

# Modelling Energy Use in Households: A Social Practice Theory Approach

Kavin Narasimhan  
Aimie Hope  
Thomas Roberts  
Maria Xenitidou and  
Nigel Gilbert

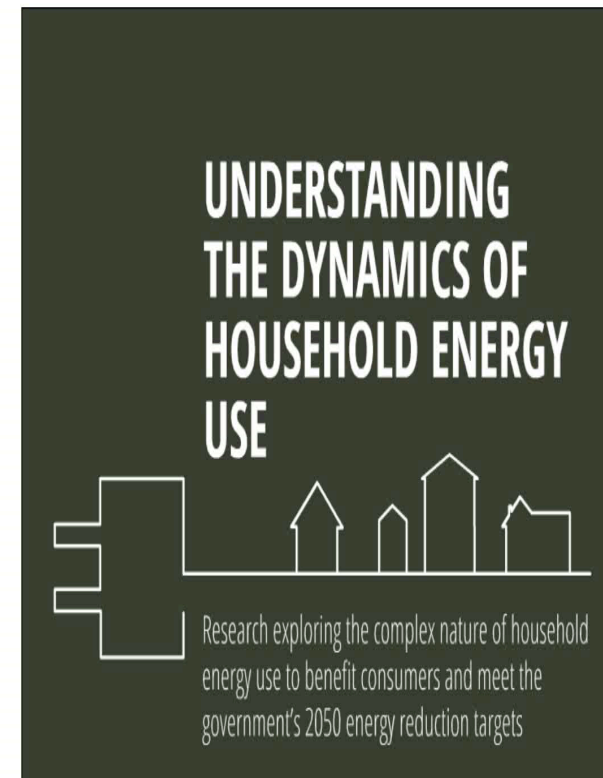
Centre for Research in Social Simulation  
<http://cress.soc.surrey.ac.uk/web/home>

**cress**



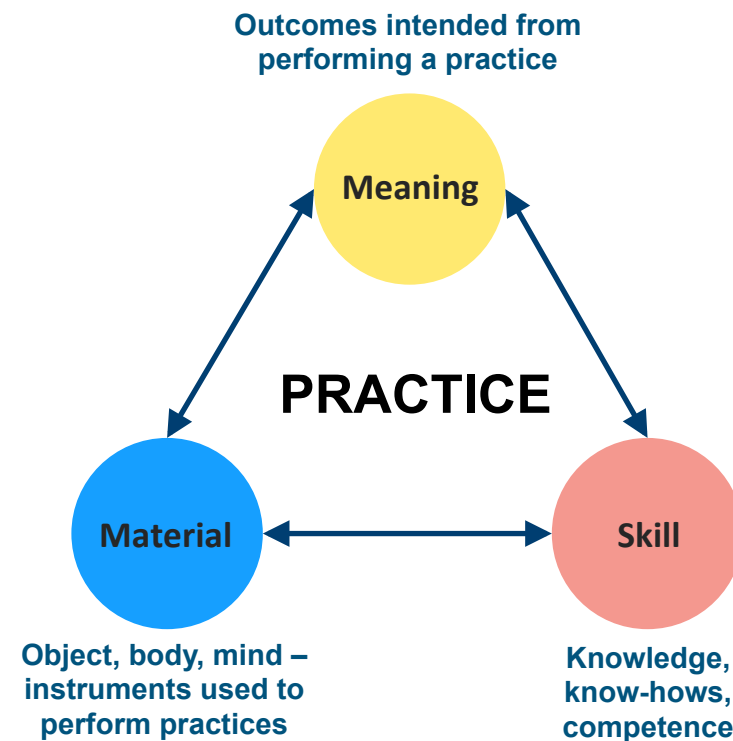
# Overview

- » 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

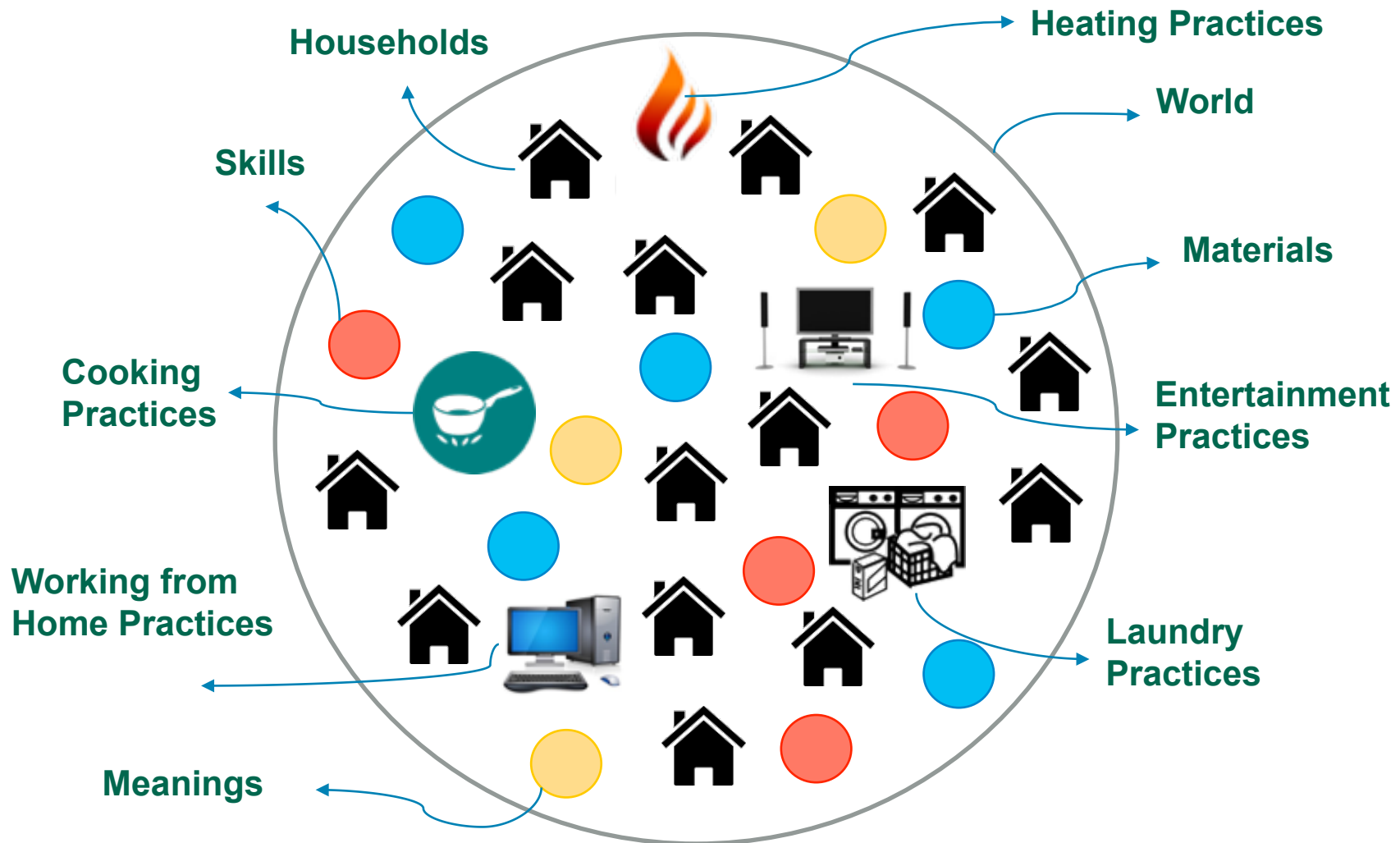


# A Practice Theory Approach

- » 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



# 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



WEATHER

TENURE

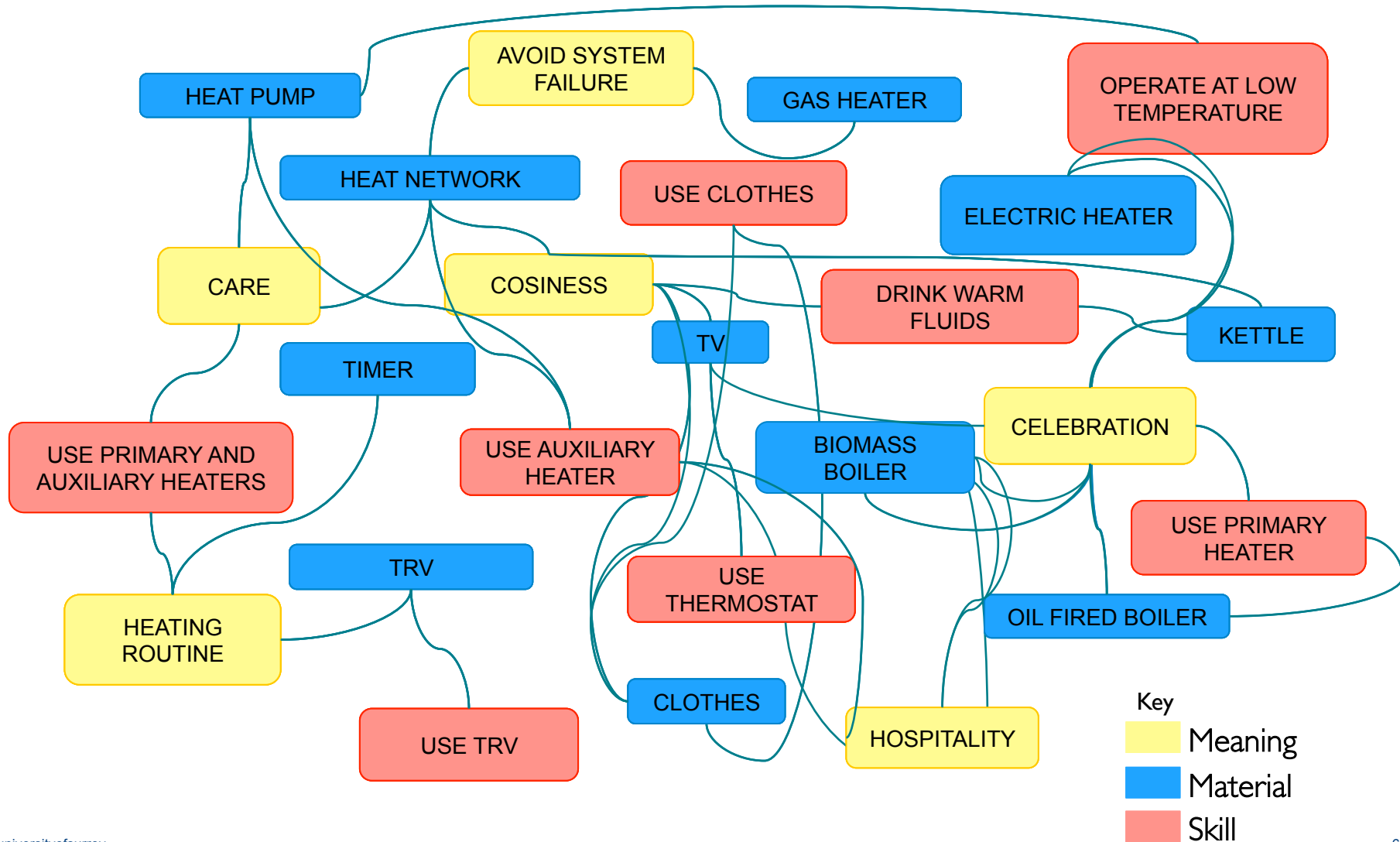
OCCUPANCY

INCOME

TARIFF

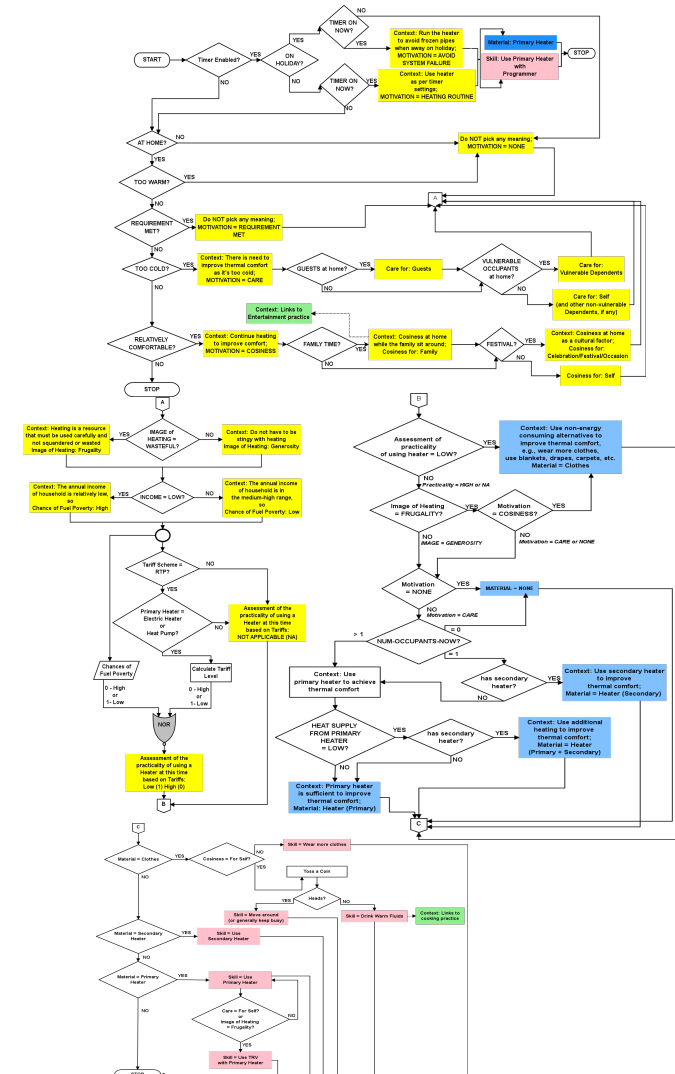
HISTORY

# Visualising the Links between Elements



# 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

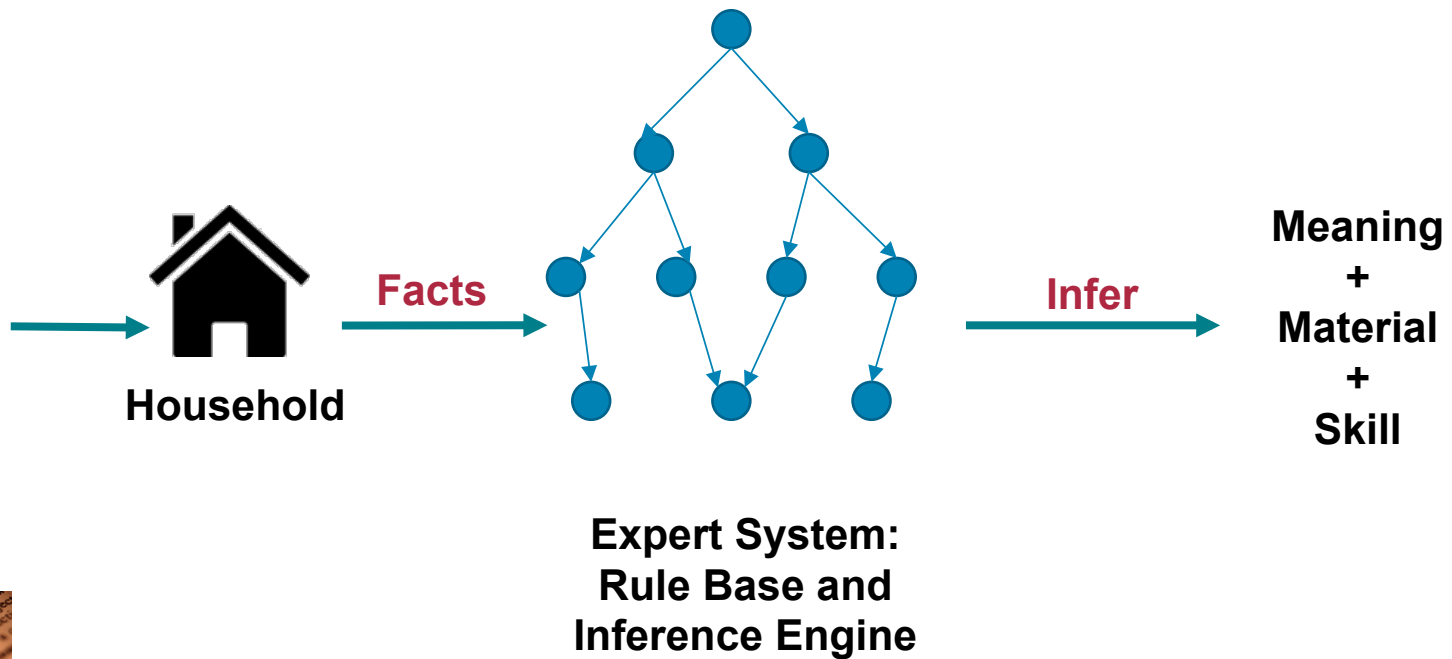
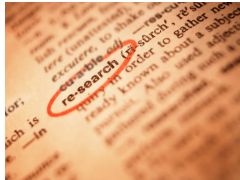
**Walking  
Interviews**



**Survey**

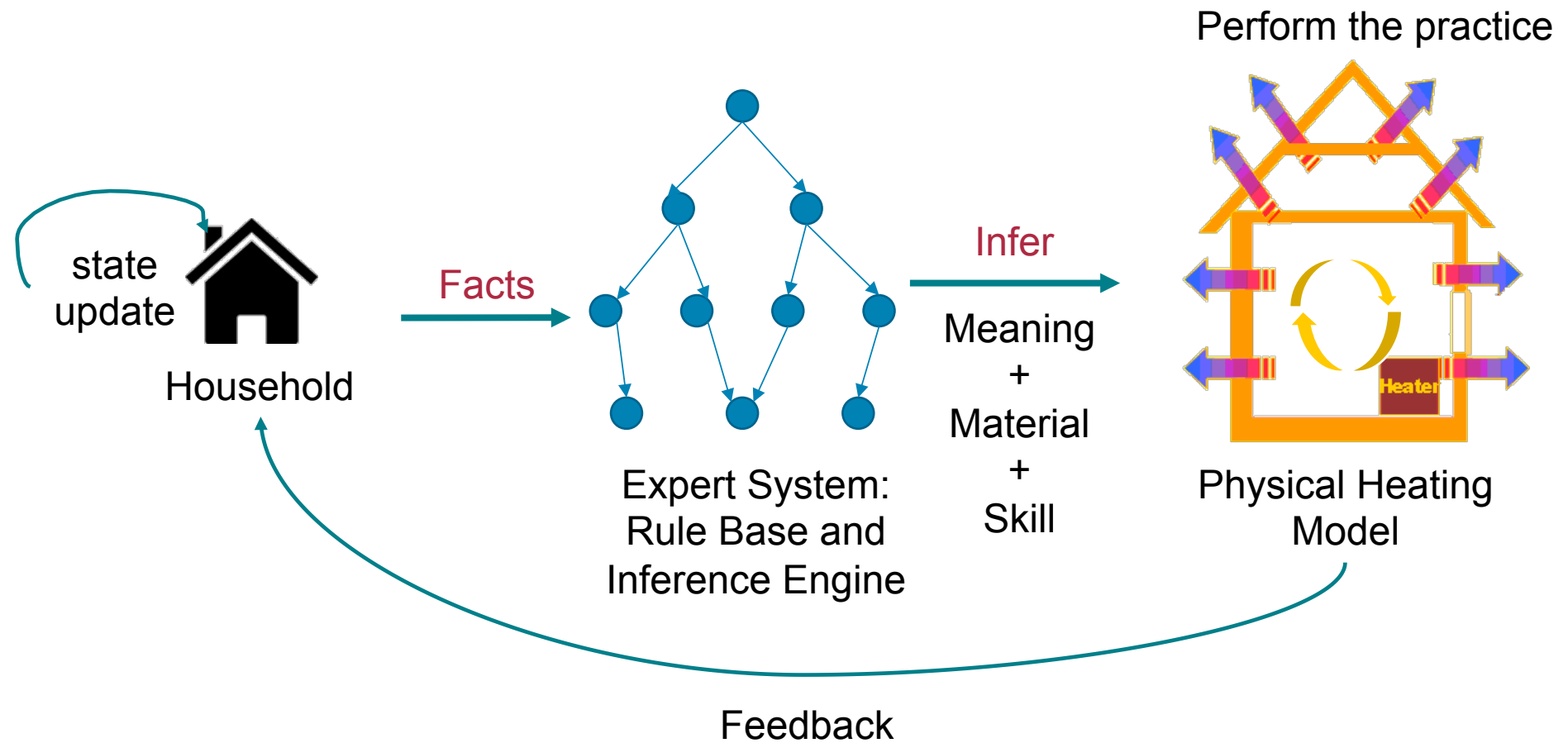


**Reports**



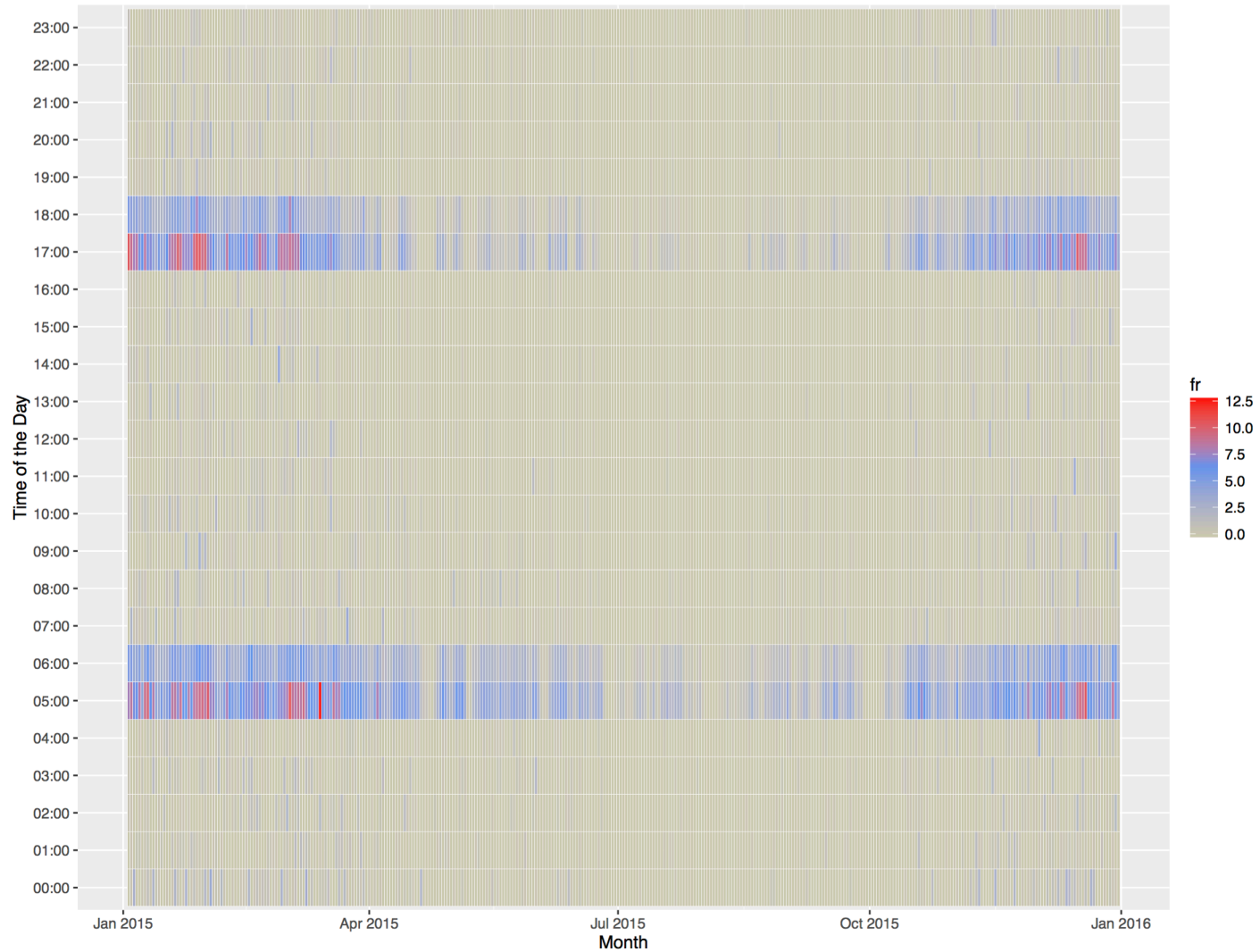


# HOPES: Heating Practice



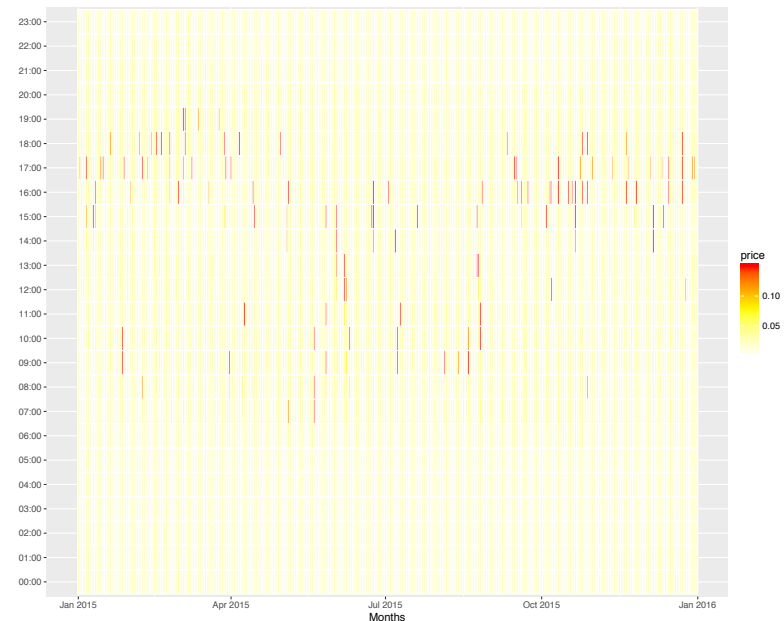
# Heating Profiles of Households in a Flat Rate Scenario

FR: ENERGY



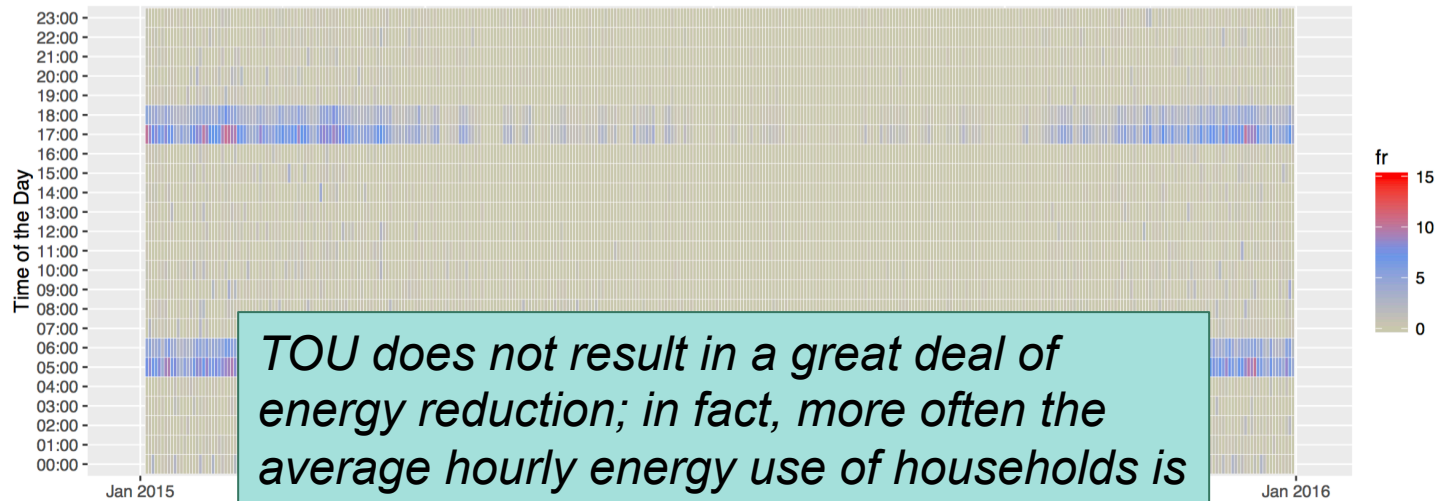
## Time of Use Scenario and Price Signals

- » 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.

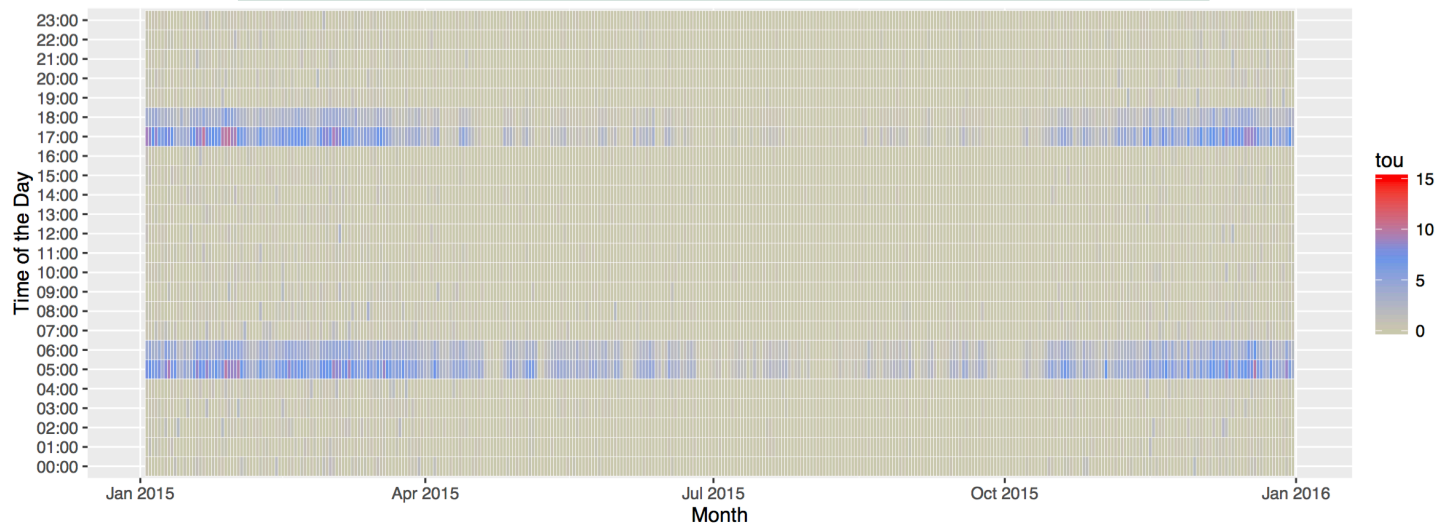


# Heating Profiles of Households

FR: ENERGY

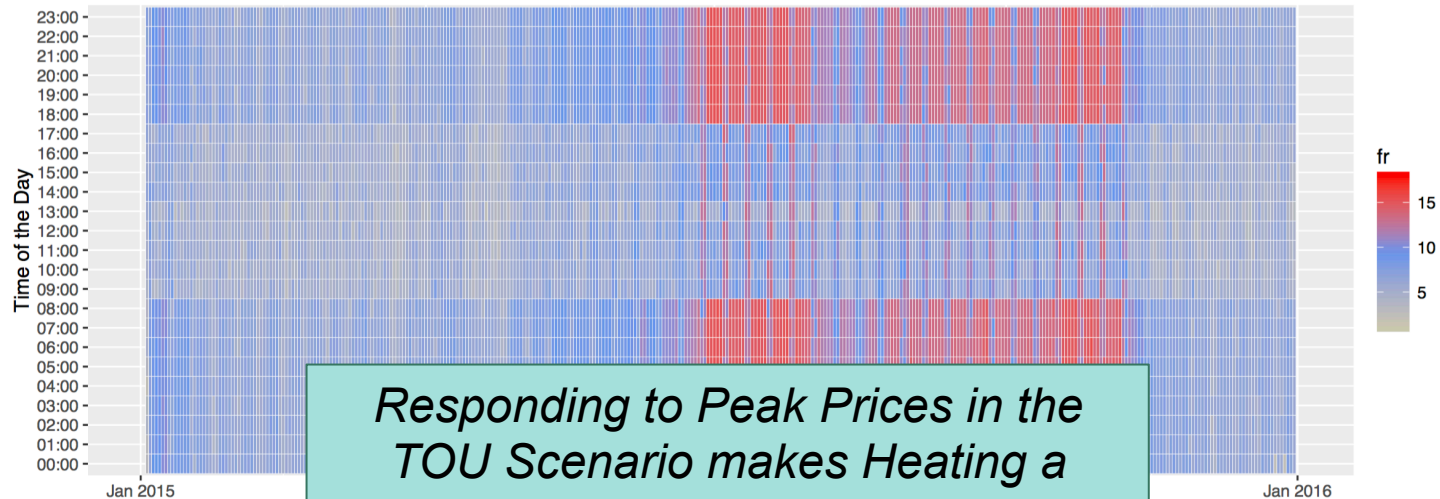


*TOU does not result in a great deal of energy reduction; in fact, more often the average hourly energy use of households is equal to or higher than the FR scenario*

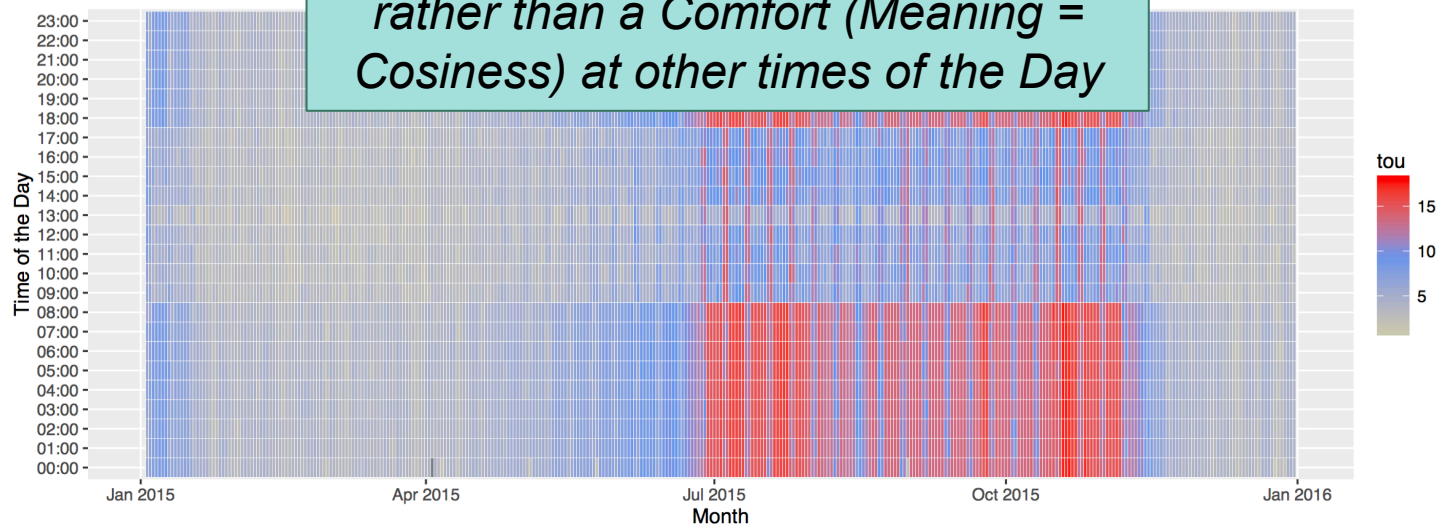


# Deriving a Practice-centric Understanding of the Demand Profile

FR: COSINESS



*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



**WholeSEM University of Surrey:**

**Dr Kavin Narasimhan:** Research Fellow. HOPES.  
[k.narasimhan@surrey.ac.uk](mailto:k.narasimhan@surrey.ac.uk) (@kavinpreethi)

**Dr Aimie Hope:** Research Fellow. Walking interviews.  
[a.hope@surrey.ac.uk](mailto:a.hope@surrey.ac.uk) (@aimiehope)

**Dr Thomas Roberts:** Lecturer. Walking interviews.  
[t.m.roberts@surrey.ac.uk](mailto:t.m.roberts@surrey.ac.uk) (@Env\_Sociology)

**Dr Maria Xenitidou:** Research Fellow. Survey.  
[m.xenitidou@surrey.ac.uk](mailto:m.xenitidou@surrey.ac.uk) (@Mxenitidou)

**Professor Nigel Gilbert:** Co-Investigator (WholeSEM)  
Director (CRESS, Surrey)  
[n.gilbert@surrey.ac.uk](mailto:n.gilbert@surrey.ac.uk) (@micrology)

# Thank You

**Acknowledgements**

The UK Engineering and Physical Sciences Research Council (EPSRC) supported this work through the Whole Systems Energy Modelling Consortium (WholeSEM) project (grant EP/K039326/1).