

Anable, J., Anderson, B., Shove, E. and Torriti, J. (2014) *Categories, Concepts and Units: Representing energy demand in and through time*. Working Paper 3, Lancaster: DEMAND Centre

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# Categories, Concepts and Units: Representing energy demand in and through time

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DEMAND Working Paper 3.<sup>1</sup>

## Abstract

Methods of data collection are unavoidably rooted in some sort of theoretical paradigm, and are inextricably tied to an implicit agenda or broad problem framing. These prior orientations are not always explicit, but they matter for what data is collected and how it is used. They also structure opportunities for asking new questions, for linking or bridging between existing data sets and they matter even more when data is re-purposed for uses not initially anticipated. In this paper we provide an historical and comparative review of the changing categories used in organising and collecting data on mobility/travel and time use as part of ongoing work to understand, conceptualise and describe the changing patterns of domestic and mobility related energy demand within UK society. This exercise reveals systematic differences of method and approach, for instance in units of measurement, in how issues of time/duration and periodicity are handled, and how these strategies relate to the questions such data is routinely used to address. It also points to more fundamental differences in how traditions of research into mobility, domestic energy and time use have developed. We end with a discussion of the practical implications of these diverse histories for understanding and analysing changing patterns of energy/mobility demand at different scales.

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## Introduction

If we are to achieve the UK policy goal of reducing energy consumption by 20% (DECC 2013) we need to understand what people *actually do* with energy, why they do it and how the current state of play came to be. Only then can policies or commercial strategies intervene effectively in the UK's socio-technical energy ecosystem. This paper, which arises from an ongoing programme of work responding to this need, aims to understand, conceptualise and describe the changing nature of the social activities that underpin domestic and mobility related energy demand in UK society.

Our approach to this challenge begins from first principles, arguing that people use energy, and move around in the course of, and as part of accomplishing social practices of one kind or another. From this it follows that understanding energy demand depends, above all, on understanding the timing and location of a range of inter-connected social practices (Shove 2012). In short we need to know what people are doing, when, where, for how long, and with what implications for energy demand.

As we go on to describe, the types of potentially useful data that have been collected to date reflect contrasting traditions each of which has its own history, each marked by a series of specific ambitions, accidents of funding, changing policy priorities and institutional interests. The key features and moments in these diverse trajectories have not arisen by accident, but are, we argue, outcomes of the changing rationales and preoccupations around which various forms of data collection and analysis are justified and organised. By implication, the problems we have in bridging between studies of energy, time and mobility arise from the fact that issues of 'demand' are conceptualised in radically different ways across these fields.

In describing these features and moments, we have three main aims. One is to provide some social historical background and hence some partial understanding of how it is that contemporary forms of data collection come to be as they are in relation to the still mostly separate fields of time use, energy demand and mobility. A second is to identify and review the various methods and units of measurement that are employed across these domains. Thirdly, and more ambitiously, we build on this discussion as a means of exploring possible ways not of integrating but of exploiting these separate sources, in order to proceed with the project of characterising and analysing energy demand, here viewed as an outcome of the many social practices that are reproduced in the UK today. The resulting paper involves a combination of methodological history, reflection and synthesis. As becomes clear, the strategy of setting traditions of time use, energy and mobility research alongside each other brings differences of purpose and orientation sharply into view.

In the short term, there may be ways of working with existing data and of using it to address critical but unconventional questions. Having a sense of how past lines of enquiry have developed allows us to explore these issues. However, in so far as forms of data collection and analysis *follow from* predefined problem definitions, it will be hard to move beyond these established lines of enquiry unless and until there is some radical re-definition of 'the problem' of energy demand by those who fund and commission research. By implication, possibilities for (better) capturing the broader dynamics of demand depend on the formulation and prioritisation of fresh cross-sectoral questions, and for new lines of enquiry developed in response.

We do not offer a comprehensive history of data collection in three sub-disciplinary fields. However, our necessarily selective review is nonetheless useful in identifying and explaining critical points of difference in method and purpose. We begin with a brief account of what it means to think of energy demand as the outcome of social practices (Shove 2003, 2012; Warde 2005) and lay out the

'knowledge requirements' that follow from this approach. This in turn leads to a discussion of data sources that could fulfil these requirements. We then briefly characterise current approaches to the consideration of time and timing in energy demand research and in doing so we note the (to us) over emphasis on economic 'rational', asocial, a-temporal and atomistic consumption averages. As we suggest, narratives recognising the importance of variation and change are essentially missing. Reflecting our primary interest in characterising changing patterns of demand, we then give a sense of the types of questions and underlying concerns that have been addressed in time use and mobility studies, showing how these shape the fine grain of data collection and analysis. Taken together, these reviews illustrate how units and categories evolve alongside the practices they seek to capture, and how the studies themselves reflect an ever-shifting range of policy-relevant preoccupations including work, employment and leisure. Finally, we provide a reflective commentary that brings the reviews together and notes opportunities for innovative analysis.

## Energy demand: First principles

As we have noted above, the main purpose of this paper is to help conceptualise and describe the changing demand for energy within UK society with a particular focus on domestic energy use and energy use for personal mobility. Even a cursory review of the energy demand literature suggests that whilst thinking about energy *as if people mattered* is not that uncommon, asking questions about *what people do* and about how this relates to patterns of energy demand is a surprisingly radical objective (Shove et al. 2008; Skea 2009). To make progress we first take a step back in order to establish some basic principles from which to proceed:

- 1) *Energy demand is an emergent outcome of what people do and 'what people do' is seen as a nexus of the social practices in which they are engaged, the time at which they are enacted and the place(s) in which they performed.*
- 2) *Variation and change in energy demand must therefore relate to:*
  - a) *Variation and change in the performance of social practices that directly or indirectly require energy;*
  - b) *Variation and change in the temporal and spatial distributions of these performances;*
  - c) *Variation and change in the 'energy intensity' of these performances.*
- 3) *Our research programme must therefore be able to:*
  - a) *Define, recognise and reveal the changing performances of practices over space and time*
  - b) *Detect the processes that reproduce and transform practices over time*
  - c) *Support the analysis of the changing resource intensity of these transforming practices* (SPRG 2012)

It follows from these principles that understanding energy demand depends, above all, on understanding the timing and location of a range of interconnected social practices. It also follows that we need to combine data on the sequencing, synchronisation, timing, location and performance of a range of social practices and we need to do this across the UK population and over time.

Whilst the academic and policy literatures contain an increasing number of studies of current energy consumption as measured through household metering, appliance monitoring and the like (Richardson et al. 2010; Yohanis et al. 2008; Zimmerman et al. 2012), there has been little attempt to consider the interconnections between the practices that underpin these summary patterns of demand. We therefore have very little idea *how energy is actually used in everyday life* and we have very little idea of the degree of variation that exists within the oft-reported 'consumption averages' or of the temporal relationships involved. Furthermore, as far as we are aware there have been very few considerations of how the performances and significances of these patterns may have evolved over time (Shove 2003).

Although out of scope of this paper, it is also clear that if we want to make the step from social practices to energy itself then we need to find ways of assigning 'energy/carbon intensity' to the various performances of the practices of interest so that future 'scenario modelling' of changing performances and/or prevalence of social practices can have worked-through 'energy/carbon implications'.

## Current approaches to time and timing in energy demand

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 our analytic purposes. Current studies of domestic energy demand concentrate on overall consumption or appliance use measurement. Thus rather than seeking to link practices through appliances (or lighting & heating systems) to consumption, the nature of the activities that generate observed consumption is essentially ignored. Similarly, approaches to analysing mobility (and related energy demand) tend to focus on emergent patterns of transport 'demand' and on the average direct and indirect energy implications of volumes of 'transport' of different modes rather than considering the social practices that might be generating (or be a consequence of) that mobility in the first place.

In the domestic context, methods of quantifying energy demand are rooted in disciplines as divergent as energy econometrics, electrical engineering, environmental psychology and household economics. Summaries and reviews of studies and models of energy demand tend to be organised with reference to discipline (Espey and Espey 2004) or to the method of analysis (Jebaraj and Iniyar 2006; Suganthi and Samuel 2012; Swan and Ugursal 2009). There are important differences of approach, but in general the most frequent mode of domestic energy analysis involves linking measurements of building characteristics, appliance ownership, environmental data and energy consumption to limited socio-economic characteristics of the occupants using a range of statistical models (Aigner, Sorooshian, and Kerwin 1984; Dilaver and Hunt 2011; Filippini and Hunt 2012; Hondroyannis, Lolos, and Papapetrou 2002; O'Doherty, Lyons, and Tol 2008; Yohanis et al. 2008). A few have also incorporated aspects of habitual energy use or, at least, included some recognition of the temporality of demand (McLoughlin, Duffy, and Conlon 2012; Richardson et al. 2010) either through stochastic models derived from measured energy use or from appliance time of use data (Yao and Steemers 2005).

The over-riding objective of these studies has been to model and forecast household energy consumption rather than to describe temporal patterns and understand the practices that give rise to energy demand. The physical, technical and price data, along with the modelling techniques habitually used in energy demand research imply that the material, visual and physical tend to prevail over the variable and correlational (Shipworth 2013). The type of data used in such studies is indicative of their normative intentions. For example, many rely on or aspire to generate *averages* of energy consumption (by day, by week, by years etc.), rather than reveal or collect micro-level and heterogeneous traces of time (and space)-based energy demand. It could be argued that an interest in quantity (the volume of demand) prevails over an interest in quality (when demand occurs and how it varies). Even where the intention is to reproduce household specific load profiles (Richardson et al. 2010; Widén, Nilsson, and Wäckelgård 2009), studies are usually based on probabilistic modelling.

There are some exceptions in that a few researchers have attempted to take account of the timing and nature of specific energy-consuming practices. Recent work deducing carbon footprint information from time-use diary data (Druckman et al. 2012) represents one such effort, but of more direct relevance are studies which use time-diary data as the basis for modelling energy demand (Ellegård and Palm 2011; Palm and Ellegård 2011; Torriti 2012; Widén, Lundh, and Vassileva 2009).

Here, patterns of energy demand are ascribed to the range of activities recorded through reference to existing data on the average energy intensity of different appliances. More recent work (Durand-Daubin 2013) has highlighted the extent to which this method may or may not be valid for different appliances in different contexts.

In summary, not only is there little data on variation and change in energy-demanding practices but 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 or modelled away as an error term rather than a key feature of the way energy is in fact used. This is unfortunate as it seems likely that considering such variation is important for identifying loci of potential intervention and change (Pullinger et al. 2014). In the next section we draw inspiration from 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) and review a range of datasets that may allow us to analyse variation and change in domestic and mobility related energy demand.

## **Time use and energy demand**

Having delineated the boundaries of the problem of interest and identified shortcomings in current approaches we turn to a review of two forms of potentially relevant data. The first are generic social science time use surveys that provide potentially useful and relevant insight into what people do, when they do it, and how this varies between people and across time. They may also help explain the patterns of mobility demand that follow from what people do and from where different practices are enacted. We then turn to a discussion of the UK National Travel Survey, treating this as, in essence, a bespoke form of time-use data. In both cases we provide a background to the collection of these data, taking account of the assumptions embedded within the survey design and within the methods and units of data collection that follow. We use this material to show how styles of data collection have changed over the years, and to show what such changes reveal not only about changing practices but also about institutional research priorities.

### ***Time use over time***

Generally administered as part of a household or individual survey and covering all activities throughout (ideally) a given week, the time-use diary has been a niche instrument in quantitative social science research since 1909 when The Fabian Society's Women's Group collected daily diaries "from working class women who were 'poor' but not the poorest and 'respectable' in Lambeth, London with the purpose of revealing both how these women coped with raising families on minuscule wages and to reveal the nastier side of life in poverty." (Reeves 1978).

As discussed below, time use diaries rarely have a single 'purpose'. They can accommodate and fuel different lines of enquiry and the project of studying the way time is used is frequently related to some broad interest or public concern, for instance, in women's work or the changing experience of childhood; or more focused market-related issues, such as consumption or how leisure time is spent. These interests are often part of still broader debates. For example sociologists such as Harvey (Harvey 1993) and in particular Gershuny (Gershuny and Miles 1986; Gershuny 2003) have developed time use studies as an alternative to the standard 'economic' methods of national accounting. Gershuny's conclusion that time allocated to both paid and unpaid production should be the basis for an alternative form of national accounts and especially one with well-being at its heart (Gershuny 2011), is, in part, founded on the observation that new ways of measuring productive activities in the late 19th Century produced the concept of the service sector, thereby revealing a hitherto overlooked mode of immaterial production.

With respect to our aim of analysing change in both domestic and mobility related practices over time, the extensive detective work of Gershuny and his Oxford Time Use Research Centre team has built on foundational research from the 1960s that brought together a plethora of diary-like studies especially from the UK, France, Canada, the USA and Russia/USSR (Converse and Szalai 1972). The Oxford team has assembled a dataset of comparable studies from the 1950s to the present and in its most recent incarnation as the Multinational Time Use Study (Gershuny et al. 2012) this includes detailed activity sequences for the 5-10-15 minute time slots with 'harmonised' activity codes. This record of time and social practices is, inevitably, incomplete. In some cases excluded studies were specific or based on convenience samples and thus of less use in analysing overall trends in practices but in others cases the datasets simply no longer exist. Historical data from the decades prior to the 1990s is largely available only through the combination of good luck, the forward thinking of the original data collectors and the stability of their chosen archival methods. In addition, as we discuss below, anyone planning to conduct comparative analysis over time must wrestle with changes in coding schemes, data collection methods, sampling and response details and, of course, the fact that the datasets included are understandably likely to be the ones that were the easiest to acquire, process and post-hoc harmonise.

Looking back over the history of time use studies in the UK via the Multinational Time Use Study (MTUS) and related studies gives a sense of how such concerns have evolved. Unfortunately the BBC Audience Research funded time-diary studies of 1939, 1947, 1948, 1950, 1952 and 1953 leave no surviving data or documentation although it is interesting to note that it was the 'new media' of broadcasting that generated the apparently new need for temporal analysis of consumption or, more accurately, the analysis of the 'availability to consume'.

Thus even though these earlier studies form the first representative random national sample time use surveys in the UK (Gershuny 1983), our record effectively begins with the BBC's 1961 "The People's Activities and Use of Time" study which asked one person from a sample of households with TVs and/or radios (but none without!) to self-complete a ½ hour coded diary in April. The diary used 120 activity categories to post-hoc code the self-reported activities and then proceeded to additionally code any concurrent media use. Little information on the rationale for the study remains but a sample of the diary instrument<sup>2</sup> suggests that the BBC wanted to know which programmes were being watched (and when), what was being done concurrently and what respondents' opinions of the programmes were. This is supported by the fact that activities between 00:00 and 06:30 were not recorded at all. This was not because nothing of interest was likely to occur but because at the time the BBC did not broadcast before 10:00 (17:00 on Sundays) or after 10:15pm.

Media consumption on the move was of special interest (primarily radio - although a 'Travel with TV' code is included perhaps for completeness) but locational codes were limited to at/not at home. Some further indication of location can be imputed from the activities that are coded and car use can be distinguished from other models of transport. Indeed so obsessive was the interest in media consumption that even 'Driving lesson<sup>3</sup> with radio' and, even more strangely, '...with TV' was coded. However the social nature of media consumption appears of little concern - the diary did not collect any information on who the respondent might have been with at each diary timeslot.

These threads, features and motivations remain evident through the BBC's 1974-1975 "The People's Activities and Use of Time" study which again excluded the period from 02:00 to 05:00, chunked activities into ½ hour slots but this time collected data from August 1974 to March 1975 to support

<sup>2</sup> See <http://www-2009.timeuse.org/information/studies/data/downloads/uk/bbc/1961/bbc1961.pdf>

<sup>3</sup> Indeed 'Driving Lesson' itself was a separate activity code for reasons that are unclear.

seasonal analysis. Here the motivation for the study is abundantly clear with the diary instrument stating

“In designing programme schedules to meet the needs of the public it is important to know the times at which people listen and view and what kinds of things people are doing at the same time as listening and viewing. For example, it may not be a good idea to show a Women’s Magazine programme on television at a time when most women are preparing a meal...”<sup>4</sup>

Interestingly, there is little explicit evidence of an appreciation of the extent to which daily activities and broadcasting schedules iteratively co-define each other with neither necessarily ‘having’ to fit the other but each adjusting to the other through a range of feedback and adaptation processes (Livingstone and Lunt 1994).

Unlike the 1961 study the 1974-75 survey collected data from all persons aged 16+ in the household and collected more detailed information on secondary activities. The original locational coding was at/not at home and, as we might expect, with/without access to a radio but more complex codes have recently been imputed via the nature of out of home activities. Again, co-presence with others is unknown (so that the same activity reported by individuals from the same household on the same day cannot be assumed to be done jointly) but the day’s activities have been collapsed to a mere 40 different activity codes with the likelihood, as in 1961, that short-duration activities and trips were substantially under-reported. Travel mode was, again, car vs ‘something else’ but only for travel to/from work or school. Although a whole category was given over to ‘Knit, sew, dressmaking’, travel mode for leisure activities was not coded at all. To further complicate matters various ‘out of home’ leisure activities could well have included travel and where this was not explicitly stated by the respondent, significant underestimates of total travel time are likely.

With the introduction of ESRC funding for the time-diary study of 1983-84 a more general social scientific motivation for the subsequent data analysis reveals itself not only in the more detailed 180 category coding and inclusion of all twenty-four hours but also in the nature of the data collected. Again respondents completed diaries as free text but in 15 minute slots over seven days with up to 4 coded (‘main’ plus anything else up to the 4<sup>th</sup> recorded). Respondents were also asked where they were, who else they were with at the time and their relationship between these companions and the respondent. It is not clear why the activity slot was shortened to 15 minutes although it may reflect international experiences that led to the recommendations contained in Harvey’s 1993 paper (Harvey 1993). As suggested, the general social scientific focus appears to have generated the need to classify a range of activities in ways that were previously aggregated in various ways. Thus labour market (even ‘job search travel’ is coded separately) and leisure participation are captured in greater detail as are forms of interpersonal communication and civic/voluntary activities. Curiously ‘Driving lessons’ still features as a category (although we know nothing of music lessons for example) as does ‘Knitting, sewing, dressmaking’ even though less than 8% of the population report it. Capturing the decline of previously common activities requires the inclusion of increasingly rare acts and it is unclear when these become sufficiently irrelevant to be dropped or merged. It is also hard to tell whether zero-reported time represents actual non-participation or whether it is an indication that participation is sufficiently rare as to be un(der) reported in a sample-based survey. For a research programme interested in analysing change over time, these decisions are crucial.

In general terms subsequent ESRC (1987), ONS (1995, 2000 and 2005) studies which form the remainder of the current (July, 2013) MTUS took a similar approach. The ESRC 1987 study again uses

<sup>4</sup> <http://www.esds.ac.uk/doc/1425/mrdoc/pdf/a1425uab.pdf>

15 minute activity slots with 24 hour coverage and detailed locational and co-presence. There is little change on the activity coding front with 'Driving lessons' still coded. It is at this point that we see the first reference to 'electronic mobility' through the coding of telephone conversations although it is interesting to note that 'Correspondence' has featured as an activity since 1961. Computers as tools for the completion of other activities (and as energy users) also appear in 1987 with 'playing computer games' being given a distinct code. There are further efforts to distinguish between educational activities, home paperwork, job search, home working and work brought home which do and do not involve the use of a computer (different codes were used depending on whether a computer was used). The separate coding of 'write by longhand or typewriter' and 'write on word processor' is also notable even though the distinction between longhand and typewriting was historically ignored.

As we move into the 1990s the Office for National Statistics implemented a lightweight 'yesterday' diary in May 1995 as a pilot for its contribution to the Harmonised European Time Use Survey (HETUS). The diary itself forced the selection of 1 of 30 activity codes (including 'Other') with no location or co-presence data and nothing on mode of travel. Paid work by those who normally travel was coded as 'at work' rather than travel, again potentially resulting in underestimates of 'travel time'. Of the 30, four codes are given over to varieties of computer use: games vs internet/email (rare in 1995) vs education vs work done at home. Interestingly explicit instructions for the children's diary state that "Time spent travelling to an activity or place... should be included as part of that activity itself"<sup>5</sup> making any estimates of overall travel time for children almost impossible. Here too the increasing preoccupation with children's ICT-mediated time is evident in the distinction between 'computer use for games' from 'for information, internet and email' or from 'for school work'.

Fortunately the 2000/1 first 'official time use' survey implementation of the full HETUS contribution expanded substantially on the 1995 pilot with a June 2000 to September 2001 sample period to enable seasonal analysis. The study was explicitly designed to "provide complementary data to existing sources such as the Labour Force Survey, General Household Survey and the National Travel Survey" (Short 2006) and was a response to identified gaps in current labour market statistics and especially with respect to the unpaid productive work of women. In addition as a contribution to HETUS, a minimum set of codes were specified by EUROSTAT. All individuals aged over eight in each sampled household were asked to respond to different versions of the diary and to record their activities in finer-grained 10 minute time slots. Secondary activities were recorded as was location and co-presence. Following the 1995 pilot described above, travel in the course of work was separately coded but in a manner considered complex by a later review (Short 2006). This is partly reflected by the post-hoc coding of 265 activity codes into a carefully designed hierarchy such that, for example, 9\*\* is 'travel', 91\* is work related travel and 911 is travel in the course of work whilst 913 is travel to and from work (commuting). This complex scheme was also used to distinguish between activities using and not using ICTs so that, for example, 371 codes household management (not using the internet) whilst 3722 codes for shopping for/ordering food online in contrast to 3723 which codes for shopping for and ordering clothing via the internet. Interestingly services provided by phone (e.g. banking vs booking tickets vs catalogue ordering) are aggregated with paper-based activities in 371 whilst distinctions between internet-based activities such as food shopping vs banking vs holiday organisation are maintained reflecting the then pre-occupation with teasing out different forms of online service provision. As a signifier of changing times, there was no longer provision for 'driving lessons' (now part of 'free time study') and sewing/knitting became part of 'handicraft and textiles'.

<sup>5</sup> <http://www-2009.timeuse.org/information/studies/data/downloads/uk/1995/wave7.pdf> p4



As Short (2006) notes in her review of the study this plethora of codes is perhaps inevitable given the need to draw together multiple cross-departmental interests and justification for cross-departmental funding in the situation where there is no specific funding source. In addition, and perhaps equally inevitably policy analysis requirements in 2003 when the data and suitable analytic resource was available were rather different from those anticipated at the time of commissioning. Nevertheless the ONS team report analysis for the (then) DfES on education and child related activities; for the DCMS (Media & Sport) on leisure, sport and cultural (non)participation; for the DoH (Health) on physical activity levels in the context of obesity; the DfT (Transport) as a way to review the effectiveness of the National Travel Survey and by the ONS themselves to determine levels of unpaid labour and the rate of churn between the paid and unpaid labour economies and the extent to which couples spend time together amongst other projects. Presciently the report also notes the potential use of the data to analyse consumption of fuels and water linked to the *timing* of the use of household appliances as well as the extent to which the time-use of household members is inter-dependent. Finally Short's review also notes the potential of using the timing of activities to analyse changes in activity patterns around life-stage transitions such as retirement - a point of potential inflexion which, amongst others, has been identified as a potential critical point for interventions to shift habitual, accepted ways of consuming (Browne, Medd, and Anderson 2013).

The most recent nationally representative UK Time-Use survey was carried out in 2005<sup>6</sup> by the ONS as part of its rolling omnibus surveys and again funded by a consortium of UK Government Departments (DCMS, DfES, DoH, DfT) and the ESRC. The study was intended to provide a limited and necessarily less costly and thus less detailed update on the 2000/1 data. Data collection was scheduled from March to December 2005 to enable seasonal analysis and as with the 1995 data, one respondent (aged 16+) per household was asked to fit activities for 1 randomly selected day into 30 pre-coded categories for each of the 10 minute slots. Secondary activities were collected with location coded as home vs elsewhere and although mode of transport is recorded in some detail, including distinctions between forms of public transport, there is no information on co-presence with others. The iterative design of codes is again revealing. Whilst child and adult care was previously captured when a respondent listed it as a main activity, analysts were now keen to know when a respondent was responsible for a child or other adult - such as through background caring or just in-home presence with younger children. Other changes of relevance include the use of the secondary activity to record computer use when the main activity was, for example, online shopping or email and the attempt to make clearer distinctions between different kinds of travel. Quite how modern practices of shopping or media consumption using a mobile device whilst travelling (and thus using energy in all sorts of ways) would be coded under this scheme remains an open question.

Overall these histories give a sense of how the *raison d'être* of a time-use study, the interests of its prime funders and the method of implementation alter the nature of the information collected and the potential for subsequent secondary analysis. There is a clear tradition of diary methods and of coding different activities and there are common issues of co-presence and location with the basic unit of analysis being the individual (the diarist). Codes and categories change over time and for a variety of reasons meaning that the changing nature of practices themselves must somehow be untangled from the ontological drift of measurement methods and coding systems. Not only is the subject matter potentially changing but so are the terms in which it is defined and observed.

This becomes abundantly clear when we consider the work done as part of the creation of the Multinational Time-Use Study dataset which draws together all of the above datasets as well as those from a range of international sources (Gershuny et al. 2012). In order to provide the ability to compare the uses of time *over time and between countries*, the MTUS has had to undertake a post-

<sup>6</sup> A new nationally representative time use survey is planned for 2014/15 (Fisher and Gershuny 2013).

hoc harmonisation process which has involved interpreting, condensing and where necessary imputing not just overall time use totals but in recent versions, specific activities at specific times of day. As studies of other kinds of data 'sharing' and transformation process have shown (Carlson and Anderson 2007), this entirely necessary process nonetheless throws up endemic ontological dilemmas that matter for those who use the data and for the types of questions it can be employed to address.

### ***Travel diaries***

Surveys of personal mobility generally take the form of travel diaries with the objective of capturing the movements of respondents over a specified period. In addition to methodological issues (periodicity, target population, methods of data collection), many differences can be found relating to the reference period (one day or seven days), units of data collected (for example journeys or stages), specification of journey purposes, treatment of very short or 'long distance' trips, multiple movements within large facilities (e.g. shopping centres) and the treatment of escort trips and children's travel.

At the national level, data has been continuously collected (Battellino and Peachman 2003) for many years in Germany, The Netherlands and UK, and more recently in New Zealand, Italy and the USA in order to assess the significance of trends in transport behaviour. However, some countries have stopped conducting continuous surveys at the national level (Denmark) whilst others have recently started again (Sweden). Whilst the Netherlands has stopped the well-known Dutch Mobility Panel (LVO) after 10 waves, it still conducts the National Travel Survey on large samples (Ortuzar et al. 2011).

The first British NTS was commissioned by the (then) Ministry of Transport in 1965/6 and further periodic surveys were carried out in 1972/73, 1975/76, 1978/79 and 1985/86 with data available from 1972 onwards with the exception of 1975/76 where the response rate was too low. The survey covers personal travel within Great Britain by all residents of a representative sample of households thus excluding travel by people not living in households, such as students in halls of residence and tourists or other visitors from abroad. All members of the household (including children) were required to complete a 7-day travel diary of all personal travel within Great Britain, with an additional interview in the case of long distance trips for a longer period.

Since July 1988, the NTS has been carried out as a continuous survey with fieldwork being undertaken in every month of the year and with an annual set sample. The advantage of the continuous study is that research users are able to discern seasonal and cyclical movements as well as trends over time although it is interesting to note that as far as we are aware, there has been little analysis of within-week patterns of travel. In the past, the sample size was designed to produce reliable estimates of the main survey variables at GB level through the aggregation of data over a three-year period but from 2002, the sample size increased to about 15,000 households a year, to enable analysis for single years. The overall response rate in 2007 was 61%, but higher in the rest of the country (63%) than in inner (47%) or outer (55%) London (Anderson et al. 2008).

In general the NTS provides detailed information on different types of travel, where people travel from and to (country level), distance, purpose, what kinds of people are doing the travelling and how often. The NTS is the only source of national information on subjects such as cycling and walking which provide a context for the results of more local studies.

The travel diary was redesigned for 2007 following an extensive development study and respondents are now asked to record each journey or 'trip' and provide details of origin and destination, purpose,

mode, distance travelled, time, number travelling in their party, vehicles used, tickets used and cost. The diary is filled out by/for adults and children and in addition the adult version of the travel record asks respondents to detail any parking costs, road tolls or congestion charges paid when travelling by car, as well as indicating whether they were a passenger or driver. Memory joggers are also provided to help participants remember basic details when travelling without their diaries and on day 7, the child travel record asks whether the respondent spent any time in the street (e.g. playing, talking with friends and so on).

One of the greatest points of debate and of difference in how mobility is measured has to do with the definition of a journey. The controversy stems from the need – for purposes of measurement and analysis - to attribute a (main) journey purpose to movements which may involve multiple stages and multiple modes of transport and which may be undertaken for a variety of reasons consecutively or even simultaneously. Of course this also implies uncertainty about how to define the start time, overall trip time and time spent on each travelling ‘stage’.

In 1965, a journey (then known as ‘a trip’) was defined as a ‘one way course of travel having a single main purpose’. Where more than one mode of travel was used on a particular journey, each part of the journey using a different travel mode or each change of travel ticket constitutes a single journey ‘stage’. However, the main difficulty arises in the identification of the ‘main’ journey purpose. As discussed below, in the earlier surveys, there was a hierarchy of journey purposes, meaning that for a multi-purpose journey, certain purposes were automatically deemed to be ‘main’ – for example, work takes precedence, and shopping or personal business is given priority over purposes other than work or education.

In later surveys, (from 1985 onward), the concept of a purpose hierarchy was used less rigidly and instead, the ‘main’ purpose was defined as the purpose without which the trip would not have been made. The respondent’s own interpretation was the first point of reference, but the length of time spent at any ‘destination’ was also used to determine the dominant purpose. If a subsidiary purpose was included at a stop along the way but was not important enough to figure in this definition (e.g. stopping for a newspaper en route to work), it was disregarded. Whether one or more journeys were recorded depended on the overall purpose of the travel, on the time spent and on whether the stop on the way significantly affects how the person travels or where they go. If the person did two things at the end of the same trip, the respondent is asked to decide which constituted the ‘main purpose’ of the trip. These responses were used to determine the ‘purpose to’ for that trip and consequently the ‘purpose from’ of the next trip.

In addition to defining the main purpose, challenges arise from the various ways in which single purpose multi-stop trips have been treated. These are typically shopping trips in which people travel from shop to shop or business-related activities during in-work travel. In the earlier NTS surveys (1965 – 1975/6), a trip around the shops was omitted. In 1978/9 a trip around the shops was included as part of the original trip to the shops. In 1985/86, the term ‘series of calls’ was applied to trips made up of frequently broken travel between many stops – so that a trip to the shops, around the shops and back again was coded as three trips with the trip around the shops being coded as a series of calls trip. Such outings were later changed to only single stage trips (i.e. there and back) made for the purpose of ‘shopping’ or ‘in the course of work’, with separate analysis done on ‘tours’ (2002).

The emphasis placed on comparability of data generated by sequential waves of the NTS means that continuity has been maintained in how mobility is measured. This is especially evident in the measurement of journey purposes, which continue to this day to stem from the original ‘core’ journey purposes specified in 1965. Any variation has taken the form of some disaggregation of

'super' purposes into a few constituent activities. As a result, the purposes defined in the early years of the survey had disproportionate influence on the long-term measurement of mobility and on related forms of conceptualisation, understanding and policy. On the other hand, the journey purposes that were initially specified were sufficiently broad to accommodate subsequent more detailed specification.

The following paragraphs show how categories have been defined and sometimes sub-divided, starting with journeys to and from home.

'Home' trips are coded according to the main reason why they were made. Each trip is assigned two codes reflecting the 'purpose to' (i.e. the reason the respondent went to somewhere) and the 'purpose from' (i.e. the reason the respondent was at the place where they are travelling from). The overall purpose of a trip is normally taken to be the activity at the destination, unless that destination is 'home' in which case the purpose is defined by the origin of the trip.

*Work/commuting* is used only for trips to or from the respondent's usual place of work and home. All other work trips must be coded 'in course of work'. If there is no usual place of work, all travel to work is classified as in the course of work. Work trips made by respondents with no fixed workplace (for example, site workers, travelling salespeople) are always recorded as being 'in course of work'. Teleworking was added in 2002.

Trips made in the course of *work/business* covers all trips made as part of the respondent's paid job and which are to/from a place other than the usual place of work. However, journeys made in the course of work which are solely for moving goods (including small packages delivered by a messenger) or for moving the vehicle itself, are excluded. The associated outward or return trip without the goods is also excluded unless there is a different underlying purpose. Also excluded are the journeys made by conductors, guards, drivers of public transport since the drivers and other staff had no purpose of their own in going to the destinations. However, journeys made by commercial travellers and sales reps in the course of their work are usually included since the main purpose is for them to reach their destination.

*Other work* trips cover all other trips to work and work to home. These few trips are often amalgamated with other personal business trips since they often involve returning to work after a visit to the shops etc.

Education related trips cover school children and students' journeys to and from their schools/colleges. This category is used for full-time students, students on day release and part-time students following vocational courses although the previously mentioned exclusion of full time students who do not live in households should be noted.

From 1998 *shopping* has been separated into 'convenience' and 'goods'. Where food and other goods are bought together, the respondent is asked to say which of these two categories defines the 'main' purpose of the trip. Journeys are included whether purchases are made or not (i.e. window shopping is included). Services such as opticians or hairdressers are excluded, being covered by personal business. Frequently a shopping trip will consist of three trips; i) one to the first shop, ii) a 'series of calls' from the first to last shop and iii) a trip from the last shop. In the earlier NTS surveys (1965 – 1975/6), a trip *around* the shops was omitted. In 1978/9 a trip around the shops was included as part of the original trip to the shops (leading to an increase in recorded instances of shopping and personal business). In 1985/86, the term 'series of calls' was applied to trips made up of frequently broken travel between many stops – so that a trip to the shops , around the shops and

back again was coded as three trips with the trip around the shops being coded as a series of calls trip.

Journeys to services other than shops such as to hairdressers, launderettes, banks, doctors, libraries, church etc are coded as *personal business*. In 1985/86 an extra category was introduced for personal medical business including visits to the doctor, dentist, optician, chiropodist, chemist (to collect a prescription for oneself) and hospital (but not just to visit). If the purpose is the medical care of other people, the purpose is coded as personal business – other.

*Entertainment* has undergone many changes over time. It initially included all types of social activities excluding 'public events' but including trips to cinemas, theatres, dances, bingo, art galleries, museums, political meetings, trade union meetings, club activities, non-vocational evening classes and keep-fit classes. It also applies to trips to watch sports, or to take part in certain indoor sports and games such as table tennis, darts and snooker. Sport was divided into 'watching' and 'participating' in the 1975/76 survey but this was changed again in the 1985/97 surveys so that watching sport was included in a category combining entertainment and public events. Eating and drinking has also been subdivided to separate eating as a social occasions from eating 'alone or at work' (the latter is included now under personal business).

In recent years *personal social* has been refined to distinguish between visits to friends or relatives in their home (although stays of more than 4 nights is considered a 'holiday') versus trips to meet friends elsewhere than in a private home. In this last case ('other social'), the main purpose must be to socialise with particular persons rather than to visit a particular place or event.

*Other personal travel* was subdivided into holidays or day trips in 1975/76. Holidays were defined as involving 'at least one night away from home for leisure/recreation purposes' (but only that part of the trip made in Great Britain). In 1978/79, holidays excluded staying with friends or relatives for 1-3 nights – instead, these short stays with friends were coded as social. A visit to friends or relatives that involves an overnight stay of four nights or more is also coded as 'Holiday base'. Day trips are trips for pleasure purposes within a single day but not codeable as social, entertainment etc. This definition applies where the trip itself is the pleasurable activity (e.g. a scenic drive, non-specific sightseeing or simply 'going for a walk').

Finally *escort* journeys are those where the main purpose is to escort another person such as taking a child to school or collecting people from the railway station. *Other non escort* journeys are trips that cannot be coded into of the named purpose categories e.g. Persons learning to drive.

Although data is collected from respondents as part of a household travel survey, the format of the NTS diary and most analyses are such that each journey is taken to be the responsibility of one person in the household. This leads to further complications and assumptions about the primary purpose of the journey. For example, it is almost impossible to say whether accompanying persons are simply tagging along or are they the reason for the journey in the first place. In earlier surveys, escort trips were not a discrete journey purpose. Instead, purpose was coded as the purpose of the person being accompanied – this meant that education, personal business and shopping were boosted in earlier surveys. In 1985/86 an 'escort' code was used when the respondent had no purpose other than to escort or accompany another person. Thus 'escort' is used either for a mother escorting her son (who has a purpose of his own) or for a son tagging along with his mother (who has a purpose of her own). In such cases it is necessary to know the purpose of the person being 'escorted' as well as the fact that the main purpose of the trip is to 'escort' someone. If there is any doubt about whether the person had a purpose of his own, then the escort code is not used. The 1985/86 technical report gives two examples: (i) if a husband drives his wife to the shops and stays

with her, then he is regarded a shopping since it would be difficult to distinguish whether he is escorting, accompanying or actually shopping (ii) in the case of a young girl with her father on a shopping trip, the girl would be coded as escort/ accompany if she had no purpose of her own in being there other than to be with her father. However, if he was buying her a coat and it was necessary for her to be there to try it on, then she would be coded as 'shopping'.

The use of the escort category demonstrates the challenge of measuring and understanding simultaneous activities within the household. The advantage of undertaking a household-level survey is somewhat eroded by the need to allocate 'responsibility' to one individual – a strategy that makes it difficult to identify simultaneous activities and journeys involving several members of the same household.

The notion of distance is also central to national travel surveys and transport modelling. In measuring mobility, long and (very) short distance trips are both problematic, causing debate about what can be regarded as daily mobility and indeed, what counts as a valid 'journey' to measure. Since its introduction, the UK NTS has repeatedly changed the definition such journeys and the information it has collected about them. For example, there continues to be an ongoing debate about how best to measure walking, particularly short walks and walks 'for their own sake'. In the first NTS, walks under a mile were not included at all. In subsequent surveys there were differences in whether walks under 50 yards were included depending on whether they took place at the beginning, middle or end of a journey. The current situation is that walks over a mile are included in each day of the travel diary, but shorter walks are included on the 7<sup>th</sup> day only to reduce burden on respondents. This means that very short walks can only be analysed in the aggregate to ensure all days of the week are covered. It should also be noted that walking is only included if on the public highway. In other words, to be included it must take place 'along a public road, associated footpath, on a paved or tarred footpath or public area with unrestricted access'. Walking a dog or just taking a stroll is included if it takes place in these public places.

National Travel Surveys dedicated to daily mobility are generally the only source of information about long distance travel in many European countries (e.g. in Denmark or Netherlands). This is so despite the fact that it is very difficult to obtain representative statistics on long distance travel even with relatively big samples. Because the movements involved are rare, that long reporting periods are required to increase the chance that respondents will report at least one journey. In most national travel surveys, additional modules are dedicated to long distance travel (Frei, Kuhnimhof, and Axhausen 2010). The decision to use distance as a criterion is widely accepted in transport planning but the exact cut-off (what is 'long?') and type of distance (crow-fly or network distance) have never been harmonized and vary from country to country and survey to survey.

In the NTS, long distance journeys (LDJs) have consistently been defined as journeys over 50 miles or more within Great Britain. This is interesting in itself given the fact that average journey distances have increased substantially over the 50 years of the survey's existence. In recognition of the fact that long journeys are less frequent and would not be adequately captured by a one week travel diary, the NTS has asked respondents to separately record these trips for a period prior to the diary ranging from 3 weeks (from 1992 – 2010) and currently to one week prior, with a maximum of 40 such journeys allowed.<sup>7</sup>

<sup>7</sup> However, in 2010, the number of LDJs reported in that week (5,301) was lower than then number reported in the travel diary (6,653), demonstrating the challenge of asking people to recall information. As the information collected in the travel diary was likely to be more accurate, the LDJ records were weighted so that the number of LDJs reported on each day equalled the average number (for a day) reported in the travel diary.

Frei et al. (2010) make the point that there are other elements of underreporting in relation to long distance journeys. Such trips often involve fragments of movement (e.g. walking through airports) but “it is impossible to ask the respondents to report all movements undertaken during a multi-day long distance journey”.

Reviewing the history of how a journey has been defined and measured in the UK NTS (with similar debates surrounding all national and metropolitan level travel surveys) reveals some of the struggles involved in capturing (daily) mobility and what it is for. Technical reports and policy statements accompanying these data collection exercises revolve around a remarkably stable agenda, the focus of which has not changed over many decades. The consistent ambition is to capture all the movements of respondents for at least a day but as this review reveals, a very large number of movements are actually *excluded* – these include very short journeys, those not on the public highway, those not carried out by ‘conventional households’ or tourists from abroad, those within large facilities such as shopping centres, factories or airports, movements abroad and whilst on holiday, travel as part of work (delivering goods) and to some extent, those which involve accompanying or escorting other people. In addition, whilst it is possible to match data from different members of the same household – and so discover which journeys are made together - there is no way of knowing about non-household members with whom respondents might share their trips.

In addition, the requirement to define the ‘main’ activity and the ‘main mode’ on multi-stage journeys undermines the potential significance of subsidiary purposes and sequences of activities. For instance taking children to school on the way to work does figure as a purpose in its own right – a feature that in part explains why NTS data indicates that the school run accounts for just 2% of car distance travelled. Other data, including the fact that roads are substantially quieter during school holidays suggests that school runs are being analytically subsumed beneath commuting trips. Just as problematic, the focus on main purpose makes it almost impossible to ‘see’ the changing bundles of activity of which wider practices of commuting or parenting are composed.

Travel surveys are preoccupied with journey purpose and with broad economically oriented categories such as work, education and shopping. These purposes are themselves often ill-defined so that all types of shopping (for example) are equal and social/leisure categories are muddled even though they account for just under 50% of all distance travelled (Anable 2002). Further, there is no sense of what travel time is used for by those not actively driving. Thus whilst the main journey purpose might be work, the main activity on the journey might be reading the newspaper, working, socialising or sleeping. In addition, the attention given to the purposes flanking the main part of the journey is so limited that it is almost impossible to gain an understanding of how mobility is immersed in the details of daily life.

Overall, methods of measuring mobility suggest that transport research and planning is based on a very narrow set of perspectives. Most of the models used in transport planning treat the transport system as an independent entity and assume that travel behaviour is primarily a function of transport system characteristics (origins, destinations, time and distance). NTS data is used as input to the National Transport Model to produce results which appear plausible as predictions. However, very few long term validations of such models have been made. This results in a circular pattern in which data is collected about trips and purposes and in which decisions are subsequently framed in terms of mode, destination and timing. As a result there is tendency to concentrate on the transport determinants of trip frequency and to view these as part of the overall structure of travel ‘choice’, taking little or no account of inter-relationships between the practices of which daily life is made, or of the relationship between these and the forms of mobility they entail.

## Representing energy demand

For those caught up in the flow of daily life, distinctions between time use, mobility and energy demand make no sense: one topic blurs seamlessly into the next during the course of the morning 'rush hour', when shopping and planning an evening meal, or when putting children to bed. By contrast, the categories and units around which data collection and analysis revolve depend on much sharper forms of demarcation and on lines of enquiry grounded in specific methods of framing correspondingly specific problems.

Starting with the deceptively simple challenge of finding out what people are doing, when, where, for how long, and with what implications for energy demand, we discovered that potentially useful energy and mobility related data have been collected in ways that reflect contrasting methodological, political and practical traditions. Not only does each field have its own view of 'the problem' but each has an evolving political history of objectives, funding arrangements, policy priorities and institutional interests. These keep each view in place and keep them apart.

Not surprisingly, national statistics speak to the concerns of the 'state'. This is perhaps most obvious in the case of travel data, the dominant purpose of which has been to measure the 'need' for transport infrastructure and investment. In addition, there is a consistent, if implicit focus on economic productivity: with travel as with time use data there is a tendency to foreground employment and societally or morally 'good' journey purposes and/or uses of time. The dominant concerns of the energy field are harder to detect but there is no mistaking a preoccupation with energy as such, and with the technical efficiency of buildings and appliances. It is only in this context that it makes sense to invest in datasets which include measured minute by minute electricity consumption for samples of households over periods of months and even years (Richardson et al. 2010; Zimmerman et al. 2012), but which provide *no information at all* about what people were doing or what practices lie behind the measured consumption. In bringing some of these threads together, Table 1 provides a simple but powerful representation of just how different these traditions are.



Table 1: Data on energy, time and mobility – comparing units, categories and themes

	Energy/buildings	Time	Mobility
<b>Units/scale of measurement</b>	W/kW, seconds, minutes, half-hours, quarterly, annual	10 minute slots	'travel events' across a day/week
<b>Purpose of activity</b>	Often unspecified: likely to include heating, lighting, using appliances	Represented in coded categories	Represented in coded categories: much debate
<b>Duration</b>	Days, weeks, years Estimates (appliance use)	Itself the topic	Journey time
<b>Timing</b>	Peak / off peak, seasons, week days	Recorded, could be analysed, often not	Detailed information start and end times.
<b>Frequency</b>	Rarely considered	Not much insight due to 1-day diaries	Hard to handle infrequent (long distance) journeys
<b>Individual/household/collective units of analysis</b>	'Meter' or 'appliance' as aggregator of demand. Disaggregation to individuals/acts rare	Individual – some data on co-presence	Individual plus – escorting/accompanying
<b>Multiple purposes/multi-tasking</b>	Rarely considered other than through aggregation of appliance use	Primary and secondary activities are sometimes recorded	Primary and secondary purposes
<b>Virtual living</b>	Rarely considered to date	Internet use, computing	Teleworking (from 2002), ordering online.
<b>Spatial reference</b>	Rooms within the home	Home and away	Only away from the home

In retrospect, the goal of somehow 'joining up' studies of energy and mobility using the 'native' data appears to be somewhat naïve. As we have described, such a project runs into the immediate difficulty that issues of *demand* are conceptualised in radically different ways across these fields. As a result it is difficult to see how we might bridge between the data that has been collected to date.

On the other hand, our comparative review has drawn attention to a handful of shared concerns. For example, it is evident that interactions between people in space and time are persistently complex and routinely difficult to 'measure' and analyse. 'Multi-tasking' – where one activity is engaged in 'at the same time' as another is rarely addressed in travel surveys which seem to assume that 'travelling' is the only thing one does whilst on the move. Not only does this have implications for the analysis of the timing of energy use (e.g. media use on the move), it is also relevant for understanding and analysing instances in which the timing of energy consumption from the service provider's point of view (e.g. when mobile devices are being charged) does not correspond to the timing of energy consumption from the users' point of view (e.g. when such devices are being used).

Whilst most recent time-use studies provide some detail on secondary activities, the inevitable condensing and homogenisation of detailed activity codings in harmonised studies reveals the difficulty of analysing subtle yet significant changes in the co-performance of practices over time. As an example, understanding how novel practices involving 'mobile energy' evolve, and how these are

woven into new and existing patterns of travel/mobility may be hard to detect in any meaningful way. This is made doubly difficult by the conspicuous lack of regular cross-sectional (Fisher and Gershuny 2013) or indeed longitudinal time-use data with which to analyse trends on a year by year basis. The absence of longitudinal data in particular, with the exception of a small scale ICT-focused panel from the late 1990s (Anderson 2005), means that we have little in the way of data to help us understand how practices and their consequent energy demands change as a result of (or as a precursor to) lifestage or lifestyle changes, changes in household composition or forms of accommodation.

A second cross-cutting theme has to do with the integration of time use and energy monitoring data and with the potential for unravelling adaptations in practices and substitutions in energy use. We cannot, for example, assume the simple nexus of appliance <-> practice. The same appliance may be used in different ways for different practices and, conversely, different appliances can be used to support the same practice. One only needs to consider variations in cooking practices or in the use of a refrigerator (Hackett and Lutzenhiser 1985) to appreciate this and to see why a focus on appliance-only data cannot tell us all we need to know about the changing meaning and materiality of energy-using practices.

A third common feature of the diary method as used in time use and in travel studies is that it is not very good at capturing infrequent but potentially energy intensive practices. We noted that the NTS tried to address this through an additional survey element – a technique that is sometimes also used with time-use studies and with similarly problematic expenditure diaries of the kind that underpin models of consumption. The more general point is that diary studies (whether of time or expenditure) are generally intended to provide mean values of total expenditure/time use for particular population groups and largely assume that recall or measurement error is randomly distributed. Thus mean values across a population sub-group may be accurate but values for specific respondents may not (Anderson 2012). Of course longer-term energy monitoring studies may well record infrequent but energy intensive activities such as feasts and celebrations (e.g. Christmas) that are examples par excellence of the synchronicity of social practice-driven demand. Unfortunately we have yet to find many studies collecting such data over a long enough period of time and for a large enough sample<sup>8</sup> to offer scope for more than just preliminary analysis.

These are not insuperable problems and to end on a more optimistic note, our review suggests that collecting time-use diary data on ‘the whole day’ and all activities therein together with varying levels of detail of location, co-presence and secondary activities may provide a partial solution. For example, whilst the interleaving of multiple activities is rarely considered in studies of household energy demand and is almost impossible to capture using travel diaries, it may be revealed through the careful analysis of sequences and patterns in time-use data. In this respect time use data promises to provide better insight into energy-related issues of location, co-presence, secondary activities and forms of temporal fixity and flexibility than could be achieved through the analysis of transport and household energy datasets.

More ambitiously, re-formulating ‘the problem’ of energy demand as the emergent outcome of what people do and seeing ‘what people do’ as a nexus of the social practices in which they are engaged, the time at which they are enacted and the place(s) in which they performed opens new lines of enquiry. If we represent energy demand in these terms, it makes sense to draw on current and historical time-use diary data, using this to produce a more integrated understanding of the co-

<sup>8</sup> For example Richardson, I., & Thomson, M. (2010). One-Minute Resolution Domestic Electricity Use Data, 2008-2009. Colchester, UK: UK Data Archive [distributor]. doi:<http://dx.doi.org/10.5255/UKDA-SN-6583-1> and the data collected as part of the CHARM (Rettie, Studley, and Barnham 2009) and [CBIES](#) projects.

evolution domestic and mobility-related practices. By implication this would allow us to develop a more sophisticated account of the changing nature of energy demand even if we are not yet, and perhaps never, able to translate this into conventional units of kilowatt hours or litres of oil equivalents of direct and indirect energy demand.

In conclusion, our historical review of data collection regarding mobility, time use and energy demonstrates the different priorities and preoccupations that underpin the type of information gathered, and the terms in which it is analysed. It is no accident that we have struggled to find the data and the resources with which to address basic questions about what energy/mobility is for, or to show how demand relates to the patterning, the flow and the variations in social practices that are enacted in society. It is no accident that relevant questions have simply not been asked or have been intentionally excluded or somehow obfuscated in the data collection, coding or archival processes. The fragmented and partial data that we have is a direct reflection of the fragmented and partial way in which questions of energy demand are conventionally framed. In the end, establishing a more concerted, more integrated understanding of present and future demand depends on radically reframing the terms in which the problem is defined and understood.

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