Experts' Group on R&D Priority-Setting and Evaluation (EGRD)

Behavioural economics, policies and modelling

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IEA

Overview

- **Links between social science, behavioural economics, policy**
- **Integrating BE into energy and climate models**
- **Energy system optimisation models (ESOMs)**
- **Summary**

Methodologies and frameworks for social sciences (Huebner et al)

- **Understanding the underlying rationale and the behaviour**
  - Practice theory
  - Psychology (the individual)
  - (Sociology) (the individual in society)

- **Measuring the actions**
  - Energy monitoring
  - Web surveys
  - Walking interviews
  - Preferences (stated vs. revealed)
  - Historical data

- **Modelling**
  - Agent-based model
  - Discrete choice
  - Econometric model

Behavioural economics (BE) and policy

- **Behavioural economics**
  - **The relationship between economics and psychology**
  - **Aims to apply scientific method to the study of economic activity**
    - Empirical studies of decision making and models are applied to economic problems
  - **Based on repeated experiments and observations**
    - Rational (predicted) vs. irrational (unpredicted) behaviour
- **The relatively new science of BE is – rapidly – informing policy**
- **Strong features of early applications to regulatory design**
  - Choices are influenced by the **simplicity of the information** and the range of options
  - Consumers are drawn towards **more convenient options**, especially default options
  - The **attributes of options** can affect how they are weighted in the decisions
- **Decision processes**
  - How to account for non-linear decisions (i.e. compound factors)

Source: OECD (2017), *Regulatory Policy and Behavioural Economics*, OECD, Paris

Behavioural economics (BE) and policy (2)

- **Policies - most often regulatory**
  - **Tax compliance**
  - **Consumer policy**
    - Markets with relatively complex products (financial services, health insurance, markets involving service contracts such as energy)
- **Examples of policies informed by BE**
  - **United States:** Credit Card Accountability Responsibility and Disclosure Act (based on behavioural evidence); vehicle fuel efficiencies (EPA changed the labelling of MPG)
  - **United Kingdom:** Behavioural Insights Team (internal consultancy for UK policy makers which uses local policy trials and experiments to test behaviourally informed ideas)
  - **Australia, France, Denmark, Sweden, Norway, UK, US and EC:** Promoting awareness of BE among policy makers generally
- **Evaluating success**
  - Easier to identify possible solutions than to measure the impacts

*OECD (2017), *Regulatory Policy and Behavioural Economics*, OECD, Paris

Energy and climate models

- **Priorities**
  - **Accurately representing the intersection between energy technologies, economics and human behaviour is not straightforward, and right now is ignored in most modelling studies**
  - **Consumer behaviour can both be an opportunity and a barrier to energy system transitions**
  - **Therefore to understand how consumer behaviour influences energy system pathways is essential for planning low-carbon pathways**

Integrating BE into energy and climate models

- **Contributions of social science (behaviour) are more difficult to measure than those of other disciplines (natural sciences, engineering, technology, medical, health) or economic (financial)**

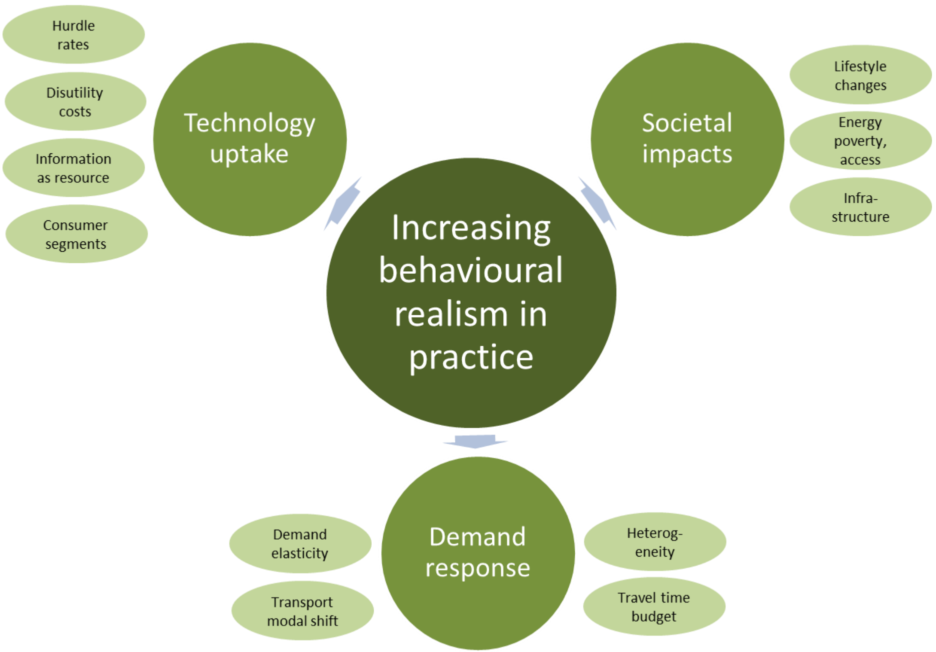
- **Behaviour:** intangible, indirect elements (who, how, when, why)
  - Information base: surveys, social science
  - Outcomes: case studies, hypotheses
  - Messages: inferred

- **Modelling:** tangible, quantifiable elements (prices, consumption)
  - Information base: data collection
  - Outcomes: scenarios
  - Messages: relative cause-and-effect

Key modelling parameters

- **Costs**
  - Hidden or intangible costs
  - High time preference
- **Price sensitivity (elasticities)**
- **Rate of technology adoption**
  - Hurdle rate
- **Behaviour**
  - Dependent on the individual and the social group/context
  - Natural vs. accelerated replacement rates ("nudge")

Modelling approaches to behaviour



Source: UCL Energy Institute (2015), Addressing the behavioural gap in energy/economy models", BE4 workshop, UCL Energy Institute, composite of modelling approaches.
https://iea-etsap.org/index.php/etsap-project/be4-presentation

Motivations for integrating BE into models

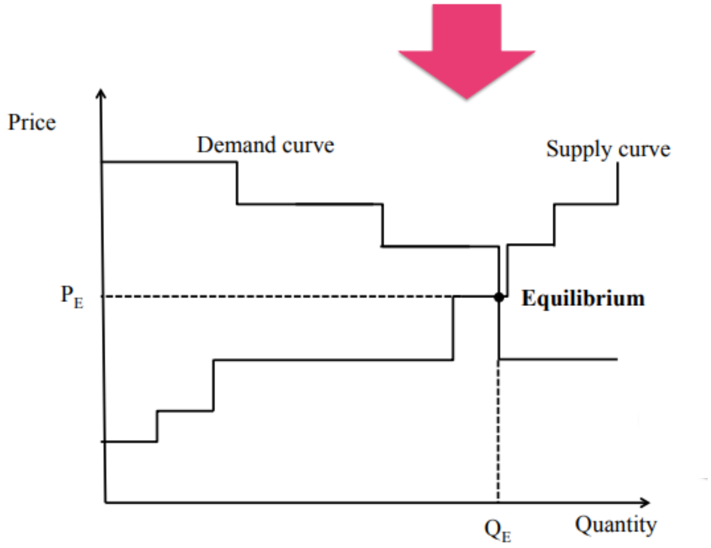
- **Building sustainable energy systems requires a focus on a broad range of issues**
  - Technologies, economics, energy efficiency and low-carbon fuels
  - Behaviour

- **Energy/engineering/economic/environment (E4) models typically neglect behaviour**
  - Progress in recent years to integrate behaviour

- **Risks and benefits**
  - **Risks:** ignoring the role of behaviour
  - **Benefits:** addressing behaviour in long-term mitigation modelling
  - Experience with methods enables improvements

Achieving technology transitions in ESOMs

- **Optimum least cost technology pathways: implicit assumptions**
  - Rational decision-making
  - Perfect information
  - Competitive markets
  - Perfect foresight
  - "Social planner" perspective
  - Only price-based demand response (if at all)



Source: UCL Energy Institute (2015), Addressing the behavioural gap in energy/economy models", BE4 workshop, UCL Energy Institute, composite of modelling approaches.
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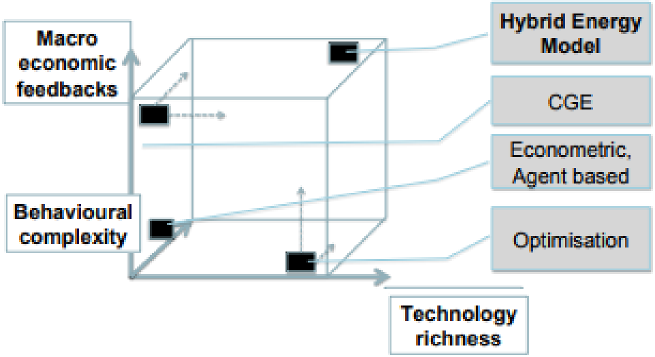
Main challenges of modelling behaviour

- **Limited understanding of 'behaviour'**
- **Lack of theories that fully explain behaviour**
  - **Data issues**
    - Lack of high-quality data relevant to behaviour
    - Digitalisation (cheap sensors and data storage) opens new opportunities to observe behaviour
      - Vast amount of potential "big data"
      - Does not directly translate into information
      - Methodologies needed to filter, analyse and understand the data.
  - **Huge variability in behaviours**
  - **Measurement issues**
    - Self-reported vs observed consumption
  - Huge complexity of the physical processes through which behaviour is translated into changes in energy demand

Source: Huebner, G., et al (2015).

Building hybrid models which integrate complex behaviours

- **Three key behavioural parameters**
  - **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**)**



Source: UCL Energy Institute (2015), Addressing the behavioural gap in energy/economy models", BE4 workshop, UCL Energy Institute, composite of modelling approaches.
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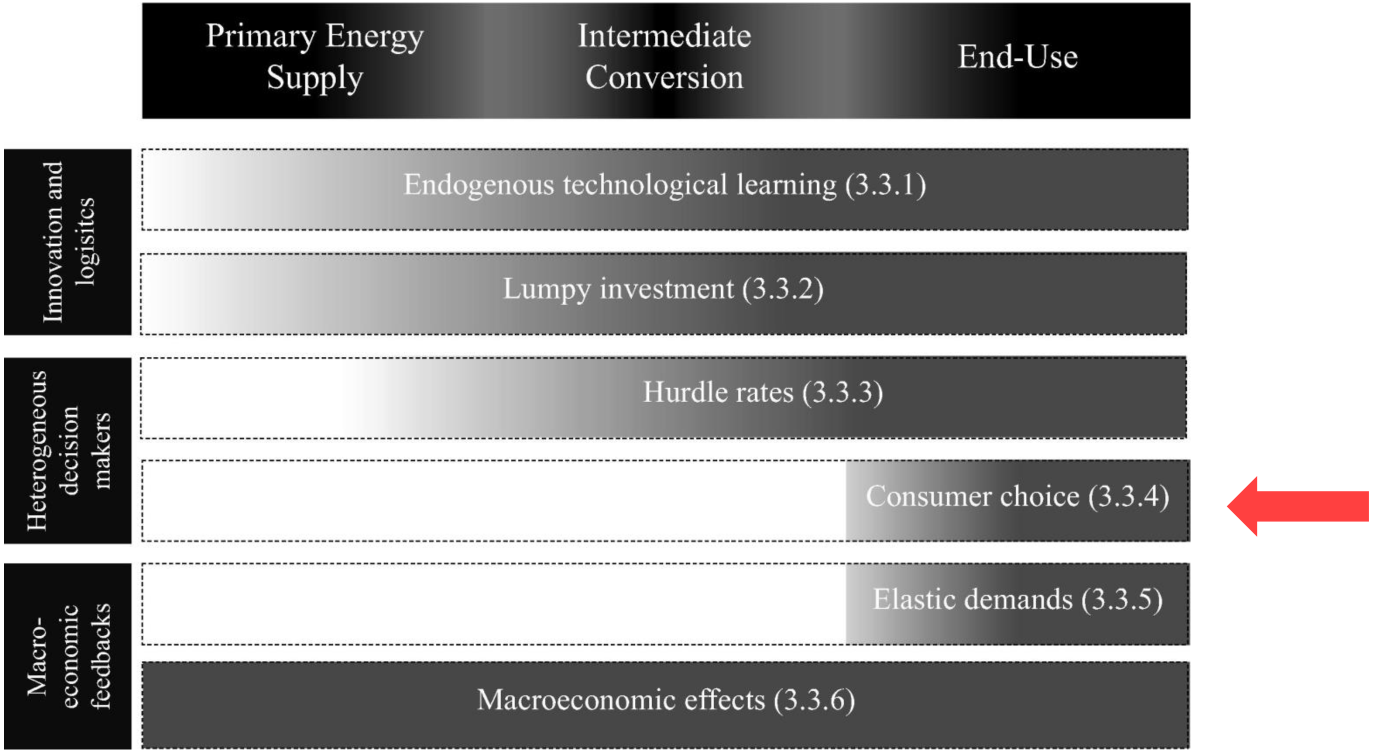
Hybrid models which integrate complex behaviours



Source: DeCarolis, J., et al (2017), *Formalizing best practice for energy system optimization modelling,* **Applied Energy** 194 pp 184-198.

Guiding principles of ESOM*

- **Let the problem drive the analysis, not the other way around**
- **Make the analysis as simple as possible and as complex as necessary**
- **Develop quality assurance procedures and apply them to input data**
- **Consider the range of sectoral detail across the model**
- **Re-evaluate the modelling approach and objectives throughout the analysis**
- **Consider uncertainties that are both endogenous and exogenous to the model and how they can affect conclusions**
- **Make transparency a goal of model-based analysis**

* Joseph DeCarolis, Hannah Daly, Paul Dodds, Ilkka Keppo, Francis Li, Will McDowall, Steve Pye, Neil Strachan, Evelina Trutnevyte, Will Usher, Matthew Winning, Sonia Yeh, Marianne Zeyringer 2017 *Formalizing best practice for energy system optimization modelling.* **Applied Energy** 194 pp 184-198

Discount and hurdle rates

- **Discount rate (global – applied across the model)**
    - **Prescriptive** or 'ethical' discounting (0.11 - 3.5%)
        - The value society attaches to present over future consumption or utility
    - **Descriptive,** or behavioural (10%)
        - Real market risk, required rate-of-return
- **Hurdle rate (applied to specific sectors or technologies)**
    - **The agent making the investment may differ**
        - Private cost of capital (7-10%)
        - Business borrowing costs (3-7%)
        - Government (1%?)
    - **May also represent**
        - The required rate of return on investment (10-15%?)
        - The perceived energy efficiency gap of individuals (up to 25%)
        - Other ways to represent behaviour

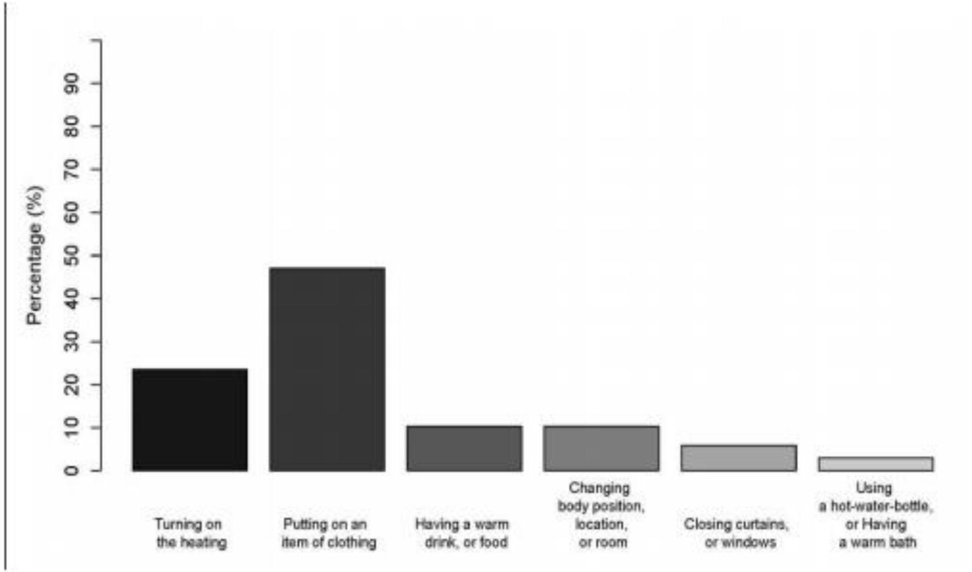
Hurdle rates

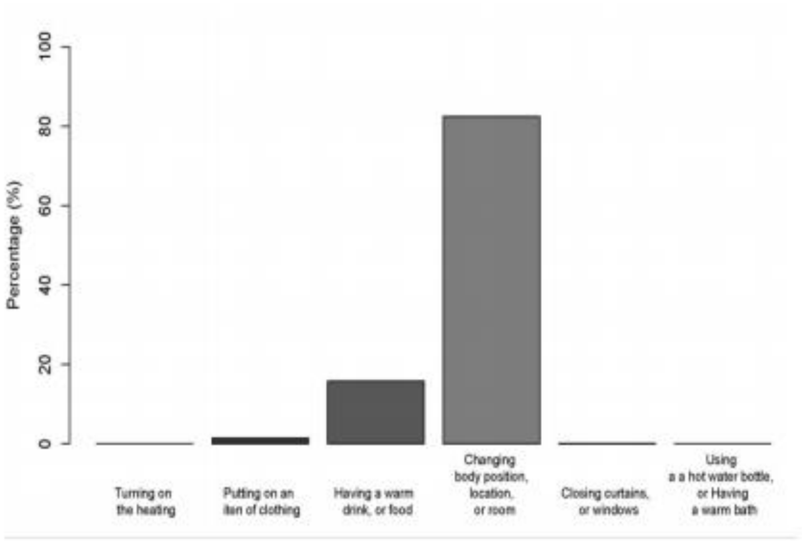
- **Case 1 (global 10%, end-use 25%)**
  - **Market investment rate**
    - *"to reflect commercial UK market rates of return"*
  - **Higher technology-specific discount rate**
    - *"to account for market risks and consumer preferences"*
  - **Imperfect knowledge and non-cost preferences**
  - **Market risk**
    - *"information deficiencies and other market imperfections in the uptake of end-use conservation options"*
- **Case 2**
  - **Cost of financing and social discounting**
    - *"The first is … in accordance to an annual return on investment. Social discounting is used to reflect the valuation on wellbeing in the near future versus well-being in the longer term"*
- **Case 3**
  - **New/unproven technologies**
    - *"a factor of 15% to reflect a higher risk in investing in unproven technologies and infrastructures"*
    - *"meant to mimic hesitancy on the part of the purchaser to invest in a newer technology over an established technology"*

Source: DeCarolis, J., et al (2017), *Formalizing best practice for energy system optimization modelling*, **Applied Energy** 194 pp 184-198.

Data issues

- **Self-reporting versus observed data**





Source: Gauthier and Shipworth (2015).

Data issues (2)

- **2012 Green Deal (UK government flagship energy efficiency programme)**
- **Consumer 'take-up'rates were calculated using results from choice modelling of main energy efficiency measures**

	Modelled uptake to March 2015	Actual uptake to February 2015
Solid wall insulation	147,000	1,704
Cavity wall insulation	830,000	320
Loft insulation	364,000	938
Glazing and draught proofing	~100,000	254

Source: Department of Energy and Climate Change (2012).

Improvements possible

- **More 'realistic' estimates of behaviour change potential and associated costs**
  - **Data collection:** Focus groups, surveys
- **Understand the relationship between hypothetical - and actual - behaviour**
- **The narrative for the model results should be consistent with the use of the hurdle rate**
  - **Prescriptive (normative) – "this is the optimal energy systems"**
    - *Are we missing out on real-world barriers to technology uptake and being overly optimistic?*
  - **Descriptive (positive) - "this is a realistic scenario for the next 50 years"**
    - *Is the use of HRs predetermining technology deployment?*
- **Consistent rationale for HRs across different technologies**
- **Rationale and HRs should be transparent**

Summary

- **Informing policies through behavioural economics (BE) has increased rapidly in recent years**
  - Challenges with data collection and methodologies
    - Non-linear, indirect, inferred
  - Provide possible solutions yet difficult to measure effectiveness and impact
- **Modelling provides valuable insights to policy makers**
  - Limited understanding of ‘behaviour’
  - Disconnect between consumers’ reported and actual behaviour
  - Too many judgements are needed
- **Formalised guidance comes at a critical time for ESOMs to inform climate policy**
  - Hurdle rates have the potential to substantially change optimal technology pathways

EXTRA SLIDES

Average hurdle rates for sectors

- **Inconsistent portrayal of**
  - **Individual purchaser behaviour**
    - Energy efficiency gap
      vs.
      low cost of borrowing
  - **Novel technologies**
    - High cost of uncertainty
      vs.
      "technology agnostic"

	UK TIMES	ESME	PRIMES/ JRC TIMES	UK TIMES/ MACRO	DECC DDM
Upstream/processes	10%	8%	7%	10%	10%
Power sector	10%	8%	9%	10%	5-19%
Agriculture	10%	8%	12%	10%	10%
Industry	10%	8%	12%	10%	10%
Services	10%	8%	12%	10%	10%
Residential	5%	8%	18%	25%	5%
Cars	5%	8%	18%	25%	5%
Public transport	7%	8%	8%	25%	7%
Road freight	10%	8%	12%	9%	10%
Aviation	10%	8%	8%	4%	10%
Shipping	10%	8%	12%	4%	10%

Average hurdle rates for residential technologies

Study	End-use type	Average rate
Arthur D. Little (1984)	Thermal shell measures	32%
Cole and Fuller (1990)	Thermal shell measures	26%
Goett (1978)	Space heating system and fuel type	36%
Berkovec, Hausman and Rust (1983)	Space heating system and fuel type	25%
Hausman (1979)	Room air conditioners	29%
Cole and Fuller (1980)	Refrigerators	61-108%
Gately (1980)	Refrigerators	45-300%
Meier and Whittier (1983)	Refrigerators	34-58%
Goett (1983)	Cooking and water heating	36%
Geott and McFadden (1982)	Water heating fuel type	67%

Sources: Sandstad et al. (1995) and Train (1985).

Source: Manon et al., (2006) Strategic Investments in Residential Energy Efficiency: Insights from NE MARKAL".

WholeSEM household questionnaire

- **Which central heating would you choose?**
  - Technology attributes are derived from UK Times Model
  - Develop a discrete choice model of heating selection
  - Derive hurdle rates which differentiate costs, novelty, hassle
  - Differentiate hurdle rates for different population segments

	Gas	Electric storage	Heat pump	Solid fuel
Upfront cost	£2,000	£2,000	£3,000	£3,000
Annual cost	£500	£750	£750	£750
CO_2 savings	-20%	-40%	-40%	-100%
Lifetime	15	20	15	20
Effort for servicing, fuelling	Low	Medium	High	Low
Operation effort	Low	Medium	Medium	High

Source: WholeSEM,