



## **LECTURE 11**

# **HUMAN FACTOR IN BUILDING ENERGY SAVING**

### **OVERALL AIM:**

***Ability in the recognition of human factor impact in building retrofit and urban regeneration and in tackling it through the development of public private partnerships and other models and instruments***



# **Erasmus+**

# What do we mean with HF?

---

- **consumer behavior** as a “set of activities prospective customers undertake in searching, selecting, valuing, assessing, supplying and using of products and services in order to satisfy their needs and desires” (Čavoški and Marković 2015)
- **Occupant behavior** has been referred as a set of “observable actions or reactions of a person in response to external or internal stimuli, or respectively actions or reactions of a person to adapt to ambient environmental conditions such as temperature, indoor air quality or sunlight” (International Energy Agency EBCP 2013)
- **Energy behavior** has been defined as “all human actions that affect the way that fuels (electricity, gas, petroleum, coal, etc.) are used to achieve desired services, including the acquisition or disposal of energy-related technologies and materials, the ways in which these are used, and the mental processes that relate to these actions” (International Energy Agency DSM Energy Efficiency 2014)



# Occupant behaviour and policy instruments

- Behaviour patterns

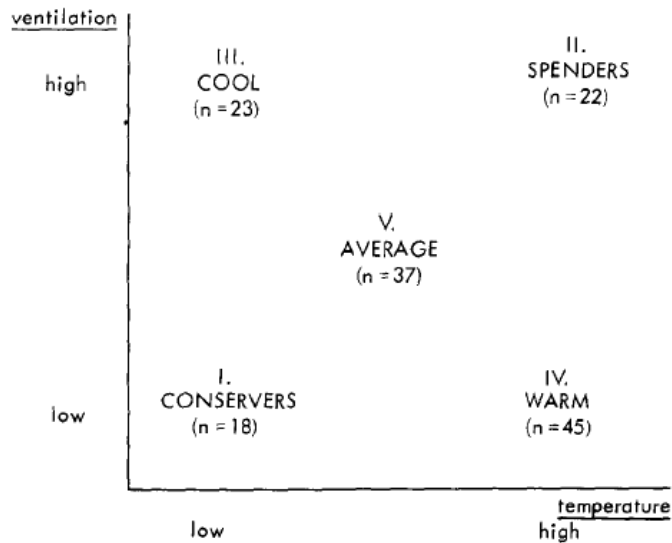


Fig. 1. The five behavioral patterns (clusters) based on temperature and ventilation (see also table 1).

W.F. Van Raaij, T.M. Verhallen, **Patterns of residential energy behavior**, *Journal of Economic Psychology*, 4 (1983) 85–106

**Different energy conservation strategies/programmes** for each behavioural patterns:

**CONSERVERS** → to reinforce high level of energy concerns and low level of comfort concerns

**SPENDERS** → changing behaviour is a difficult task. Better home insulation

**COOL** → to stress the adverse effect of high ventilation levels

**WARM** → good clothing instead of high temperature may not reduce comfort

**AVERAGE** → information on lower temp. and ventilation to move them into CONSERVERS



# Occupant behaviour and policy instruments

---

- Insights from behavioural economics and psychology

E. R. Frederiks, K. Stenner, E. V. Hobman,  
**Household energy use: Applying behavioural economics to understand consumer decision-making and behaviour**,  
*Renewable and Sustainable Energy Reviews*,  
Volume 41 (2015) 1385-1394

They applied behavioural economics and psychology to highlight the key **cognitive biases and motivational factors** that can guide the effective design and delivery of consumer-focused strategies and public policy interventions to improve residential energy conservation

## **Policy implications:**

- Loss aversion
- Normative social influence
- Perceived trust
- Avoid complexity



# Occupant behaviour and policy instruments

---

- Insights from behavioural economics and psychology

A. Karatas, A. Stoiko, C. C. Menassa, **Framework for selecting occupancy-focused energy interventions in buildings**, *Building Research & Information*, 44 (5-6) (2016), 535-551

They proposed a **conceptual framework** for selecting occupancy- focused energy interventions in buildings. The framework adopts a **motivation/opportunity/ability (MOA) approach**: measuring occupants' pre- and post- intervention exposure MOA level and energy-use profiles; clustering occupants based on identified characteristics; choose energy-efficiency intervention strategies accordingly



# Occupant behaviour and policy instruments

(continue)

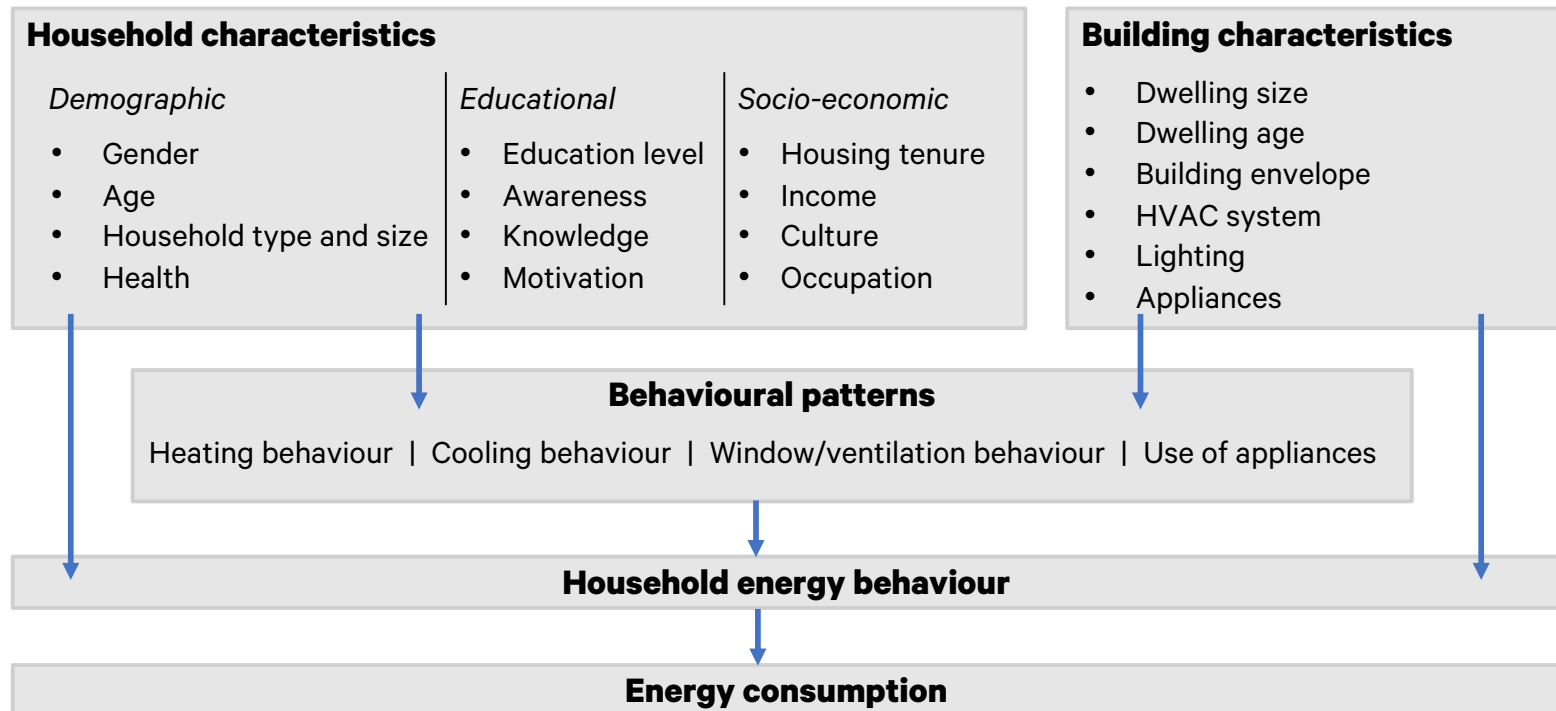
**Table 4** Characteristics of intervention strategies from a building energy-conservation perspective

Occupant MOA: characteristics	Energy policy tools	Intervention	Benefits and solutions presented to the target	Expected benefits/costs	Occupant reaction	Time to achieve benefits
<b>MOA = prone to react</b> Merely uninformed occupant Strong self-motivation No additional reinforcement necessary	Knowledge tools	<i>Knowledge based:</i> attempts to teach and create an awareness about the benefits of a particular behaviour. <i>Objective:</i> influence knowledge, attitudes and beliefs	<i>Suggests</i> benefits but does not deliver them explicitly <i>Does not add new choices</i> (uses existing choices) <i>Target is required to initiate quest/solution</i> to achieve a benefit	No explicit reward/penalty	Uncoerced free-choice behaviour <i>Voluntary compliance</i>	Promise of future potential payback Unable to reinforce directly
<b>MOA = Unable to slightly resistant to react</b> Strong self-motivation Insufficient opportunity		<i>Persuasion:</i> offers reinforcing incentives/consequences <i>Objective:</i> invite voluntary exchange	<i>Offers</i> benefits they want <i>Adds choices</i> with comparative advantage and favourable cost-benefit relationships <i>Target receives solutions</i> through well-known distribution channels	Positive reward/punishment delivered when the exchange transaction is completed	Uncoerced free-choice behaviour <i>Voluntary exchange</i> (self-monitoring – self-sanctioning)	Direct and timely exchange for the desired behaviour Direct reinforcement Expects free-market exchange
<b>MOA = resistant to react</b> Existing low-level motivation and ability cannot be overcome with additional rewards through exchange	Inducement tools	<i>Penalties:</i> prescribes a body of rules of action/conduct <i>Objective:</i> coerce and threaten to achieve non-voluntary compliance	<i>Forces</i> benefit by providing external motivation in the absence of an internal one <i>Adds proffered choices</i> <i>Target bound by legal force</i>	Sanctions, penalties and legal consequences for non-compliance	Coerced behaviour <i>Non-voluntary compliance</i>	Direct and timely exchange for desired behaviour Direct reinforcement
	Regulation tools	<i>Technology:</i> control behaviour change and referred to governmental authority and legitimacy <i>Objective:</i> coerce and threaten to achieve non-voluntary compliance		Law or other costly regulations without requiring a promise of a positive incentive		



# Determinants of occupant behaviour

---



# From behaviour change to systemic change: the role of community

---

“**Community initiatives** have the potential to establish ownership and responsibility for actions to improve environmental footprint/energy efficiency, even in situations where individuals may otherwise feel that their contribution is insignificant.”

*(European Environment Agency, Achieving energy efficiency through behaviour change: what does it take, EEA Technical report No 5/2013)*

Community-based programmes are able to achieve **multiple benefits** in the same environment, resulting in high level of awareness on risks and barriers to the effective implementation of urban regeneration programmes.

Analysis of co-benefits:

Beneficiaries	Co-benefits
Public authorities/energy providers	Subsidies avoided; arrearages savings
Property owners	High property value; rents paid on time
Households	Improved comfort, health, safety and education; preserve affordability





# Occupant behaviour and regeneration of social housing stock

---

2ndSkin approach – the Netherlands



Erasmus+

Key Action 2: Strategic Partnership Projects, Agreement n° 2016-1-PL01-KA203-026232

# Occupant behaviour and regeneration of social housing stock

---

Community Energy Saving Programme – UK



Erasmus+

Key Action 2: Strategic Partnership Projects, Agreement n° 2016-1-PL01-KA203-026232

# Occupant behaviour and regeneration of social housing stock

---

Skåne Initiative – Sweden



Erasmus+

Key Action 2: Strategic Partnership Projects, Agreement n° 2016-1-PL01-KA203-026232

# Occupant behaviour and regeneration of social housing stock

---

Rig.ener.a Programme – Italy



Erasmus+

Key Action 2: Strategic Partnership Projects, Agreement n° 2016-1-PL01-KA203-026232

# Occupant behaviour and regeneration of social housing stock

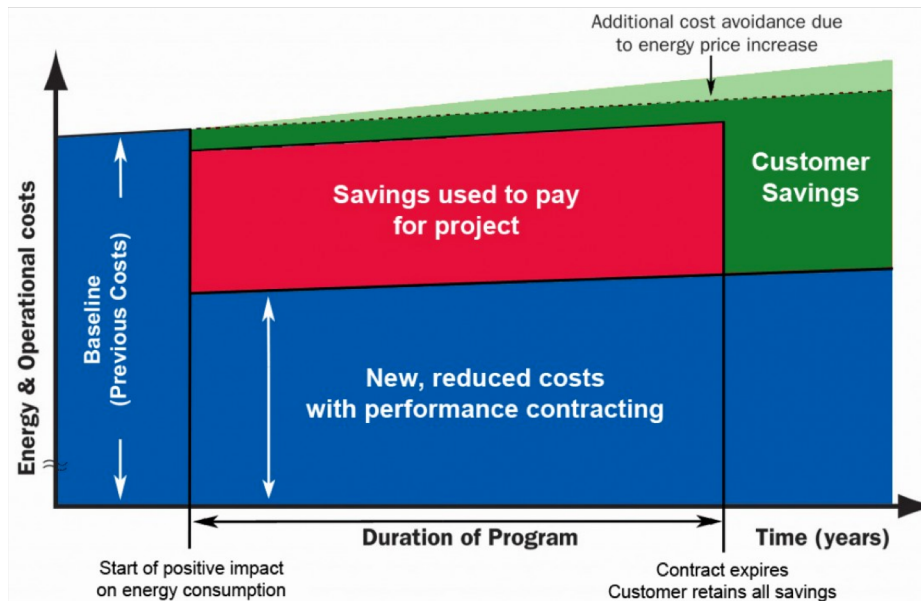
Rig.ener.a programme – Italy

Three-years programme (2016-2019)

Regeneration of social housing stock in Bologna

Involvement of private or public companies (Energy Service Companies – ESCOs)

Energy renovation of the housing stock through Energy Performance Contract (EPC).



Erasmus+

Key Action 2: Strategic Partnership Projects, Agreement n° 2016-1-PL01-KA203-026232

# Occupant behaviour and regeneration of social housing stock

## Analysis framework

	<b>2ndSkin (the Netherlands)</b>	<b>Skåne Initiative (Sweden)</b>	<b>CESP (UK)</b>	<b>Rig.ener.a (Italy)</b>
<b>Promoter</b>	Consortium of academic and industrial partners	Swedish Association of Public Housing Companies	National government	Municipality of Bologna
<b>Executor</b>	Housing associations	Housing associations	Energy suppliers and electricity generators in partnership with housing associations	Public housing associations in partnership with ESCos
<b>Type of energy consumption addressed</b>	all	all	all	Space heating
<b>User behaviour addressed</b>	Yes, through post-occupancy monitoring and feedback	Yes, through energy saving campaign material	Not directly by the programme, but by the housing providers implementing it	Yes, through tips, handbook and informative energy bills



# Occupant behaviour and regeneration of social housing stock

(continue)

	<b>2ndSkin (the Netherlands)</b>	<b>Skåne Initiative (Sweden)</b>	<b>CESP (UK)</b>	<b>Rig.ener.a (Italy)</b>
<b>Timeframe</b>	2015 - ongoing	2007-2016	2009-2013	2016 - ongoing
<b>Strengths</b>	Business opportunity; Strategy foreseen for post-occupancy monitoring and evaluation	High number of housing associations involved; Comprehensive approach to address the challenge	Public-private partnerships; Scope (national level)	Public-private partnerships; Leading role of public housing for implementation of renovation process
<b>Weaknesses</b>	Focus on apartment blocks; High dependency from the ability of the supply chain to change its paradigm	Lack of long-term monitoring scheme; Low degree of involvement of private partners	Lack of long-term monitoring scheme; Lack of a comprehensive approach to consider the impact of occupants	Only one type of energy consumption addressed; Low reduction of energy costs for the tenants during the EPC



# Summarising

---

The analysis of **behavioural patterns** is relevant not only for the design sector and for the accuracy of the simulation of energy performances, but also for policy – makers for designing **effective policy instruments**

Behaviour is more likely to be deliberately considered and changed when a **discontinuity** occurs in the household context. Therefore, urban regeneration programmes are the key opportunity to involve households in order to make them reconsidering their consumption practices.

Regeneration programmes towards energy efficiency of the social housing stock are able to achieve **non-energy co-benefits** and to reduce fuel poverty





# Summarising

---

(continue)

The regeneration initiatives analysed in Italy and in the other three countries have proven that **private companies** a significant part of the energy efficiency process in social housing stock.

Occupant behaviour can affect the **payback periods** of the investment. The more the uncertainties related to the impact of the human factor are reduced, the more the payback time of the retrofitting interventions may be reduced.



# Further readings

---

- G. Heffner, N. Campbell, Evaluating the co-benefits of low-income energy-efficiency programmes, OECD/IEA, 2011
- H. Elsharkawy, P. Rutherford, Retrofitting social housing in the UK: Home energy use and performance in a pre-Community Energy Saving Programme (CESP), Energy and Buildings, 88 (2015), 25-33
- London School of Economics, Energy Plus. Energy Efficiency in Social Housing, CASereport 89
- O. Guerra-Santin, S. Silvester, N. Romero Herrera, Building monitoring to determine occupancy patterns in renovation projects, in: I. Opstelten, R. Rovers, N. Verdeyen, A. Wagenaar (Eds.), Proceedings Conference Sustainable Built Environment: Transition Zero, Utrecht 7–8 April, 2016
- O. Guerra-Santin, S. Silvester, T. Konstantinou, 2nd skin approach to zero energy rental properties: occupancy patterns to improve energy simulation, proceedings of the PLEA 2015 – Bologna, Italy





**Project "SURE - Sustainable Urban Rehabilitation in Europe"  
implemented in frames of Erasmus+ Programme  
Key Action 2: Strategic Partnership Projects  
Agreement n° 2016-1-PL01-KA203-026232**



This work is licensed under a [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-nc-sa/4.0/).



**Project "SURE - Sustainable Urban Rehabilitation in Europe"  
implemented in frames of Erasmus+ Programme  
Key Action 2: Strategic Partnership Projects  
Agreement n° 2016-1-PL01-KA203-026232**

**This publication has been funded within support from the European Commission.**

**Free copy.**

**This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.**

**Co-funded by the  
Erasmus+ Programme  
of the European Union**

