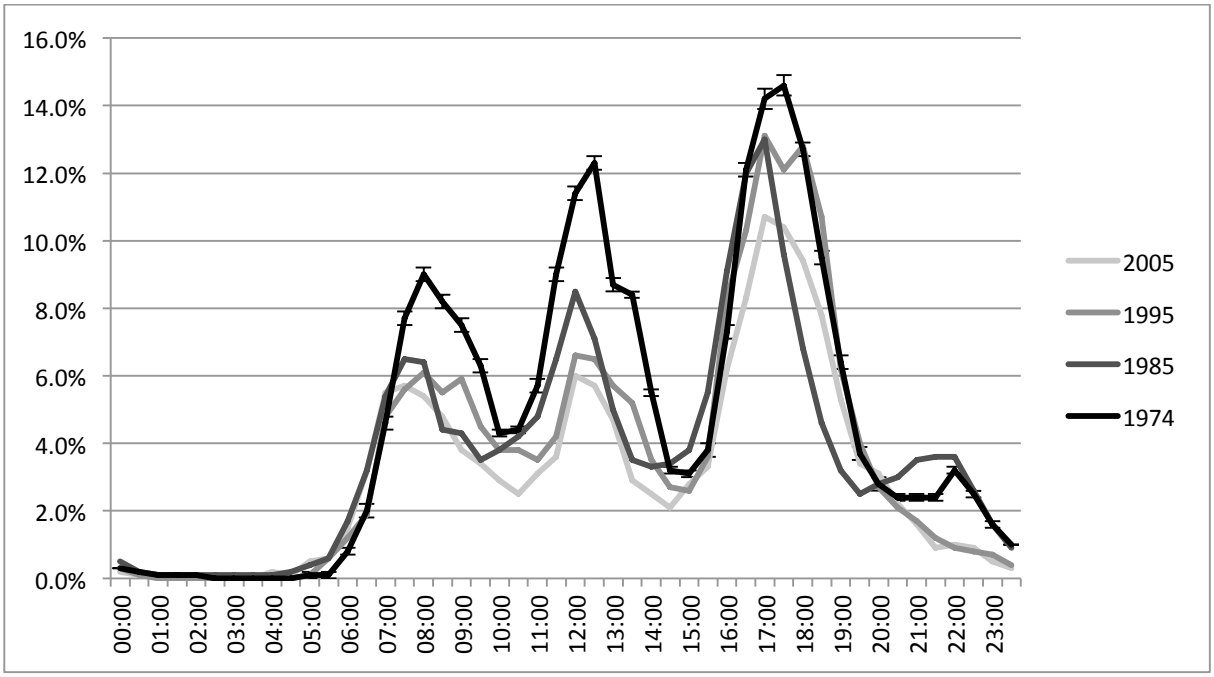

Figure 1: Percentage of activities reported as food preparation in each half hour (MTUS 1974-2005, weighted)

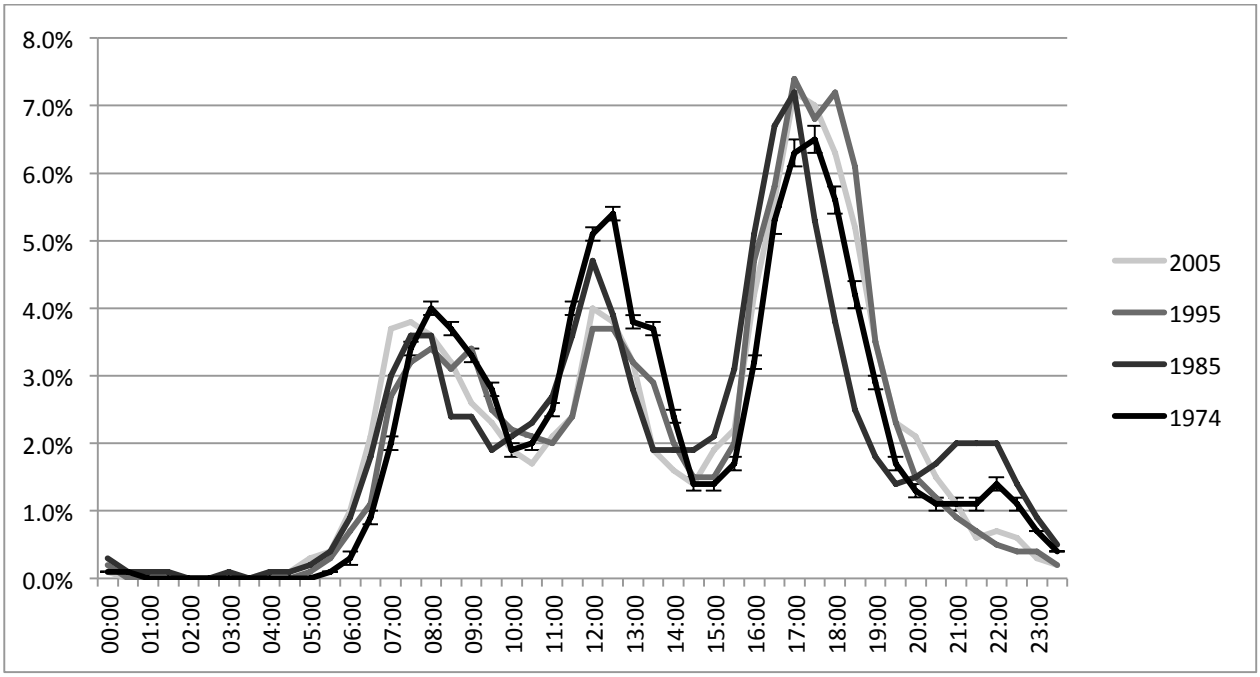

Figure 2: Relative distribution of the percentage of all 'food preparation' reported in each half hour per year (MTUS 1974-2005, weighted)

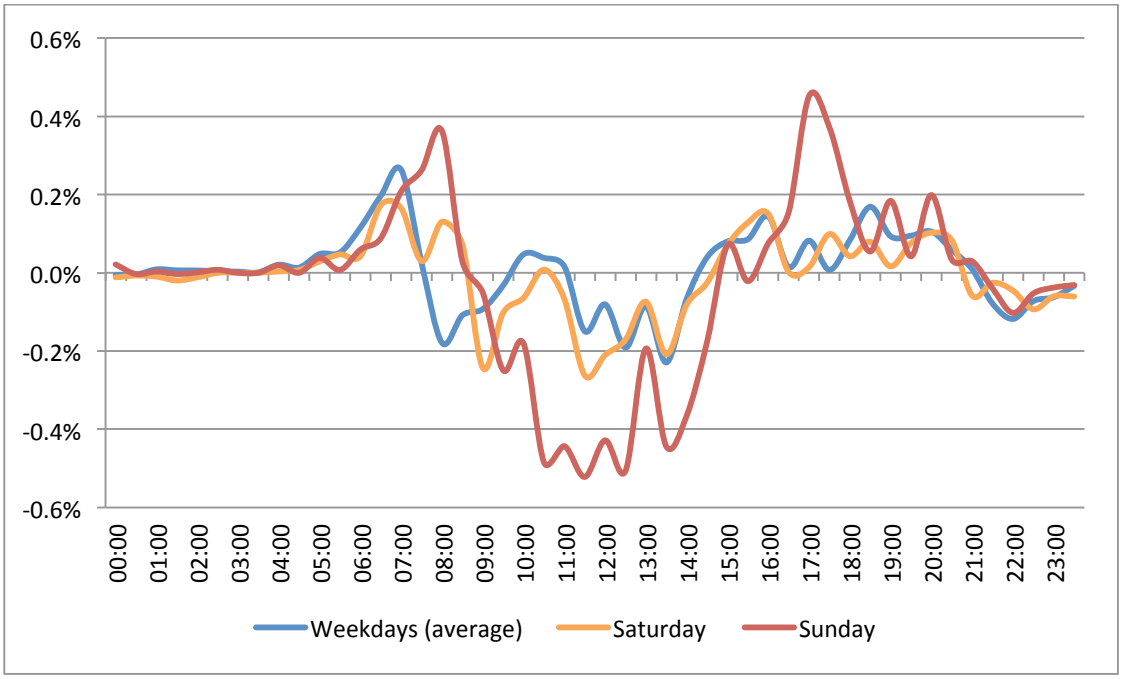

Figure 3: Percentage point change in food preparation reported in each half hour by day of the week (MTUS 1974-2005, weighted)

Further analysis focusing on 'Sunday lunch' (food preparation 11:00 – 14:00 on a Sunday) suggests that preparing 'Sunday lunch' has declined for most age groups and especially for those aged under 64 (Figure 4). Preparing Sunday lunch has also markedly declined for the middle and highest income groups but less so for the lowest income group who are also more likely to be over retirement age. This does not imply, of course, that less eating is done on Sunday – just that some of it, particularly for higher income groups, may now be done outside the home or later in the day (c.f. Figure 3 and also (Cheng et al. 2007)).

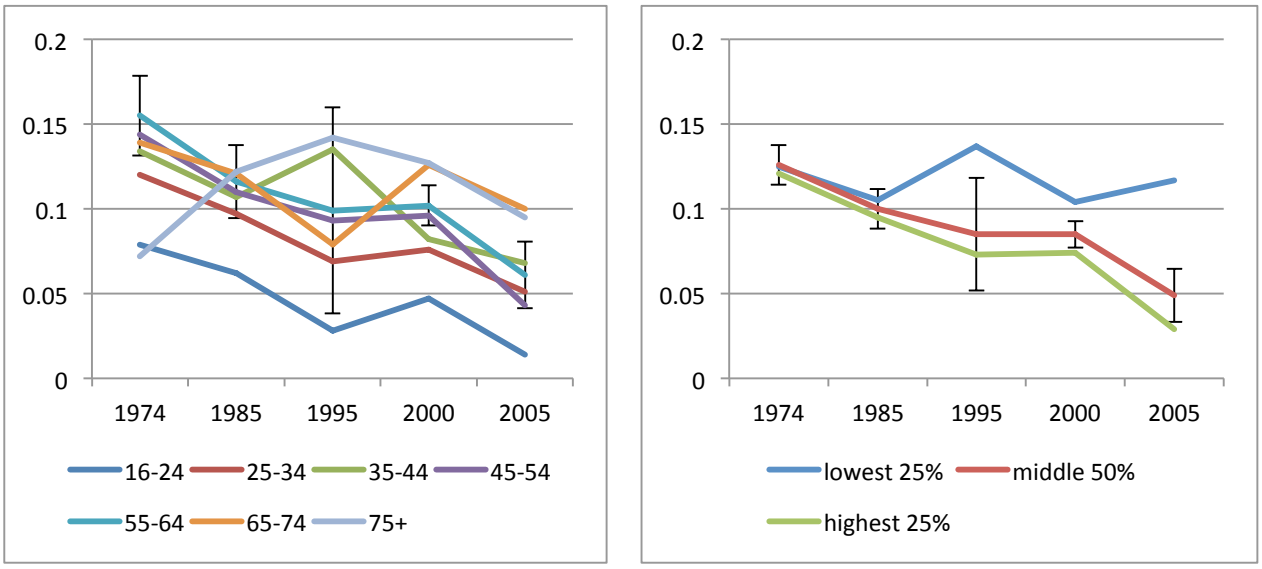

Figure 4: Mean number of half hours in which 'food preparation' at home on Sunday 11:00-14:00 was reported in each survey by age group (left) and income group (right) (MTUS 1974-2005, weighted, error bars are +/- 95% confidence interval for the 45-54 age group or the middle income group only)

In contrast to food preparation, laundry can only be meaningfully analysed from 1985 onwards (Table 4). With this in mind, Figure 5 shows the percentage point change from 1985 to 2005 in reported laundry half-hours on each day of the week by gender. Given the continuing gendered nature of laundry with 92% of recorded laundry half-hours being reported by women in 1985 and 84% in 2005, it is the shift in female reported laundry away from weekdays (especially Mondays) and towards Fridays and Sundays that is most evident. Thus the 5 percentage point increase in reported laundry on Sundays corresponds to a 32% increase in the rate of reporting and similarly the 5% increase on Fridays corresponds to an even more substantial 45% increase in the rate of reporting.

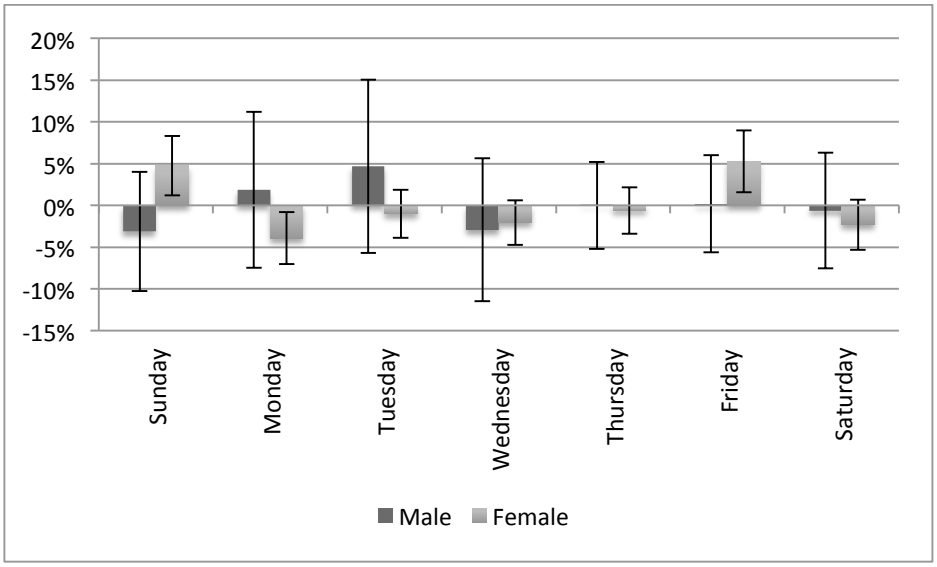

Figure 5: Percentage point increase/decrease in reported laundry by day of the week for men and women from 1985 to 2005 (MTUS UK sub-sample, weighted, indicator = any laundry in a half hour, confidence intervals = +/- 95% for 1985 proportion)

Further analysis by time of day within year (Figure 6) and of change by time of day across days of the week (Figure 7) suggest that in 2005 far more of the reported laundry was in the early morning (06:00 – 09:00) on both weekdays and Saturdays than was the case in 1985. Indeed the increase in early morning laundry for weekdays is predominantly early on Monday and Friday mornings (not shown) and, in the case of the latter, constitutes most of the change shown in Figure 5. This shift appears to have occurred alongside a reduction in weekday daytime, and especially later morning laundry on Saturdays. However the most obvious changes are focused on Sunday with an increase in morning (08:00 – 11:00), early afternoon and also early evening (20:00) laundry which may, given the definition of the time use activities, also include ironing.

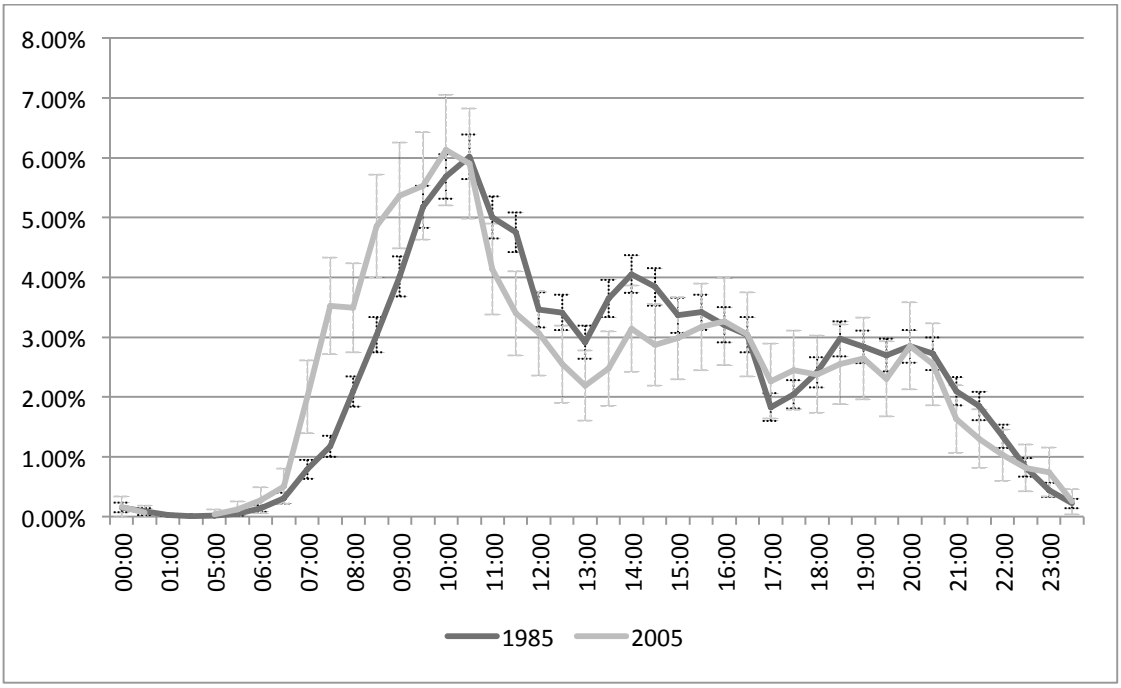

Figure 6: Relative distribution of % of yearly laundry half-hours by weekday vs weekend and by time of day for each year (MTUS UK sub-sample weighted, error bars are 95% confidence intervals).

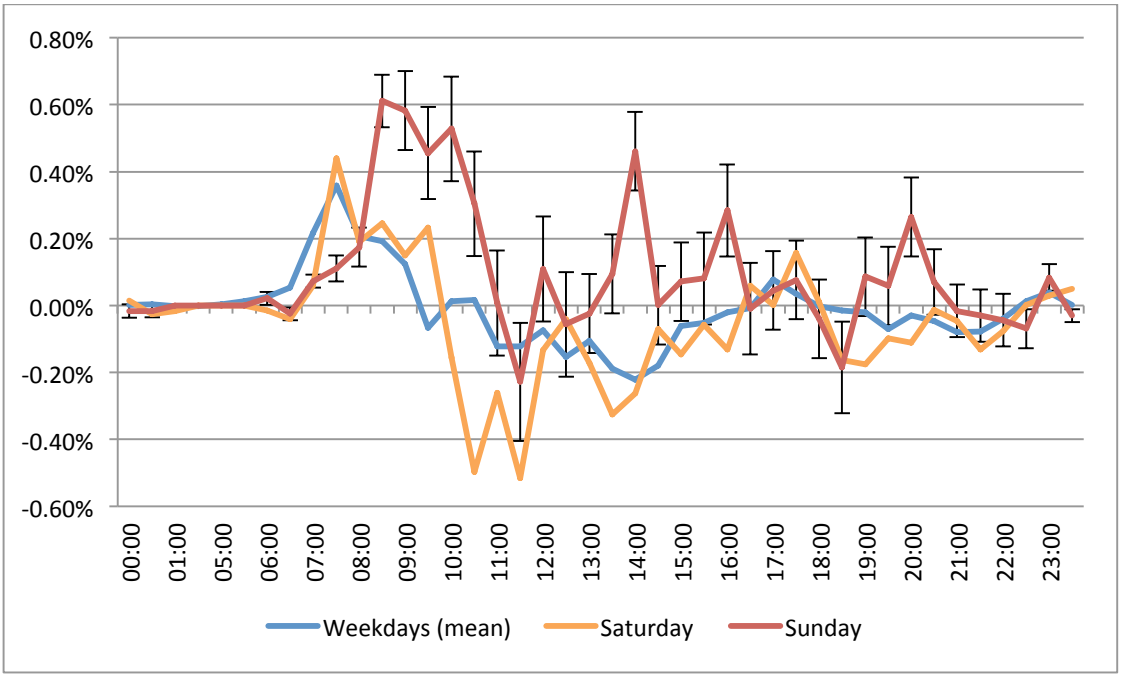

Figure 7: % point change in timing of reported laundry by weekday vs weekend and by time of day for each year (MTUS UK sub-sample weighted, for clarity, only 95% confidence intervals for Sunday included).

These shifts are hardly surprising given the strongly gendered nature of laundry confirmed above. The rate of female UK MTUS respondents aged 20-59 in full time paid work roughly doubled from 22% (35% part time) in 1985 to 42% (30% part time) in 2005, and so it is likely that one factor in the evolution of patterns of laundry over that time may be changes in female labour market participation. Indeed more detailed analysis (not shown) suggests that both early morning weekday

and early evening laundry, which coincides with peak electricity demand, is more likely to be reported by (female) respondent who were in full time work. It is also noticeable that despite the increasing availability of timers or scheduling mechanisms, there has been no increase in the very low level of late or overnight laundry.

Future demand: current car use and electric vehicle charging

As might be expected absolute levels of reported car use increased substantially during 'peak travel' between 1985 and 2005 (Figure 8) with just over 8% of respondents reporting travelling by car (either as a driver or passenger) at 08:00 and again at 17:30 compared to 5% and 6% in 1985. However it is also noticeable that day-time car use roughly doubled during the period 1985 to 2000 but then remained largely unchanged to 2005.

Interestingly the relative distribution of car use within years (Figure 9) shows rather less substantial change. Of the car use reported, there seems to be slightly more early morning car use in 2005 and less from 18:00 onwards but more during the middle of the day suggesting a slight shift towards an earlier start to morning commuting and increased mid-day non-commuting use. Analysis of the sequences of activities of which this car use is part has suggested that the former may be related to longer morning commutes to include the transportation of children to school and the latter may be related to increased use of the car for shopping (Mattioli, Anable, and Vrotsou Under review) and also to increased availability of second cars during working hours.

These small relative shifts are confirmed by Figure 10 which shows that the increased mid-day use appears to be concentrated on Saturdays and Sundays which also show the relative decrease from 18:00 onwards although as noted the magnitude of the change is relatively small. This figure also highlights the increase in car use early on Saturday mornings which is almost certainly generated by increased use of taxis although it would only be possible to unpack this using the 2000 diary data (c.f. Table 5).

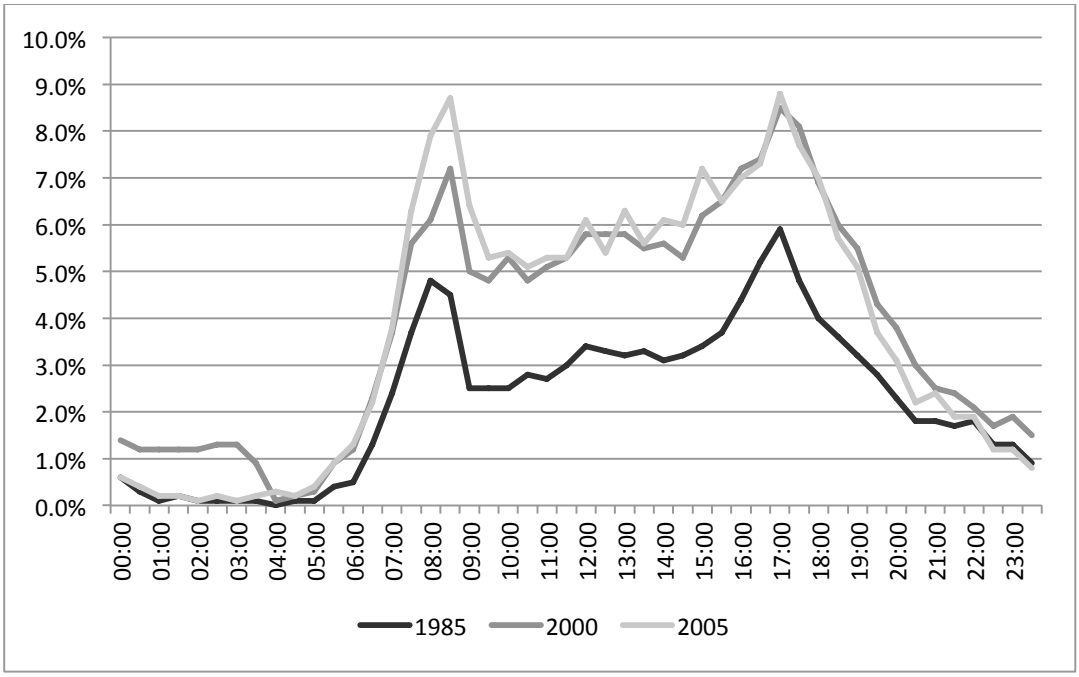

Figure 8: % of half hours with any reported car travel by weekday vs weekend and by time of day

for each year (MTUS UK sub-sample weighted, error bars omitted for clarity).

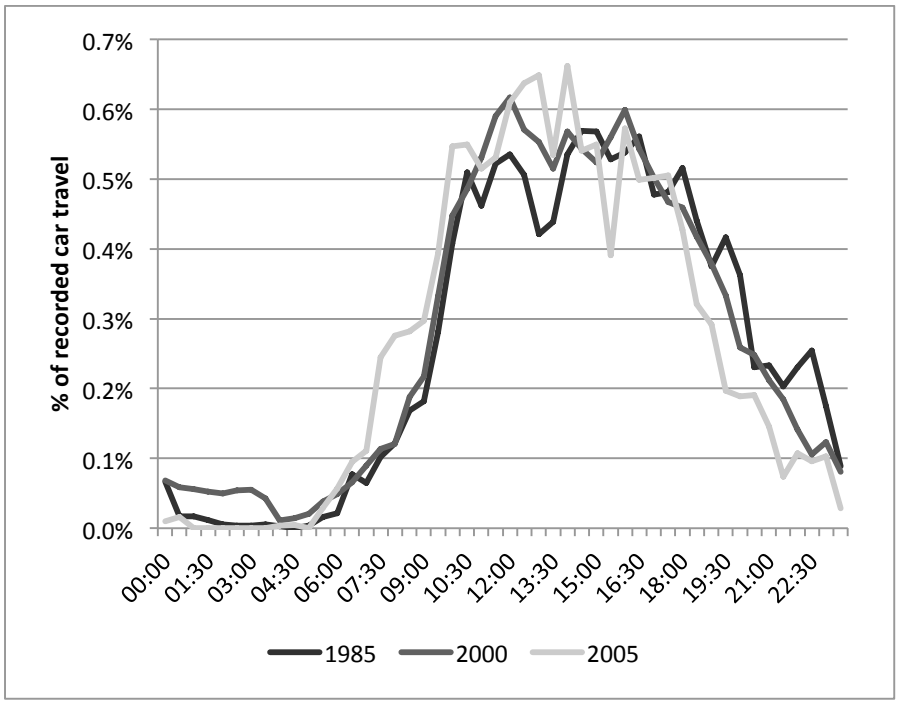

Figure 9: Relative distribution of % of car travel half-hours by weekday vs weekend and by time of day for each year (MTUS UK sub-sample weighted, error bars omitted for clarity).

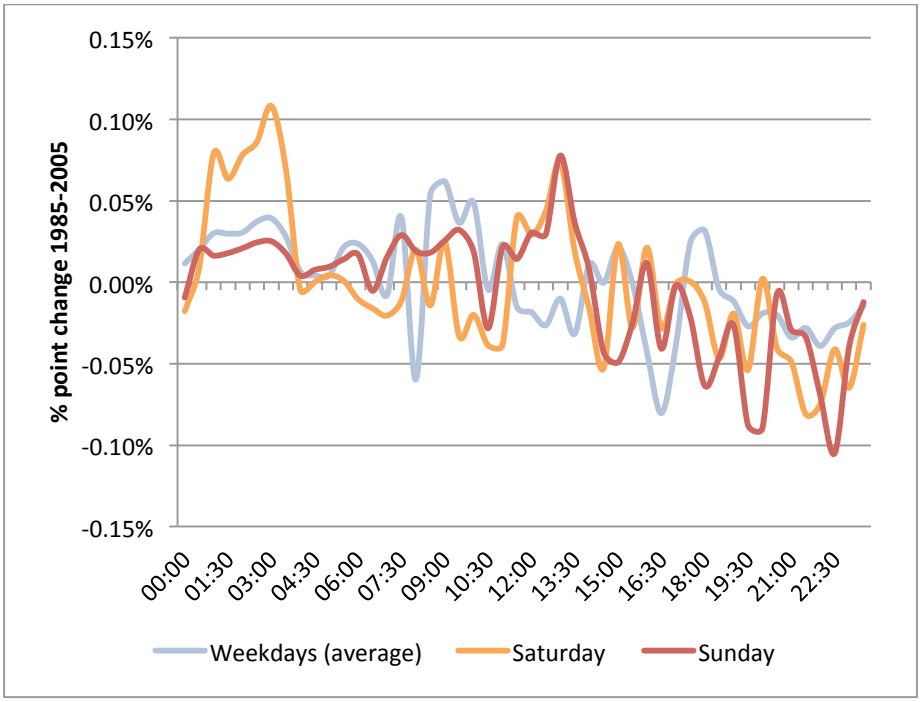

Figure 10: % point change in timing of reported laundry by weekday vs weekend and by time of day for each year (MTUS UK sub-sample weighted, confidence intervals omitted for clarity).

Whilst these evolving patterns are of interest in themselves in understanding the evolving 'cargo' functions of the car (Mattioli, Anable, and Vrotsou Under review) and thus demand for energy for mobility in relation to other practices, the focus here is on the implications of these patterns for insights into future charging of electric vehicles. If we assume that electric vehicles will be used at the same times and for similar purposes to current carbon-fuelled cars then the time diary data can

support the analysis of the probable timing of demand for re-charging. This timing is crucial to the successful engineering of local distribution networks to support EV charging (Neaimeh et al. 2013) and the results of such an analysis are shown in Figure 11.

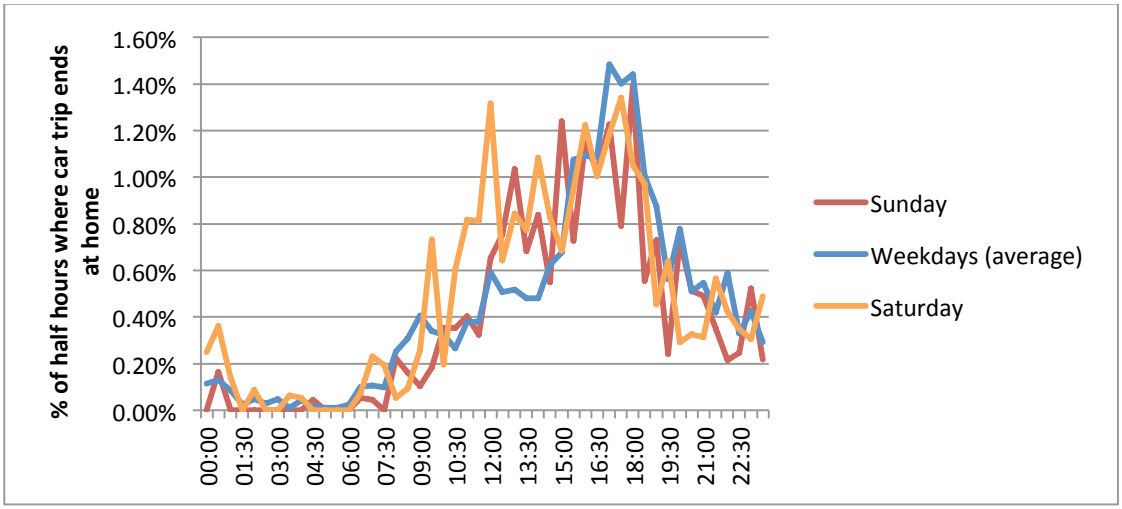

Figure 11: % of half-hours where a car trip ends at home (MTUS UK sub-sample weighted, confidence intervals omitted for clarity).

As would be expected, during the week most car-use that ends at home occurs in the afternoons following school (16:00) or evening following work (18:00) although there are also discernable 'mini-peaks' at 09:00 and 12:00. This pattern is clearly likely to impact weekday evening peak electricity demand and reflects on-going experimental charging control and tariff trials. However the pattern for Saturdays is noticeably different with a peak in charging demand to be expected in the late morning potentially following use of the car for shopping. Sunday also shows a different profile with increased levels of charging demand likely at around mid-day and through the afternoon and early evening.

Discussion

The overall aim of this paper was to demonstrate the value of historical time use data in understanding the changing nature of everyday practices that demand energy. To do this the paper introduced the Multinational Time Use Study and outlined the form and availability of harmonised time use data from representative national UK surveys over the last 30 years.

The paper then showed how the timing of three energy demanding practices have changed over time. In the case of food preparation the results suggest that food preparation during the week has been subtly redistributed towards slightly earlier and slightly later time periods with a slight reduction of food preparation during the middle of the day. However the most notable changes are to be seen on Sundays with significant reduction in food preparation during late morning and increased food preparation both earlier and later in the day. As the analysis shows these changes are not uniform across social groups indicating considerable heterogeneity not only in the likelihood of performing this practice but also in the rate of change in the prevalence of that performance (or prevalence.

In the case of laundry the (still) strongly gendered nature of the activity together with changing labour force participation by women appears to have contributed to a significant shift towards early morning weekday, evening 'peak' and Sunday morning laundry. These changes have implications for

energy demand since early morning laundry may contribute to an emerging 'morning demand' peak whilst evening laundry with it's potential to require machine drying contributes to the already problematic 'evening peak' demand. Furthermore the shift away from mid-day weekday laundry offers further problems for the potential to match local mid-day generation to domestic energy use to counteract emerging problems of over-supply of photovoltaic generation in local distribution networks during summer working hours.

In the case of car use the analysis not only illustrated the relatively small scale but nonetheless indicative shifts in the distribution of car use from 1985 to 2005 but also illustrated the potential to match mid-day weekend, and especially Saturday charging to local photovoltaic generation. This would not only to provide 'free' fuel but as with mid-day laundry, would provide a storage/power 'sink' to reduce the potentially problematic daytime photovoltaic generation load on local distribution networks.

In all cases the analysis raises rather more questions than it answers but through the presentation of the time use survey data has sought to illustrate opportunities to extend the analysis. Thus the sequence of activities surrounding car use could be used to identify the likely cause of the temporal shifts in early morning car use and further analysis of food preparation by gender and labour market participation may enable similar insights to those already derived for laundry.

Finally the near future availability of the recent 2014/15 UK time use diary survey will mean that the analysis can be updated to the present and more complex analysis of trends over time with multiple observation points can be considered. In addition more recent data will also enable the development of age cohort analysis which can start to unpick age and cohort effects on the prevalence of the performances of various practices over time. This in turn will support a substantially more rigorous analysis of the epidemiology of energy demanding practices over time.

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References

Anable, Jillian, Ben Anderson, Elizabeth Shove, and Jacopo Torriti. 2014. 'Categories, Concepts and Units: Energy in and Through Time'. DEMAND Working Paper. http://www.demand.ac.uk/29/07/2014/wp-3-categories-concepts-and-units/.

Anderson, Ben. Under review. 'Laundry, Energy and Time'. *Energy Research and Social Science*

Browne, Alison L, Will Medd, and Ben Anderson. 2013. 'Developing Novel Approaches to Tracking Domestic Water Demand Under Uncertainty—A Reflection on the "Up Scaling" of Social Science Approaches in the United Kingdom'. *Water Resources Management* 27 (4): 1013–35.

Cheng, Shu-Li, Wendy Olsen, Dale Southerton, and Alan Warde. 2007. 'The Changing Practice of Eating: Evidence from UK Time Diaries, 1975 and 20001'. *The British Journal of Sociology* 58 (1): 39–61.

Darby, Sarah. 2010. 'Smart Metering: What Potential for Householder Engagement?' *Building Research & Information* 38 (5): 442–57.

DECC. 2014. 'Developing DECC's Evidence Base'. London. https://www.gov.uk/government/publications/developing-deccs-evidence-base.

Druckman, Angela, Ian Buck, Bronwyn Hayward, and Tim Jackson. 2012. 'Time, Gender and Carbon: A Study of the Carbon Implications of British Adults' Use of Time'. *Ecological Economics* 84: 153–63.

Ellegård, K, and J Palm. 2011. 'Visualizing Energy Consumption Activities as a Tool for Making Everyday Life More Sustainable'. *Applied Energy* 88 (5): 1920–26.

Fisher, Kimberly, and Jonathan Gershuny. 2013. 'The 2014-2015 United Kindom Time Use Survey'. *Electronic International Journal of Time Use Research* 10 (1): 91–111. doi:10.13085/eIJTUR.10.1.91-111.

Gershuny, Jonathan, Kimberly Fisher, Evrim Altintas, Alyssa Borkosky, Donna Dosman, Cara Fedick, Tyler Frederick, et al. 2012. 'Multinational Time Use Study, Versions World 5.5.3, 5.80 and 6.0 (released October 2012)'. Oxford.

Higginson, Sarah, Murray Thomson, and Tracy Bhamra. 2013. '"For the Times They Are a-Changin": The Impact of Shifting Energy-Use Practices in Time and Space'. *Local Environment*, June, 1–19. doi:10.1080/13549839.2013.802459.

Huebner, Gesche M., Ian Hamilton, Zaid Chalabi, David Shipworth, and Tadj Oreszczyn. 2015. 'Explaining Domestic Energy consumption–The Comparative Contribution of Building Factors, Socio-Demographics, Behaviours and Attitudes'. *Applied Energy* 159: 589–600.

Janda, Kathryn B. 2011. 'Buildings Don't Use Energy: People Do'. *Architectural Science Review* 54 (1): 15–22.

Mattioli, Giulio, Jillian Anable, and Katerina Vrotsou. Under review. 'Car Dependent Practices: Findings from a Sequence Pattern Mining Study of UK Time Use Data'

McKenna, Eoghan, and Murray Thomson. 2016. 'High-Resolution Stochastic Integrated Thermal–electrical Domestic Demand Model'. *Applied Energy* 165 (March): 445–61. doi:10.1016/j.apenergy.2015.12.089.

Neaimeh, Myriam, Graeme Hill, Phil Blythe, Robin Wardle, and Phil Taylor. 2013. 'Integrating Smart Meter and Electric Vehicle Charging Data to Predict Distribution Network Impacts'. In *IEEE PES ISGT Europe 2013*, 1–5. IEEE. doi:10.1109/ISGTEurope.2013.6695238.

Palm, J, and K Ellegård. 2011. 'Visualizing Energy Consumption Activities as a Tool for Developing Effective Policy'. *International Journal of Consumer Studies*.

Pullinger, M, B Anderson, A Browne, and W Medd. 2014. 'New Directions in Understanding Household Water Demand: A Practices Perspective'. *Journal of Water Supply: Research and Technology - AQUA*.

Reckwitz, Andreas. 2002. 'Toward a Theory of Social Practices'. *European Journal of Social Theory* 5 (2): 243–63. doi:10.1177/13684310222225432.

Shove, Elizabeth. 2003. *Comfort, Cleanliness and Convenience: The Social Organisation of Normality*. London: Berg.

———. 2012. 'Putting Practice into Policy: Reconfiguring Questions of Consumption and Climate Change'. *Contemporary Social Science*, no. iFirst (April): 1–15.

Shove, Elizabeth, Mika Pantzar, and Matt Watson. 2012. *The Dynamics of Social Practice: Everyday Life and How It Changes*. SAGE.

Shove, E., and G. Walker. 2014. 'What Is Energy For? Social Practice and Energy Demand'. *Theory, Culture & Society*, July, 0263276414536746 – . doi:10.1177/0263276414536746.

Sofoulis, Zoë. 2011. 'Skirting Complexity: The Retarding Quest for the Average Water User'. *Continuum* 25 (6): 795–810.

Torriti, J. 2012. 'Demand Side Management for the European Supergrid: Occupancy Variances of European Single-Person Households'. *Energy Policy*.

Warde, Alan. 2005. 'Consumption and Theories of Practice'. *Journal of Consumer Culture* 5 (2): 131–53.

Widén, J, M Lundh, and I Vassileva. 2009. 'Constructing Load Profiles for Household Electricity and Hot Water from Time-Use data—Modelling Approach and Validation'. *Energy and Buildings* 41 (7): 753–68.