Modelling Energy Use in Households: A Social Practice Theory Approach

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Overview

» We took a practice theoretical approach to model energy use behaviours of households

» We used an agent-based modelling approach

» We used empirical evidence gathered using interview and survey methods to inform the behaviour of households in the model

» Results obtained from our model suggest that Time Use price signals can have counter-intuitive effects as a consequence of energy consumption being tied to the performance of social practices
A Practice Theory Approach

» A move from Individuals (individual choice/nudges) to Practices; the unit of analysis is practices

» A body of work collectively referred to as theories of practice or social practice theory

» Individuals might choose which practices to perform, but their choices are constrained by societal structures that shape and are shaped by the outcomes of human action

» Focus is on the performance, history and trajectories of practices
The HOPES Model

- Households
- Cooking Practices
- Working from Home Practices
- Meanings
- Skills
- Heating Practices
- World
- Materials
- Entertainment Practices
- Laundry Practices
Data Collection

» Qualitative research is vital to understanding the meanings behind people’s actions

» We used a method of walking interviews for collecting data on the energy use practices of households

» Interview protocols contained an outline of topics to be discussed and some open-ended questions to allow participants to respond freely and fully

» Conducted interviews in over 60 households in the UK

» Information from a survey used to complete the household narratives

» Conducted a thematic analysis of the interviews to draw out common experiences and ideas across household narratives
A Rule-based Approach for Combining Elements

» Households’ choice of meaning, material and skills are derived using a rule-based approach

» Developed by organising qualitative data within the modelling framework

» A rule-based system includes:
  • working memory
  • rule set
  • matching scheme
  • conflict resolution scheme

» The rule-based system enables each household agent to make decisions based on individual preferences (initialised based on survey data) and interactions with other households in the system
Bringing it all Together: Expert System

Walking Interviews

Survey

Reports

Household

Facts

Infer

Expert System: Rule Base and Inference Engine

Meaning + Material + Skill
HOPES: Heating Practice

- Household
- Expert System: Rule Base and Inference Engine
- Physical Heating Model

Heating Profiles of Households in a Flat Rate Scenario
Time of Use Scenario and Price Signals

» WeSIM: a comprehensive electricity system analysis model that enables optimal decisions for investing into generation, network and/or storage capacity, in order to satisfy in real-time supply-demand balance in economically optimal ways and ensuring security of supply;

» Prices generated by running WeSIM with an assumption that demand is inflexible as by-products of an optimisation that WeSIM carries out;

» At each time step, Households make a simple decision of classifying an incoming price signal as low (Tariff = low) or high (Tariff = high) by comparing it with the value of the tariff at the previous time step.
TOU does not result in a great deal of energy reduction; in fact, more often the average hourly energy use of households is equal to or higher than the FR scenario.
Responding to Peak Prices in the TOU Scenario makes Heating a Necessity (Meaning = Requirement) rather than a Comfort (Meaning = Cosiness) at other times of the Day
Some Conclusions

HOPES is an empirically-based practice-centric model of energy use in households, which

- is a contribution to overcome criticisms of the abstract nature of social practice theories
- has an expert system approach to improve model transparency and tractability
- is a logical tool to uncover some of the non-rational, routine and highly contextualized motivations for energy use in households – Demystifying the Demand Sector
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