Modelling co-evolving energy consuming social practices in the household sector

Kavin Narasimhan, Thomas Roberts, Maria Xenitidou and Nigel Gilbert

University of Surrey

International BE4 Workshop, 20-21 April 2015:
Including Behaviour in Energy/Engineering/Economy/Environment models

The problem: What is energy consumption?

Domestic energy consumption accounts for **approx. 1/3rd of total energy demand** in the UK

To date the focus has been on questions like:

How to reduce energy consumption?

How to meet the 2050 reduction targets?

But taking a step backwards:

What is energy consumption in the first place?

Energy consumption is a **by-product** of households performing routines

Sarah Pink (2012) notes *"… while I might suggest sitting on a comfortable sofa to watch a film with my family, I would not suggest that we sit together and consume energy"*

Energy isn't used for its own sake but as part of performing household routines in the service of normal everyday life

A shift in perspective – Social Practice Theory

Viewing energy consumption as a by-product questions approaches where energy is modelled as a utility and the decision making abilities of individuals are considered to be direct drivers of energy demand

Rather …

Energy consumption ought to be understood from the perspective of households performing routine activities on a day-to-day basis

Social Practice Theory (SPT) focuses on the performance of 'everyday' practices, not on the behaviour of individuals

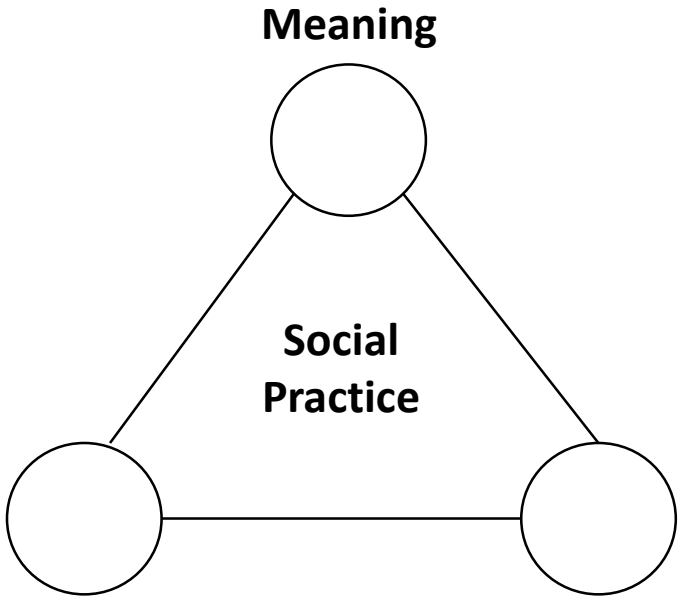
SPT offers a more intuitive theoretical basis for viewing energy consumption as a by-product of performing habitual routines

In SPT, the key question is not why is energy demand rising but on how have domestic social practices changed/changing?

Back to drawing board?

Elements underlying social practices

Outcome(s) intended from performing a practice



Material

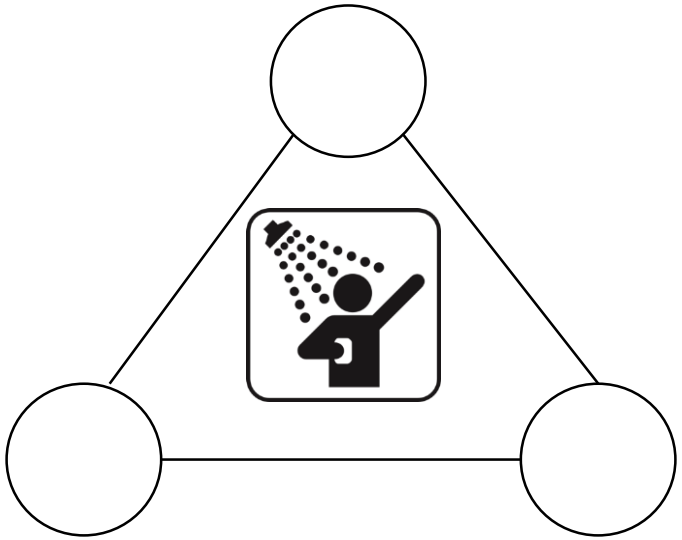
An instrument (body, mind, object etc.) used to carry out a practice

Skill

The ability to use material(s) to perform a practice

An example: The social practice of showering

Personal hygiene, morning routine etc.



Bathroom, soap, shower unit etc.

Use soap, operate shower unit etc.

The 'Rhythm of Society'

The majority of social practice research has focused on individual practices. E.g., standby energy consumption [Gram-Hanssen, 2010]; domestic heating and thermal comfort [Kuijer et al. 2012; Day et al. 2011]; cooking [Morley et al. 2013] etc.

But…

Individual social practices are rarely performed in isolation

Just as elements come together to create social practices, practices come together to create **Bundles**

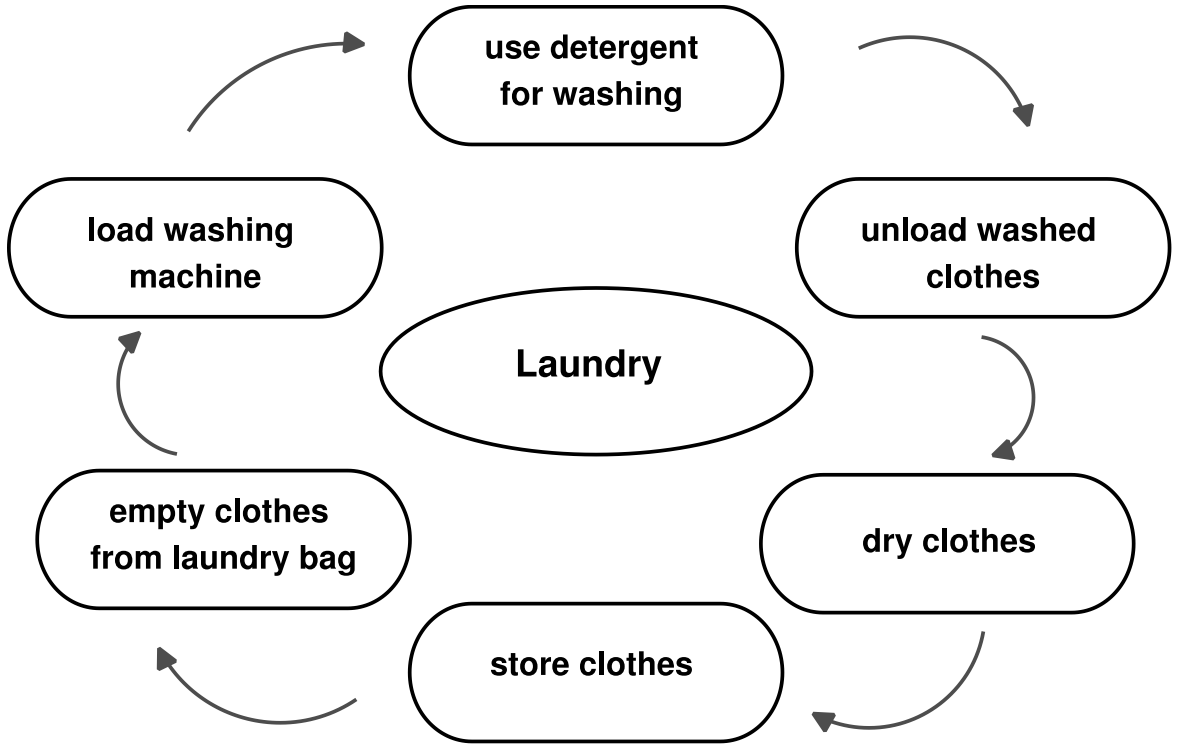
The coming together of millions of practices constitutes the 'Rhythm of Society' [Lefebvre, 2004]

Bundles make up lifestyles or habitus

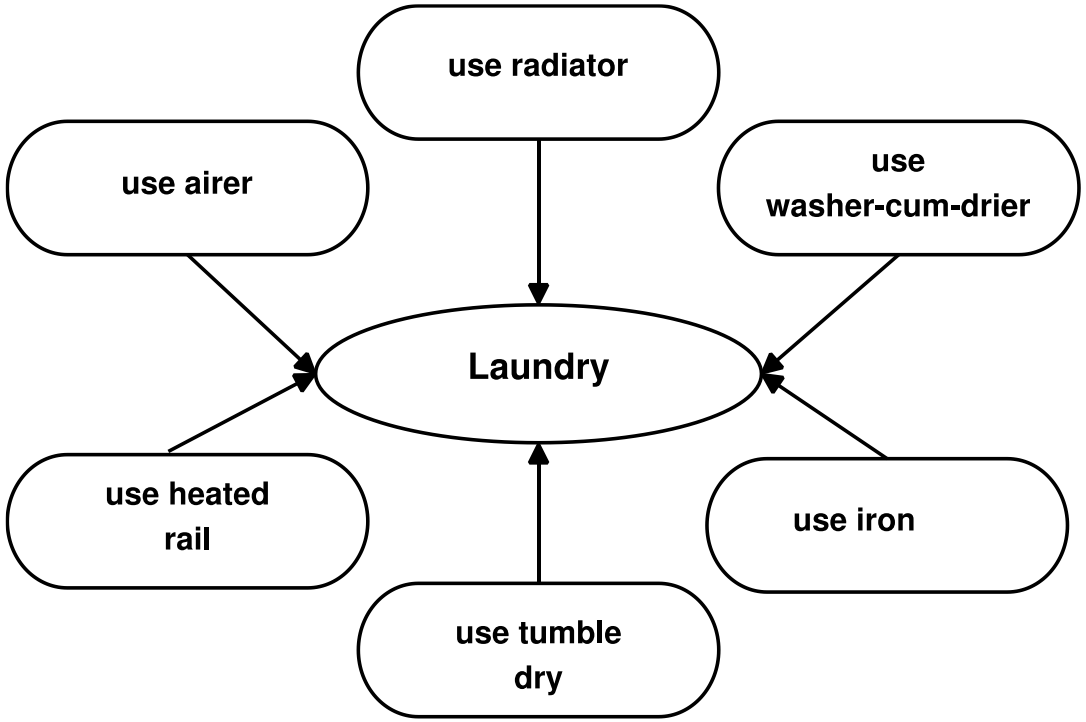
The interconnectedness between practices constituting a bundle means if there are changes to elements underlying one practice, there is a knock on effect for other related practices – **Co-evolution**

Practices (and bundles) also **co-exist**. E.g., turning the heating on when watching TV to create a comfortable and cosy ambience

The idea of *Bundles*



Example of practices contributing to Laundry

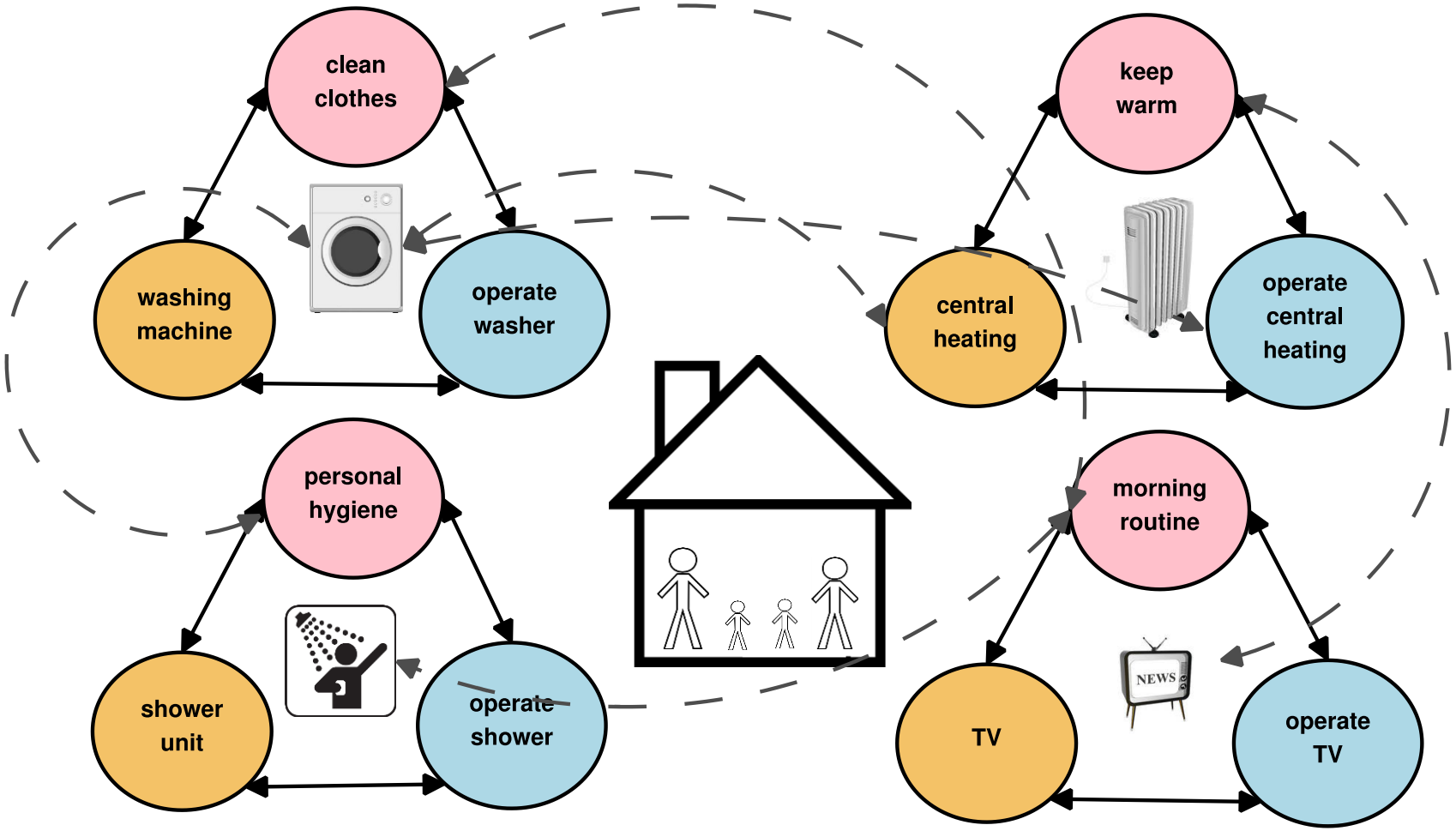


Another example of practices contributing to Laundry

Interconnected performance of bundles

A **complex system of connections** gets established between bundles

Even the slightest change has a knock on effect across the network of links between practices



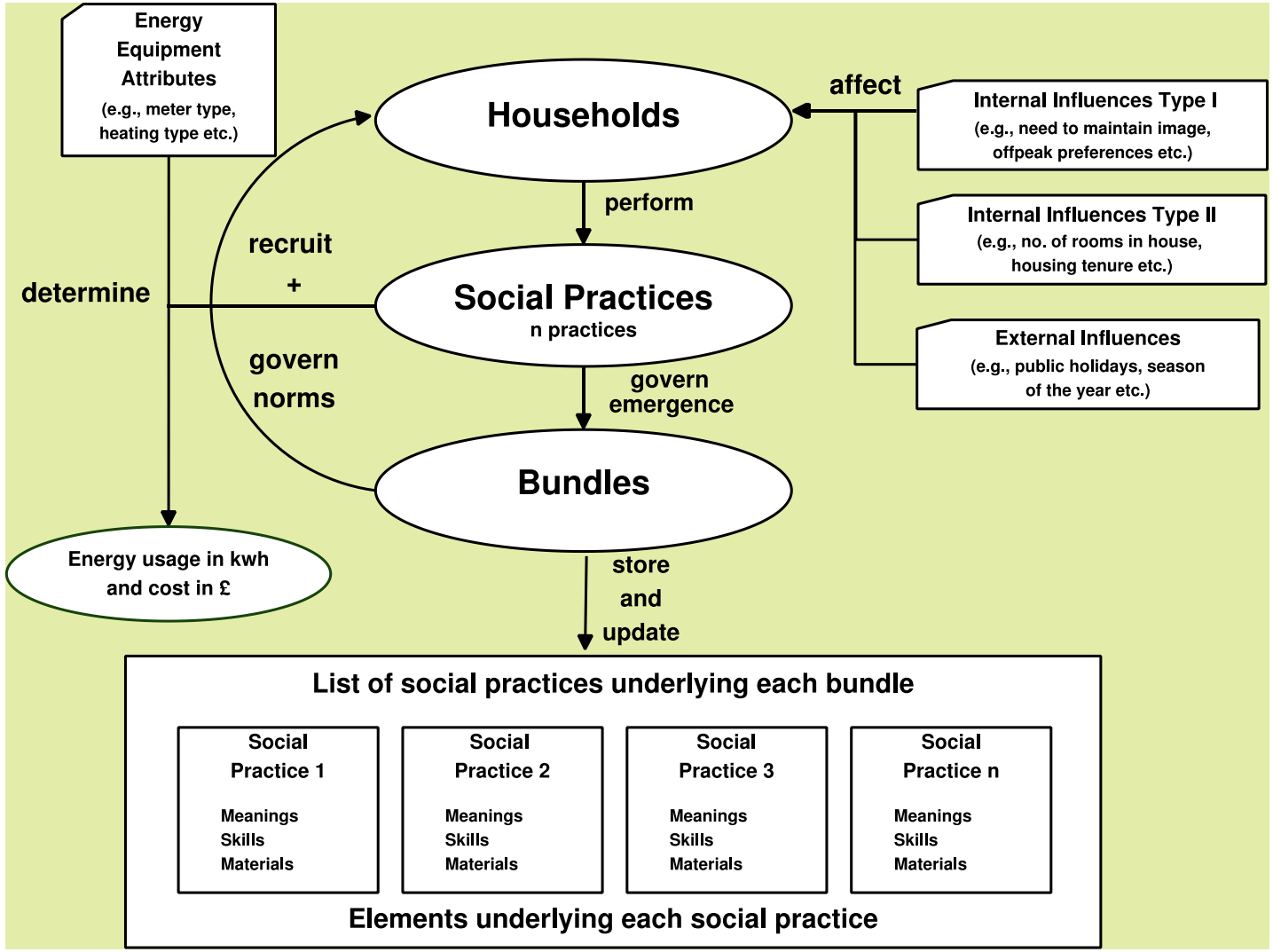
Energy Modelling? Take home points from SPT

+ Households perform energy intensive social practices; practices govern norms for their performance
  + Various factors influence how households perform practices
+ Focus is mainly on the performance of practices
+ Performance of practices are characterized by the coming together of material, meaning and skill elements
+ Practices come together to constitute bundles
+ Practices co-exist – links form and links die
+ Practices co-evolve – links evolve, elements evolve

= Energy Consumption (e.g., in kWh, cost incurred etc.)

Model conceptualisation

- Bottom-up approach to modelling
- Three stage process
- Households, practices and bundles share a micro-macro relationship



- Performance of practices are influenced by factors internal and external to household
- Performance of practices at different times of the day
- Performance affected by links between practices

What is an ABM? A brief overview

Agents are

Simplified representations of real world entities (e.g., ants, humans, households, industries etc.)

Computer programs

Characterized by a set of properties and behaviours (i.e. parts of computer programs)

Able to sense and react to stimuli (from other agents, from the environment)

Able to inter(act) with one another and their environment

Simple, autonomous, adaptive and interdependent

Environment is

The virtual world within which agents act (and react)

A model entity that constraints the flow of agents (or) flow of information between agents

Can include active entities (agents) and/or passive entities (obstacles)

Continuous, discrete or GIS

Very neutral medium (or) a rather sophisticated and complex medium

Coming together: Interaction between agents within an environment leads to the emergence of a complex phenomenon, which has distinct properties of its own

An SPT ABM

Focusing on five specific bundles of practices:

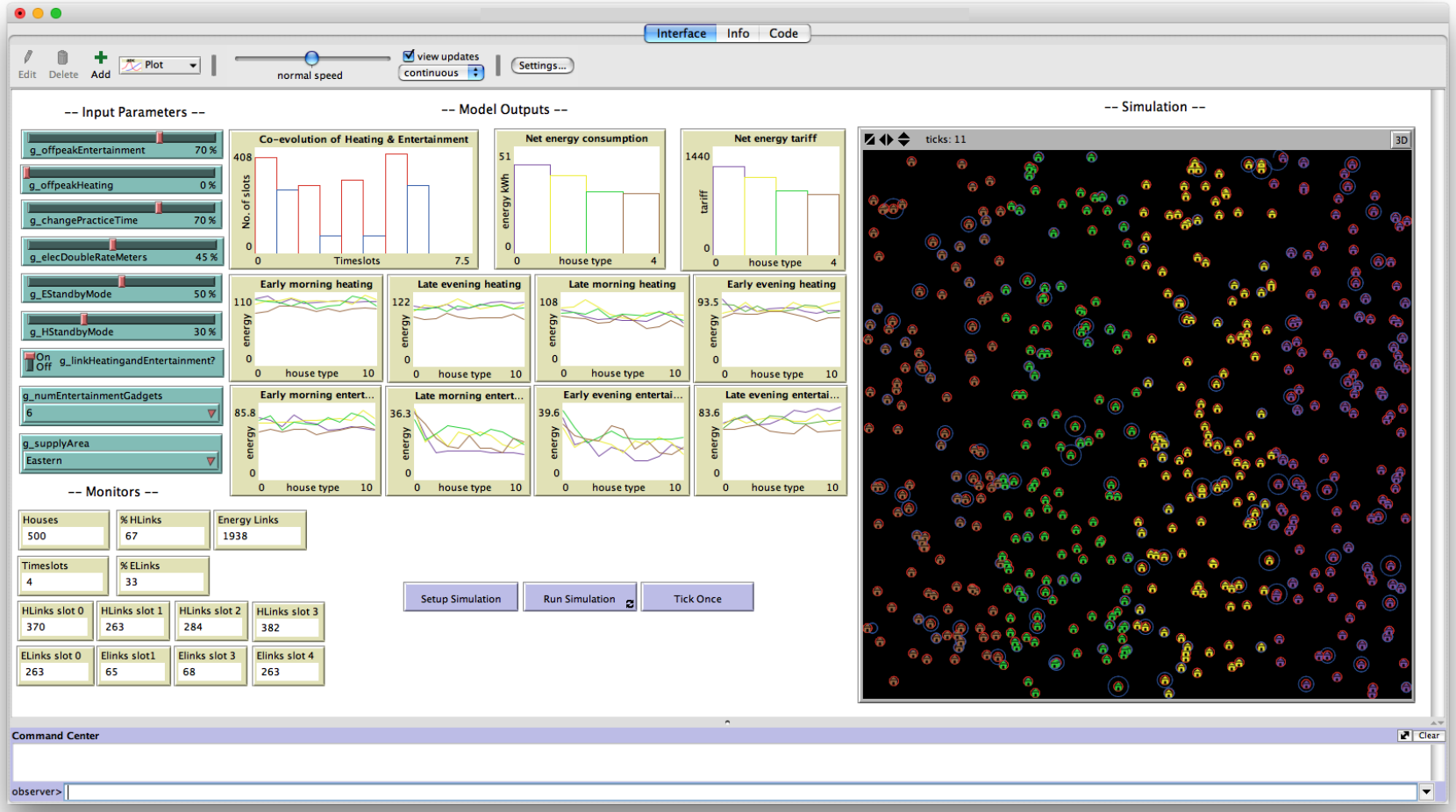
- Thermal Comfort
(central heating, thermal retrofits etc.)

- Visual Entertainment
(watching TV, using game console etc.)

- Electronic Communication
(using computer, tablet PCs etc.)

- Laundry
(using washing machine, tumble dry etc.)

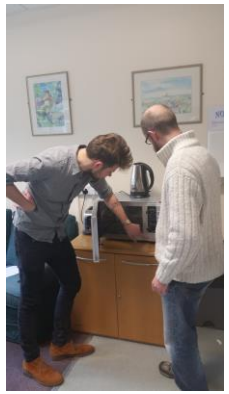
- Cooking
(using microwave, kettle, oven etc.)



ABM built using NetLogo
(https://ccl.northwestern.edu/netlogo/)

An empirically grounded ABM

Walking Interviews



Researcher walks participants through their homes

Gets participants to talk about their daily routines using visual and verbal cues

Enables participants to talk about practices in the context they perform them

Web Survey

To gather information regarding

People

Their homes

Energy consuming appliances

Reflections regarding energy consuming activities

Energy monitoring in Households

To gather energy usage data on a daily basis

Includes both energy and gas monitoring data

Monitoring individual appliances (e.g. washing machine) and appliance bundles (e.g. home entertainment)

Centre for Research in **Social Simulation**

Next steps

In-depth walking interviews with 25 households

Use of thermal images as visual cues to elicit conversation during walking interviews

Design the model

Roll-out web survey focusing on household energy use

Organize focus groups based on outcomes of the web survey

Calibrate the model

Install energy monitoring equipment in 25 households, each monitored over a period of one year

Validate the model

Thank you

k.narasimhan@surrey.ac.uk

t.m.roberts@surrey.ac.uk

m.xenitidou@surrey.ac.uk

n.gilbert@surrey.ac.uk

Follow us on Twitter: @CRESS_Surrey & @wholeSEM