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Working more consuming electricity differently? Activity network analysis of the 2014-2015 UK Time Use Survey

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1. INTRODUCTION

Research on energy demand tends to treat work and home separately, despite the fact that the two are interconnected. The aim of this presentation is to investigate the relationship between duration of the work and energy-related activities (such as Dish washing, Ironing, Food preparation, Laundry and TV, video or DVD watching) in the home. It presents network analysis of data from the 2014-2015 UK National Time Use Survey. Research questions addressed in this presentation relate to (i) how the duration of work affects the cohesion between energy relevant activities; (ii) how centrality parameters of the energy-relevant activities change between and across work days; (iii) examples of how changes in the timing of some energy-relevant activities may impact the configuration of the day; **and (iv) estimates how working from home and flexible working hours can affect the timing and amount of people's energy consumption.** Findings are presented in terms of cohesion between activities based on the duration of the work day, inter and intra-day variations in connections between activities, energy relevant-activities with an intermediary role and an example on clustering of *Food preparation* activity.

2. DESIGN/METHODOLOGY/APPROACH

The analysis of this presentation is based on the UK 2014-2015 Time Use-Survey [1], which is the most recent nationally representative time use survey available in the UK. The data was collected between April 2014 and December 2015 using a nationally representative sample of the British population using a multi-stage stratified probability sampling. The sample size consists of 9,388 individuals in 4,238 households who completed 16,550 diaries and 3,523 week-long work schedules. The time use diaries provide information about what individuals are doing during one weekday and one weekend day and when during the 24 hour periods. Additionally to the time use diary 3,523 respondents provided seven-day information about how many hours of work they done as well exactly at which hours in the day or week. In this presentation the work diaries were used to calculate the total number of hours worked per week as well as to identify the total number of work days per week. First, based on the self-reported daily work hours we divided our sample into two groups: individuals who reported working fewer than 35 hours per week and individuals who reported working more than 35 hours per week. The decision on splitting the sample based on the total number of hours followed the UK Government guidance. Second, each group was divided by the number of days worked during the week. To obtain a clear picture of the association between work days and timing of activities we decided to focus only on time use diaries that were filled in on a work day. In the final step the matched dairies were divided into five daily temporal periods of equal length aiming to capture working days from morning to evening peaks: 4am-7:50am; 8am-11:50am; 12am-3:50pm; 4pm-7:50pm; 8pm-11:50pm; 12am-3:50am [2]. In order to determine if there is significant difference between work days a non-parametric Kruskal-Wallis test was applied. **We also provide estimates on the timing of energy relevant activities and appliances electricity consumption before and after work.**

2.1. ACTIVITY-NETWORK DESCRIPTION

We constructed the activity networks based on the time use diaries [3]. In this presentation the nodes of the graphs represent the time use survey activities reported by individuals at the time ***t.*** The connection between the activities are measured by the proportion of individuals switching from one activity at the time *t* to another one at the time *t+1*. The absence of connection represents that no switch between activities were made. The arcs of the edges denote the direction of the connections between different nodes. Activities have self-loops indicating that some activities repeat itself from one time period to the next. Figure 4 provides an example of a graph with 3 activities and with 6 edges. It figure suggests that there is 50% of chance that *Dish washing* follows *Unspecified TV, video or DVD watching.*

Activities	Laundry	Dish washing	Unspecified TV video or DVD watching
Laundry	0,5	0,25	0,25
Dish washing	0,5	0	0,5
Unspecified TV video or DVD watching	1	0	0

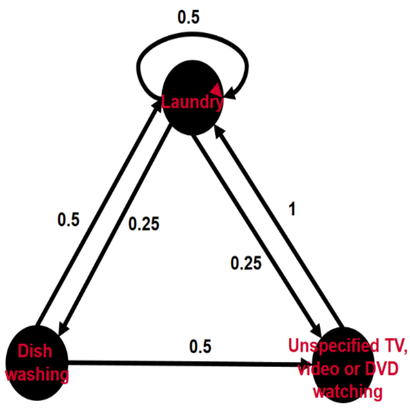

Figure 1. An example of a transition matrix and its corresponding network graph

The structural characteristics of the network was assessed with network density metrics. The weighted degree metrics was used to assess the popularity of an activity. Node clustering is based on triplets, triangles and community detection. We used R packages 'sna', 'igraph' and Gephi to describe and visualise our data.

3. PRACTICAL IMPLICATIONS

Recent developments in relation to the Covid-19 crisis exemplify the importance of understanding how developments in work arrangements underpin everyday life, including the network of activities and the timing of domestic energy demand. Even without large disruptions to normality, non-energy policies, such as the institutionalisation of a shorter working week are likely to change significantly the timing of energy-related activities. **The structure of working activities and this, combined with changes in storage and electric vehicles provision, may have implications for future flexibility in electricity demand. There are multiple implications to this work and three of which are listed here. First, we present one way of conducting empirical studies which overcomes treating time use activities in isolation. An excessive focus on what happens in the home can generate far too static representations of everyday life in which arrangements, such as work, are neglected and yet play a vital role. Second, knowing about the stability of practices throughout the day increases knowledge about daily routines in the homes. The presentation focuses on key metrics to identify which aspects of everyday life are central to how people live in their home through the lenses of work arrangements. Third, this presentation can be seen as providing methodological tools to analyse how changes in ~~non-energy~~different temporal domains, including to the structure of work and in terms of re-organisation of activities may affect ~~energy demand~~ consumption in the home and beyond.**

References:
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