Addressing the behavioural gap in energy/economy models:
Outcomes of the BE_4 Workshop and outlook for the state-of-the-art

Hannah E. Daly, UCL Energy Institute

hannah.daly@ucl.ac.uk

Motivation

Building **sustainable energy systems** require a focus on **behaviour,** along with technologies, energy efficiency and low-carbon fuels

Energy/Engineering/Economy/Environment (E_4) models typically neglect, but are moving towards capturing behaviour

There are **risks** from ignoring, and **benefits** from addressing behaviour in long-term mitigation modelling, and methods allow improvements

International BE_4 Workshop

Brought together 50 participants working on improving the behavioural realism of E_4 models; funded by IEA-ETSAP and WholeSEM

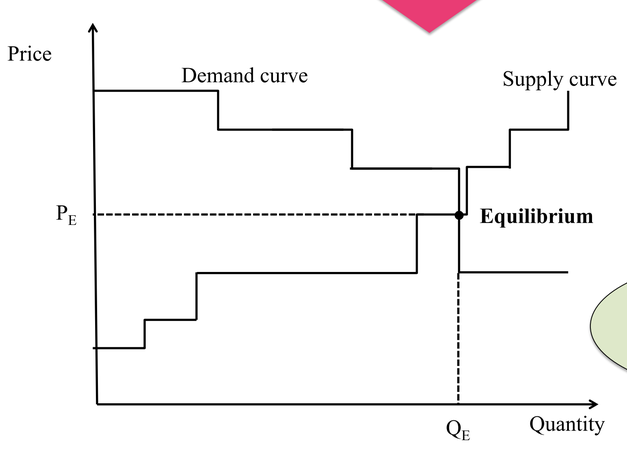
Held at UCL in London on April 20th-21st, 2015, with 21 presentations including keynote speeches from Mark Jaccard and Andreas Schäfer

*Presentations and references available at:
www.iea-etsap.org/web/BE4_Presentations.asp

Achieving technology transitions in energy systems models

Optimum technology pathways are typically achieved within these models with the implicit assumptions of:

- Rational decision-making
- Perfect information
- Competitive markets
- Perfect foresight
- "Social planner" perspective
- Only price-based demand response (if at all):



Risks of simplistic, or no accounting of behaviour:

- Techno-optimism: Over-optimistic, cheap technology adoption
- Neglecting public opposition
- Neglecting distributional impacts
- Not counting on the societal change needed for large demand response
- The availability of many low-cost options for GHG mitigation through behaviour change

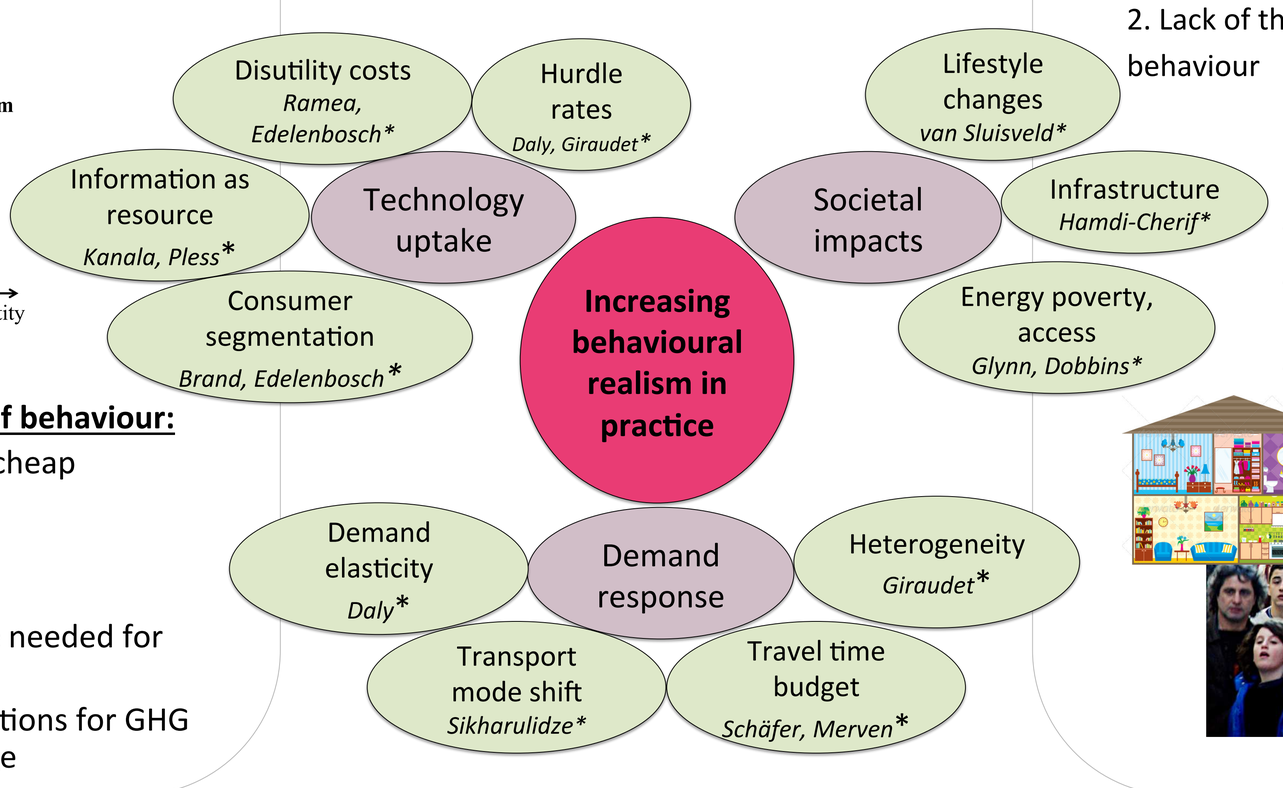
State-of-the-art in BE_4 Modelling

Introducing:

Heterogeneity in people and markets;
Hidden costs in decision-making;
Non-cost-optimal decision frameworks,

Using:

Empirical evidence
Discrete choice analysis;
Agent-based modelling;
Social science insights.



People and society: Perspectives from Social Sciences

Methodologies & frameworks from Social Sciences

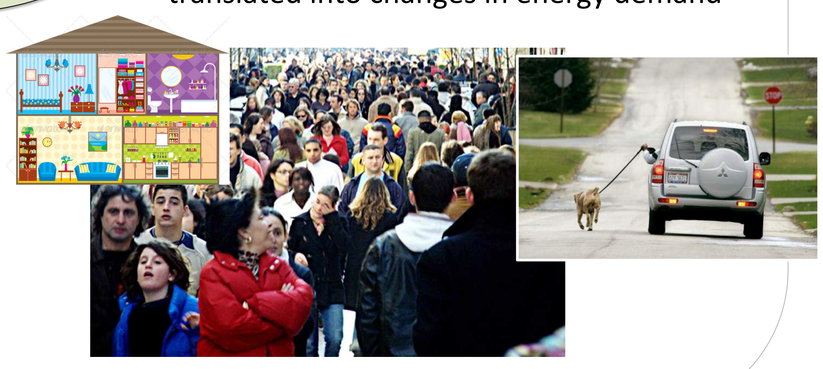
(Huebner et. al, Narasimhan et. al, Hargreaves et. al*)

Understanding	*Measuring*	*Modelling*
	Energy monitoring	
Practice theory	Web survey	Agent-based model
Psychology	Walking interviews	Discrete choice
….	Stated, revealed pref.	Econometric model
	Historical data	

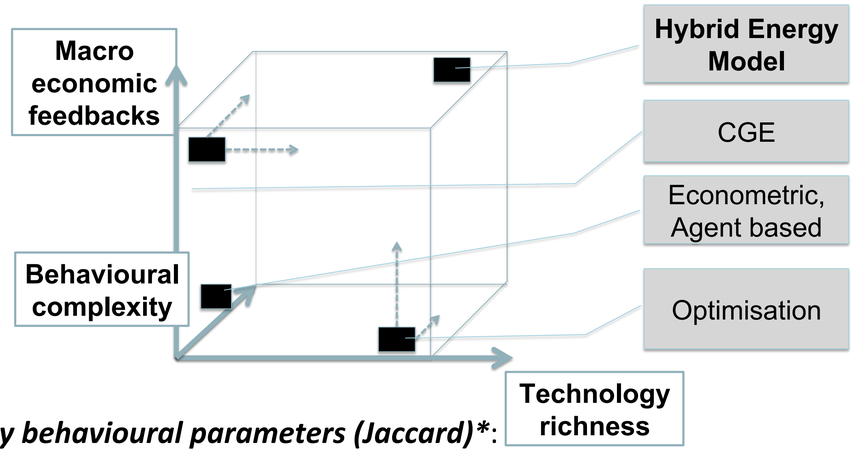
Main challenges of modelling behaviour

(Huebner et. al*)

1. Limited understanding of 'behaviour'
2. Lack of theories with substantial explanatory power of behaviour
3. Data issues: Lack of high quality data relevant to behaviour; huge variability exists; measurement issues (self-reported vs. observed)
4. Huge complexity of the physical processes through which behaviour is translated into changes in energy demand



Building hybrid models with behavioural complexity



Three key behavioural parameters (Jaccard)*:

- **Discount rate (r)** - time preference as reflected in actual decisions, excluding technology-specific risks
- **Intangible cost (i)** – technology-specific decision factors, especially differences in quality of service and cost risks
- **Market heterogeneity (v)** – reflects the diversity among decision makers in terms of real and perceived costs (logistic curve)

Discrete choice models (DCM) to estimate *r, i* and *v*

Survey / Observation → Empirical Model - DCM → Hybrid model CIMS' *r*, *i* and *v*

Market share formula:

$$\frac{e^{U_j}}{\sum_{k=1}^{K} e^{U_k}} = \frac{\left[CC_j \times \frac{r}{1-(1+r)^{-n}} + OC_j + i_j\right]^{-v}}{\sum_{k=1}^{K}\left[CC_k \times \frac{r}{1-(1+r)^{-n}} + OC_k + i_k\right]^{-v}}$$

Use OLS to estimate *v* for which predictions from CIMS are consistent with those from the DCM model.

Use DCM for more realistic projections of technology transitions

Horne, Jaccard, Tiedemann (2005) "Improving Behavioral Realism in Hybrid Energy-Economy Models Using Discrete Choice Studies of Personal Transportation Decisions," Energy Economics, V27.