A SYSTEMATIC TIME-USE BASED APPROACH FOR ESTIMATING RESIDENTIAL ENERGY CONSUMPTION

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WHY WORK MATTERS TO US?

- **Academic perspective:** to understand the way institutionally timed events come to regulate, order and organize activities into rhythms (at micro and macro level);
- **Methodological perspective:** to analyse the variation in sequences of activities taking place at times of peak electricity demand;
- **Policy perspective:** to encourage the development of time-use policies that target specific demographic groups during specific time periods, for specific events, in specific geographical regions and for specific equipment use.
OBJECTIVE

The aim of this study is to examine energy-related behaviours and to determine if they are influenced by the consumer's time-use behaviour.

• How duration and timing of the work patterns affects the cohesion between energy related activities?
• How time-use behaviour influences residential electricity consumption?
• How the connections between energy-relevant activities impact the configuration of the day?
<table>
<thead>
<tr>
<th>Time-use behaviour dimensions</th>
<th>Activity location</th>
<th>Activity time and duration</th>
<th>Activity sequencing</th>
<th>Activity appliance usage</th>
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</thead>
<tbody>
<tr>
<td>Activity location</td>
<td>De Lauretis et al. 2017</td>
<td>Sekar et al. 2018</td>
<td>Yamaguchi et al. 2020</td>
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<td>Activity time and duration</td>
<td>Torriti et al. 2020</td>
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<td>Mattioli et al. 2016</td>
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<td>Yilmaz et al. 2020</td>
<td>Anderson et al. 2018</td>
<td>Ramírez-Mendiola et al. 2019</td>
<td></td>
</tr>
</tbody>
</table>
## ENERGY-RELEVANT ACTIVITY

<table>
<thead>
<tr>
<th>Authors</th>
<th>Activities</th>
<th>Time Use Data</th>
</tr>
</thead>
</table>
TIME-USE BEHAVIOUR

What?
- Activity sequencing

Where?
- Activity location

When?
- Activity time and duration

How?
- Activity appliance usage

Time-use behaviour
METHODOLOGY

- Time-use diaries (TUD) and week-long work dairies
  - Identifying the various work patterns that occur on a weekly basis
- Dividing the sample into 2 categories based on the weekly duration of work patterns
- Matching time-use dairies that were completed during a work day
- Identifying energy-relevant activities
  - Measuring and visualizing the location, timing and duration, sequencing and appliance usage of energy-relevant activities

Investigate the causal effect of time-use behaviour on residential energy consumption
METHODOLOGY

Types of weekly work schedules (UKTUS 2014-2015)

Legend:
- One consecutive work day
- Two consecutive work days
- Three consecutive work days
- Four consecutive work days
- Five consecutive work days
- Six consecutive work days
- Seven consecutive work days

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seven consecutive work days</td>
<td>Six consecutive work days</td>
<td>Five consecutive work days</td>
<td>Four consecutive work days</td>
<td>Three consecutive work days</td>
<td>Two consecutive work days</td>
<td>One consecutive work day</td>
</tr>
</tbody>
</table>

Time of the day

4  8  12  16  20  24  4  8  12  16  20  24  4  8  12  16  20  24  4  8  12  16  20  24  4  8  12  16  20  24  4  8  12  16  20  24  4  8  12  16  20  24
METHODOLOGY

KEY METRIC: BETWEENNESS CENTRALITY
RESULTS: ACTIVITY LOCATION

Timing of weekly work patterns of those who worked at least 35 hours per week

Weekly work schedules:
- One consecutive work day
- Two consecutive work days
- Three consecutive work days
- Four consecutive work days
- Five consecutive work days
- Six consecutive work days
- Seven consecutive work days

Percentage of people reporting work activity

Time of the day

04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00 02:00 04:00
RESULTS: ACTIVITY LOCATION

Timing of weekly work patterns of those who worked more than 35 hours per week

Weekly work schedules:
- Three consecutive work days
- Four consecutive work days
- Five consecutive work days
- Six consecutive work days
- Seven consecutive work days

Percentage of people reporting work activity

Time of the day

04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00 02:00 04:00
RESULTS: ACTIVITY DURATION

Mean duration of energy-relevant activities of those who worked at least 35 hours during the week.
RESULTS: ACTIVITY DURATION

Mean duration of energy-relevant activities of those who worked more than 35 hours during the week.
RESULTS: ACTIVITY TIMING

Most common start times of the energy relevant activities (198 TUD from 162 individuals who worked four continuous work days and at least 35 hours during the week)

Legend: DW = Dishwash; FP = Food preparation; HC = House clean; IR = Ironing; Lnd = Laundry and TV/Video/DVD = TV, video or DVD watching
RESULTS: ACTIVITY TIMING

Most common start times of the energy relevant activities (593 TUD from 508 individuals who worked five continuous week days and more than 35 hours during the week)

Legend: DW = Dishwash; FP = Food preparation; HC = House clean; IR = Ironing; Lnd = Laundry and TV/Video/DVD = TV, video or DVD watching
RESULTS: ACTIVITY SEQUENCING
RESULTS: ACTIVITY SEQUENCING

Betweenness centrality distribution of the energy-relevant activities of those who worked more than 35 hours during the week

- TV/Video/DVD watching behaviour
- Laundering behaviour
- Ironing behaviour
- House cleaning behaviour
- Food preparation behaviour
- Dish washing behaviour

(Time periods: 06:00-07:59, 08:00-08:59, 12:00-12:59, 16:00-16:59, 20:00-20:59, 21:00-22:59, 00:00-01:59)
RESULTS: ACTIVITY APPLIANCE USAGE

Appliance electricity consumption usage of those who worked at least 35 hours during the week

**TV**
- Time period: 08:00-07:50, 08:00-09:50, 09:00-10:50, 10:00-11:50, 12:00-11:00, 13:00-12:50, 14:00-13:50, 15:00-14:50, 16:00-15:50, 17:00-16:50, 18:00-17:50, 19:00-18:50, 20:00-19:50, 21:00-20:50, 22:00-21:50

**Washing machine**
- Time period: 08:00-07:50, 08:00-09:50, 09:00-10:50, 10:00-11:50, 12:00-11:00, 13:00-12:50, 14:00-13:50, 15:00-14:50, 16:00-15:50, 17:00-16:50, 18:00-17:50, 19:00-18:50, 20:00-19:50, 21:00-20:50, 22:00-21:50

**Iron**
- Time period: 08:00-07:50, 08:00-09:50, 09:00-10:50, 10:00-11:50, 12:00-11:00, 13:00-12:50, 14:00-13:50, 15:00-14:50, 16:00-15:50, 17:00-16:50, 18:00-17:50, 19:00-18:50, 20:00-19:50, 21:00-20:50, 22:00-21:50

**Electric cooker**
- Time period: 08:00-07:50, 08:00-09:50, 09:00-10:50, 10:00-11:50, 12:00-11:00, 13:00-12:50, 14:00-13:50, 15:00-14:50, 16:00-15:50, 17:00-16:50, 18:00-17:50, 19:00-18:50, 20:00-19:50, 21:00-20:50, 22:00-21:50

**Dish washer**
- Time period: 08:00-07:50, 08:00-09:50, 09:00-10:50, 10:00-11:50, 12:00-11:00, 13:00-12:50, 14:00-13:50, 15:00-14:50, 16:00-15:50, 17:00-16:50, 18:00-17:50, 19:00-18:50, 20:00-19:50, 21:00-20:50, 22:00-21:50
RESULTS: ACTIVITY APPLIANCE USAGE

Appliance electricity consumption usage of those who worked more than 35 hours during the week
RESULTS: TIME-USE BEHAVIOUR

Four continuous work days during the week (198 TUD from 162 individuals who worked at least 35 hours during the week)
RESULTS: TIME-USE BEHAVIOUR

Five continuous work days during the week (593 TUD from 508 individuals who worked more than 35 hours during the week)

Legend: DW-Dishwash; FH-Food preparation; HC-House chores; IRIRing; LivLauLaundry and TVVideoDVD = TV, video or DVD watching

04:00-07:50

08:00-11:50

12:00-15:50

16:00-19:50

20:00-23:50

00:00-03:50

Most common start time

Most common start time

Most common start time

Most common start time

Most common start time

Most common start time

04:00-07:50

08:00-11:50

12:00-15:50

16:00-19:50

20:00-23:50

00:00-03:50

In this figure, the results show the time-use behaviour across different categories such as dishwashing, laundry, laundry and TV, video or DVD watching. The vertical axis represents the mean duration (minutes) while the horizontal axis represents different time slots from 04:00 to 00:00. The data is derived from 593 TUD (time-use diaries) from 508 individuals who worked more than 35 hours during the week. The legend includes symbols for different activities, such as DW for dishwash, FH for food preparation, HC for house chores, IR for ringing, LivLau for laundry, and TVVideoDVD for TV, video, or DVD watching. The figures highlight the most common start times for various activities across different time periods.
CONCLUSION

**Academic perspective:** The causal effect between time-use behaviour and residential energy consumption may be influenced by employment status.

**Methodological perspective:** Our framework provides a structure for addressing the causal relationship between time-use behaviour and residential energy consumption.

**Policy perspective:** The development of policies that cover the four dimensions of time-use behaviour would allow policy-makers to target specific groups of the residential population and steer their behaviours in order to achieve energy savings.
THANK YOU FOR YOU ATTENTION!

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