Residential electricity data and the reliability of self-reported use

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Outline

• Our datasets
• Research questions
• Insights and future research
Data from households

• GridSpy data:
  • 40+ households
  • Circuit level monitoring
    (e.g. hot water cylinder, heat pump, kitchen appliances)
  • 1 minute time resolution

• Household surveys
  • Energy cultures survey
    • Demographics
    • Dwelling, appliance info
    • Energy consumption attitudes
  • Time-use diaries
    • 16 houses with electric hot water
    • Self-reported energy related activities in 15 or 30 min periods
GridSpy data collection
Research questions I

• How variable is household demand?
  • Within houses & between houses

• Do household peaks coincide with network peaks?

• What appliances contribute to household/network peak demand?

➤ What opportunities exist for household appliances to be used for demand management?
Insights: Variability

House 1:
- 3 occupants

House 2:
- 3 occupants
Insights: Role of technology

House 1:
- 3 occupants
- No electric hot water

House 2:
- 3 occupants
- Electric hot water
- Spa pool
Insights: Occupancy

**House 1:**
- 3 occupants: 34(F), 33(M), 3(M)
- No electric hot water

**House 3:**
- 3 occupants: 33(M), 34(F), 1(M)
- Electric hot water
GridSpy data: A valuable asset

- 1 min resolution
  - To assess peaks
  - Battery & PV system dimensioning
- Appliance/circuit level monitoring
  - Role of hot water cylinders, heat pumps
  - Kitchen activities
- > 1 year of monitoring
GridSpy data applications

• Validating appliance / household demand models

• Characterising variability for sizing future technologies (PV, different storage types, EV)

• Modelling change in demand patterns

• What Gridspy data does not tell us
  • How activity patterns may change
  • User motivation
  • How energy use is *perceived* by consumers
Research questions II

• How do consumers *perceive* their energy use?
  • Trade-off between saving and service?
  • How do they operate appliances (e.g. heat pumps)?

• What can time use diaries tell us?
  • Timing of energy related activities?
  • Patterns of behaviour?
  • How to characterise energy behavior?

➢ What opportunities exist for managing residential demand from the *behavioural side*?
### Self-reported data: Hot water

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-use-diary period</td>
<td>1 week</td>
</tr>
<tr>
<td>Reporting times</td>
<td>Day time, 15 or 30 min intervals</td>
</tr>
<tr>
<td>Number of houses</td>
<td>16</td>
</tr>
<tr>
<td>Number of respondent</td>
<td>40 (2 – 5 per house)</td>
</tr>
<tr>
<td>Activities reported</td>
<td>461</td>
</tr>
<tr>
<td>Shower</td>
<td>216</td>
</tr>
<tr>
<td>Dishes – hand</td>
<td>98</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>51</td>
</tr>
<tr>
<td>Bath</td>
<td>43</td>
</tr>
<tr>
<td>Laundry</td>
<td>27</td>
</tr>
<tr>
<td>Wash – basin</td>
<td>20</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
</tr>
<tr>
<td>Activities per person per day</td>
<td>1.7</td>
</tr>
</tbody>
</table>
Monitored vs. self reported data: Hot water
Hot water: reported activities
Monitored vs. self reported data: Hot water
Hot water: reported vs monitored

Hot water related activities for house 45

Distribution: HotWater Controlled - Workdays
Reported activities vs. hot water consumption
Reported vs. monitored hot water consumption
Self-reported vs. monitored hot water consumption: Showers
Future research opportunities

• Social change:
  • Understanding *behaviour* and *perception* around energy choices

• Technological change:
  • Heat pumps
  • Solar power, electric vehicles
  • Battery storage

➢ Optimal residential demand management
Key points I

• Demonstrated simulation of hot water electricity demand
  • Explored some simple control scenarios/many more possibilities
  • Impact on service can be evaluated

• Possible to compare peak reduction potential with other technologies
  • Heat Pump Water Cylinders
  • Batteries

• Other appliances can be modelled to build full household simulation
Key points II

• Potential application from GridSpy data
  • Validation of appliance level modelling
  • Minute level demand of a household
    → assessment of optimal PV & storage sizing

• Need better understanding of human interaction with energy in households to find viable options for residential demand management
Thank you to the supporters of the GREEN Grid programme.