Heterogeneous electricity consumption in the residential sector

APPLICATION OF AN AGENT BASED MODEL

Oreane Edelenbosch, Luciana Miu, Julia Sachs, Adam Hawkes, Massimo Tavoni

Outline

Energy efficiency -- Agent based modelling

MUSE residential ABM model

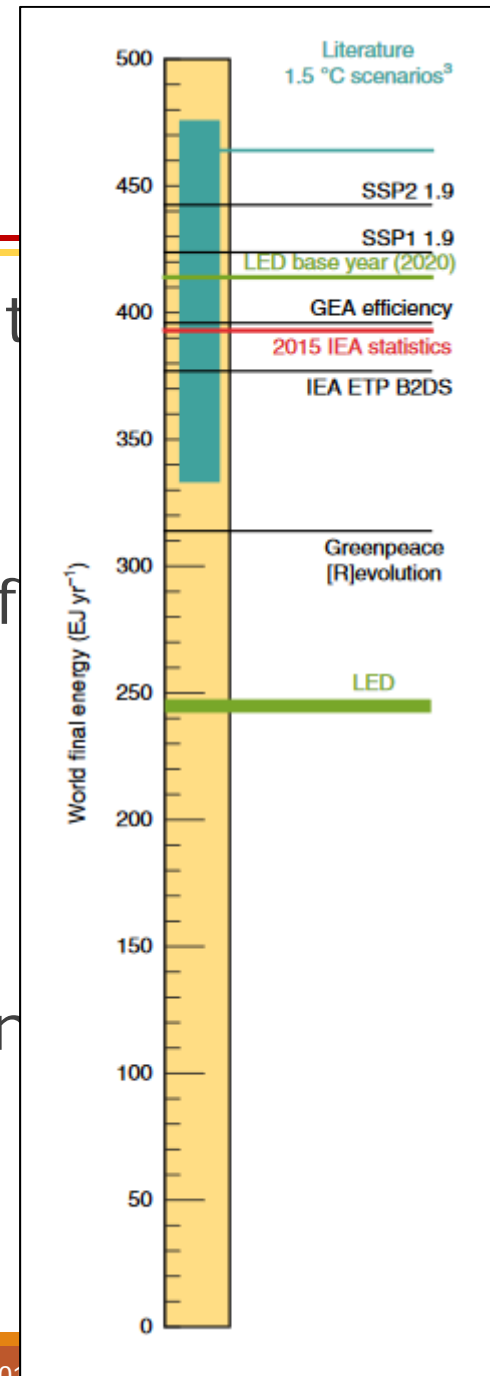Data work – characterization of agents

Connection with MUSE ?

Energy efficiency

Economic, Health, Environment[...] [sec]urity benefits

Require consumers to make dif[...]

Transport, Residential sector

Non linear relations, interaction[...]

pathdependence

Grubler et al. 2018

Advantages of ABMs

Study complex systems, focussing on uniqueness and interactions

Capturing er

Natural desc

Challenges: Ad hoc behavioral decisions rules introduced, Lack of empirical data

MUSE Residential Agent Based Model

**Residential and Commercial Building Sector Module**

(RCBSM)

- Demand sector

- Focus on six different end-uses

- Investigation of people's behaviour in making investment decisions -> Agent-based modelling (ABM)

- 48 technologies are considered
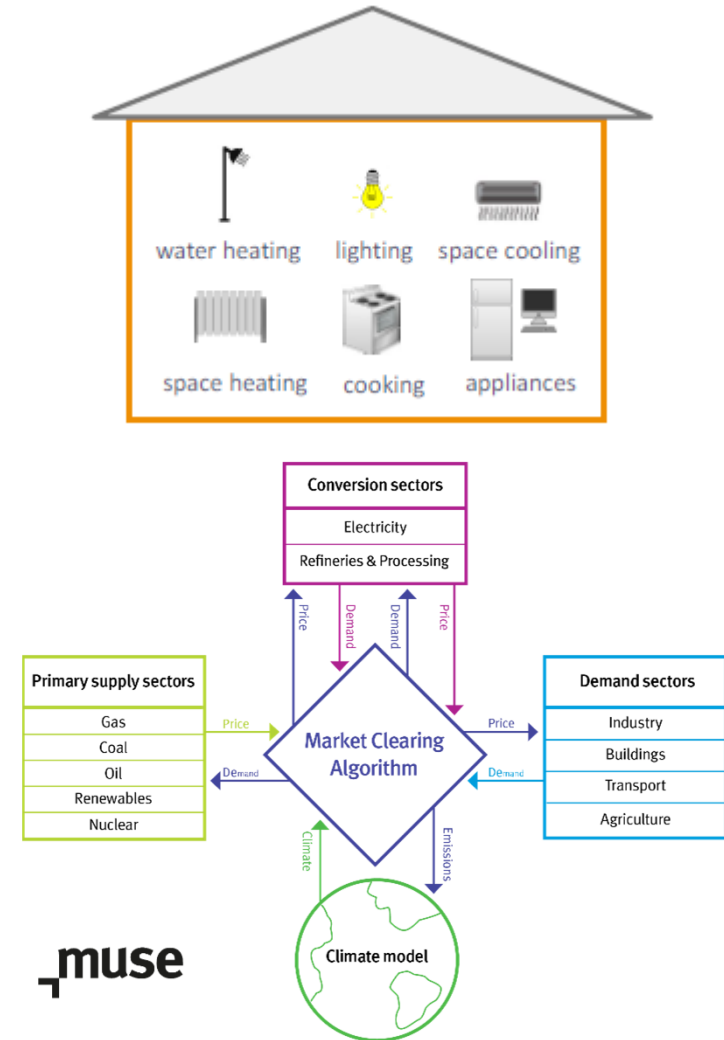
MUSE Residential Agent Based Model

• Definition of multiple agents to represent population

• Macro system characteristics results from simulation of all agents and individual behaviour

• Each agent has different attributes (budget, objective, search space, decision method, location, retrofit, new...)

• Change of agents to endogenous factors (cost change, policies,..)

• Determination of investment decision based on characteristics
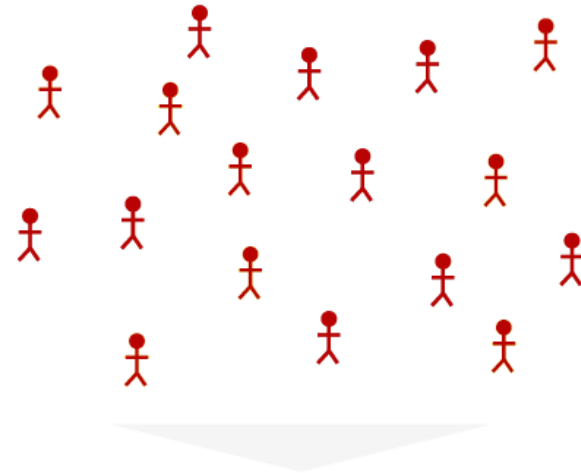
$A = \{Obj, SP, DS, TP, TS, PP\}$

- Obj objective
- SP search space
- DS decision strategy
- TP type
- PP percentage of population
- TS technology stock

MUSE Residential Agent Based Model

- Groups population according to their social status and basic values

- Peoples attitudes, orientations, lifestyles

- Definition of 6 agents to guarantee simplicity

- Relate to time preference, rationality objectives

- Objectives: costs, environment, luxury

Sinus-Meta-Milieus® in emerging markets
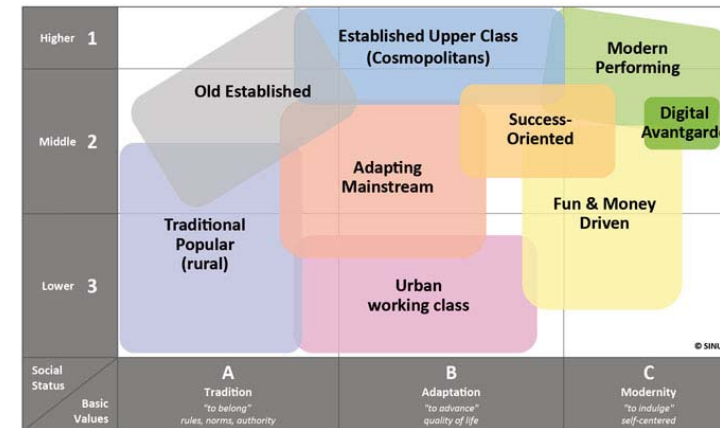
Empirically determined groups

Use houshold survey Cobham and PENNY (6,138 responses, in Italy, Switzerland and the Netherlands)
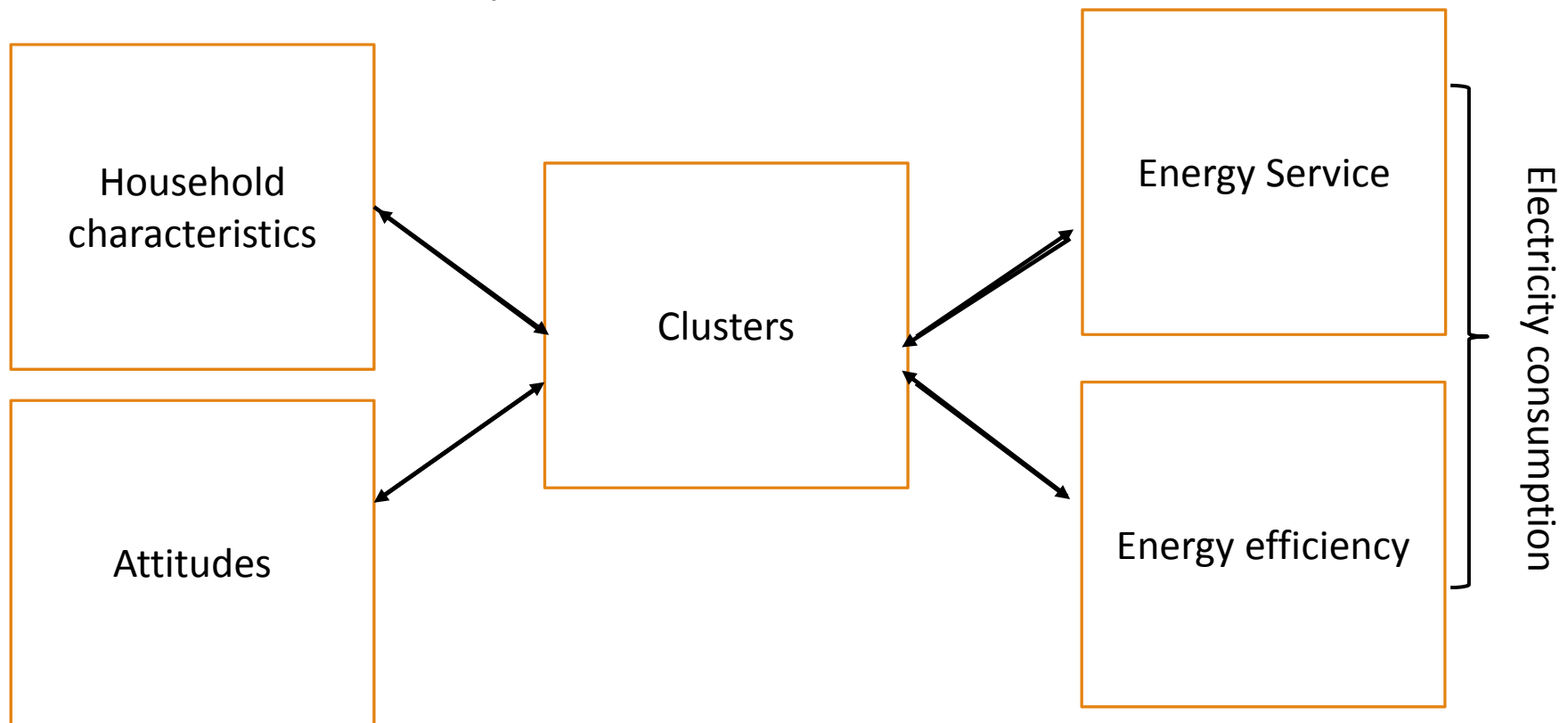
Methods: Cluster analysis

- Questions on:
  - Household characteristics
  - Environmental preferences
  - Energy related behavior
  - Energy literacy
  - Number of appliances, type and age
  - Floorspace
  - Combined with **metered electricity data**

Empirically determined groups

Use houshold survey Cobham and PENNY (6,138 responses, in Italy, Switzerland and the Netherlands)

Methods: Cluster analysis

Cobham: cluster analysis

## Definition of categories for ordinal variables

Variable	cat 1	cat 2	cat 3	cat 4	cat 5	cat 6	cat 7
Income class	0-1000	1000-2500	2500-3500	3500-5000	5000-7000	>7000	
Age range	<15	15-24	25-44	45-64	65+		
Education level	Primary or lower	Lower secondary	Vocational/ upper secondary	University (3-yr)	University (5-yr/ postgrad)		
Household size	1-person	2-3 people	4-5 people	6 or more people			
Lights off	Never	Rarely	Sometimes	Regularly	Always		
Switch off	Never	Rarely	Sometimes	Regularly	Always		
Environmental Preferences	very low	low	slightly low	average	slightly positive	high	very high
Efficiency gap	very low	low	medium	high	very high		
Lighting	very low	low	medium	high	very high		
Energy service	very low	low	medium	high	very high		
Electricity consumption	very low	low	medium	high	very high		

Cobham: cluster analysis

Optimal cluster solution: 7 clusters

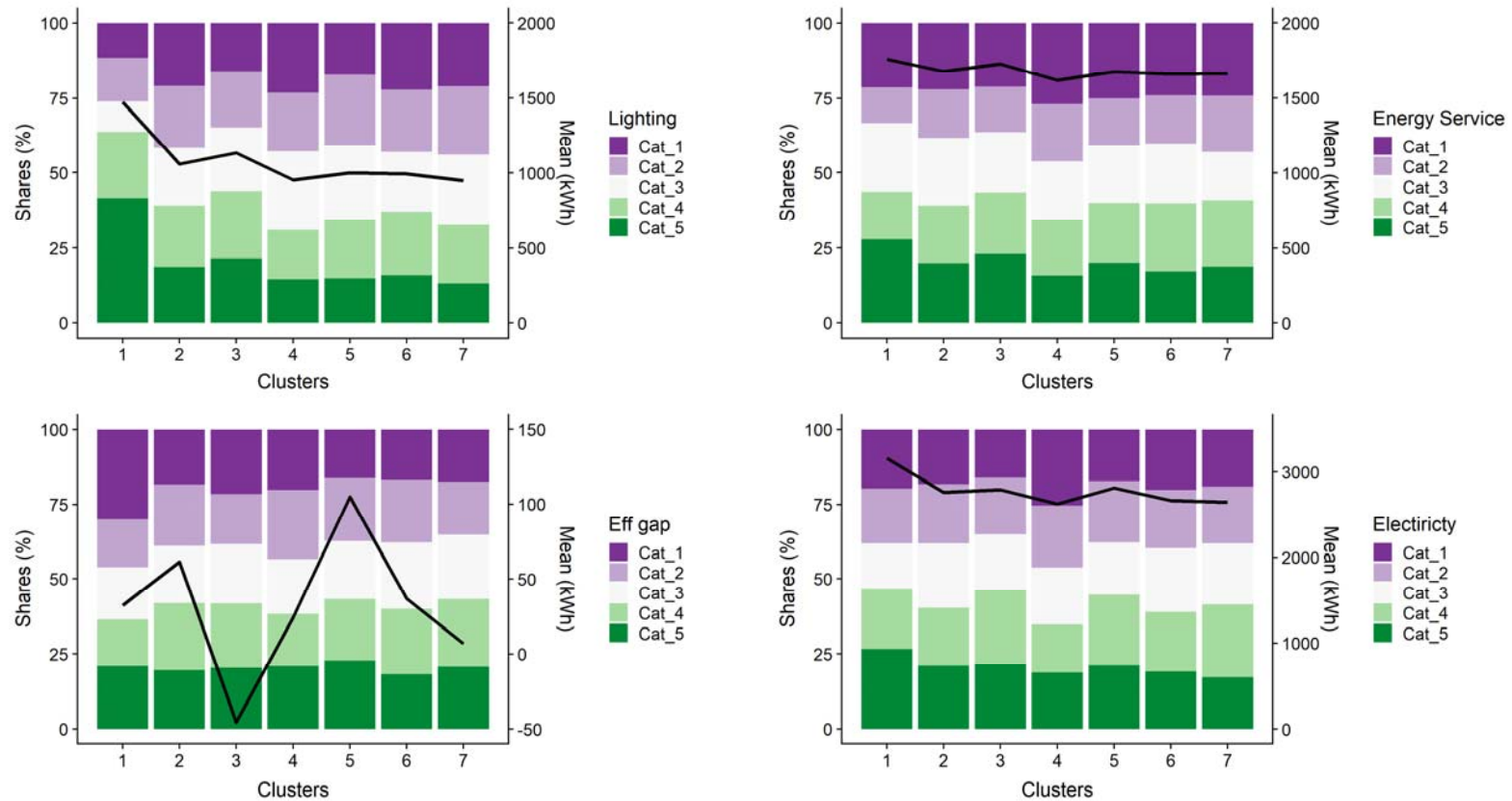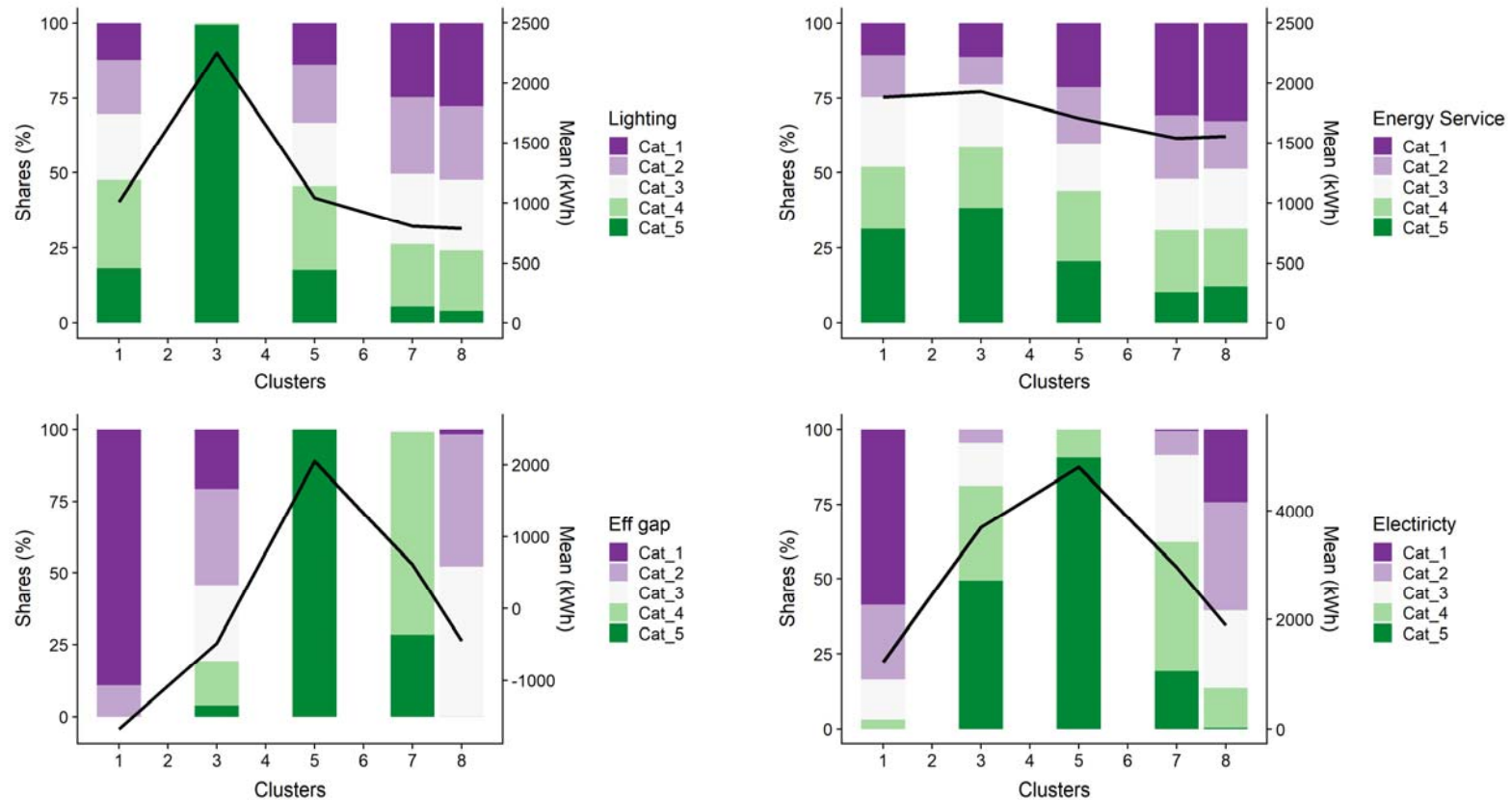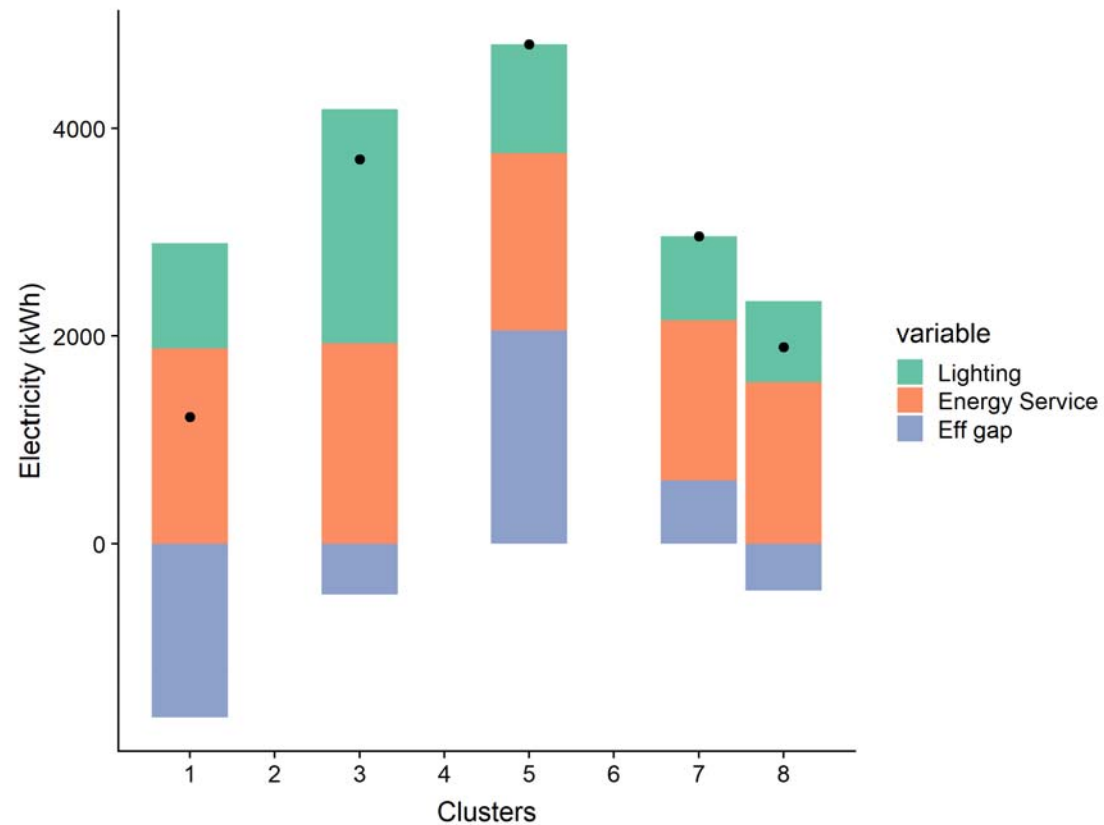| Cluster	IT	CH	NL
1	265	246	42
2	333	73	14
3	490	105	23
4	426	78	35
5	388	78	56
6	576	73	13
7	561	79	16

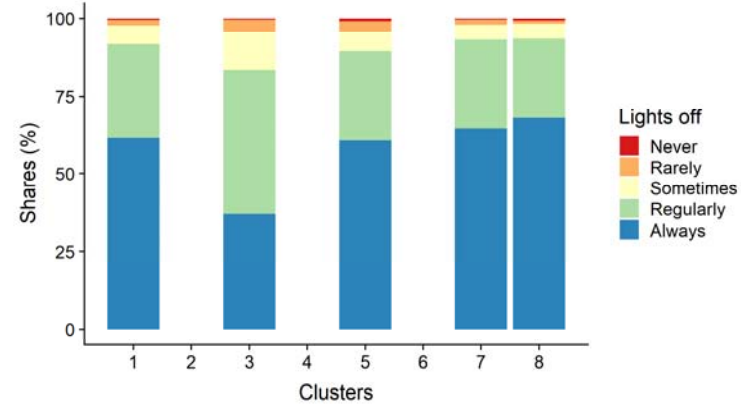# Cluster analysis: results
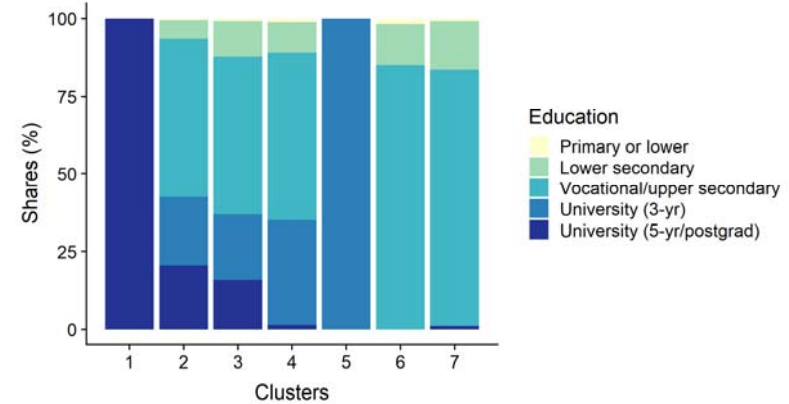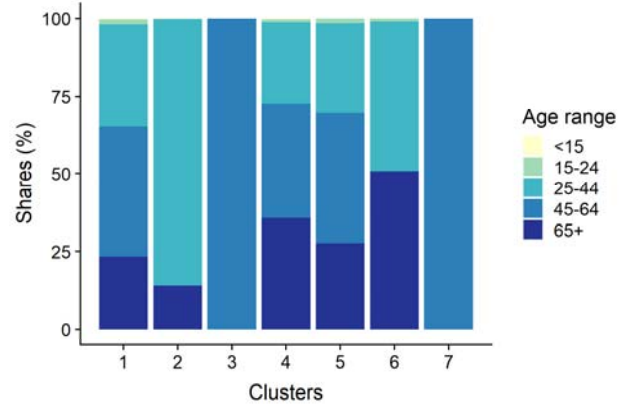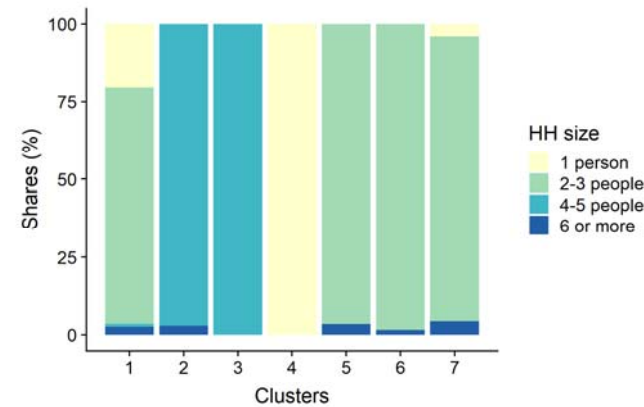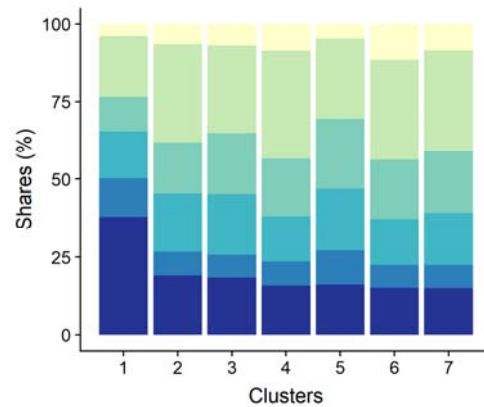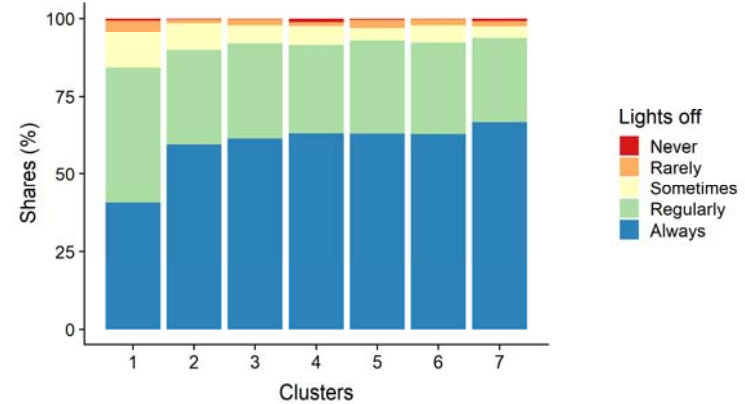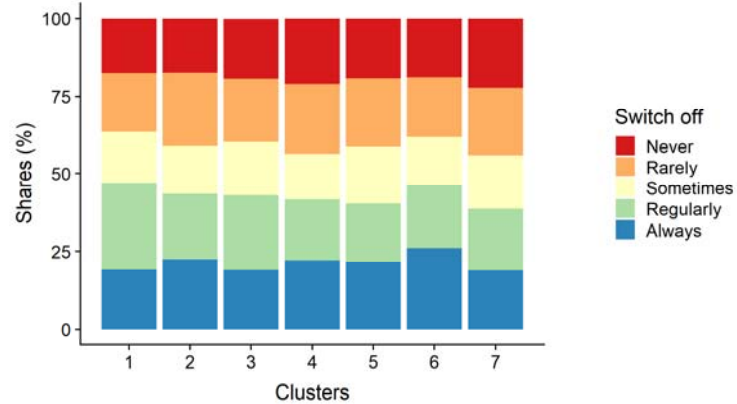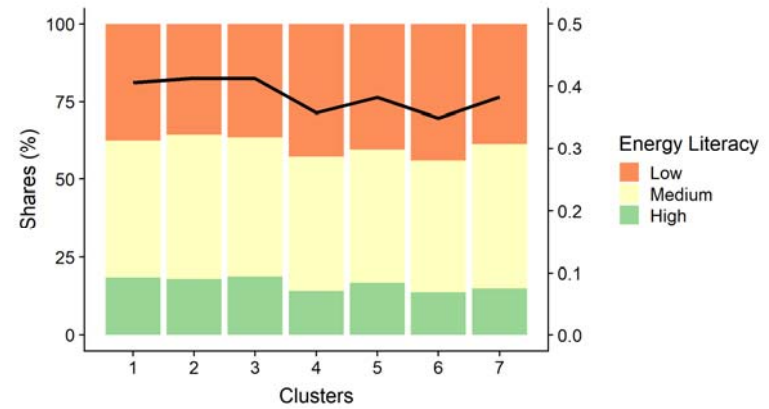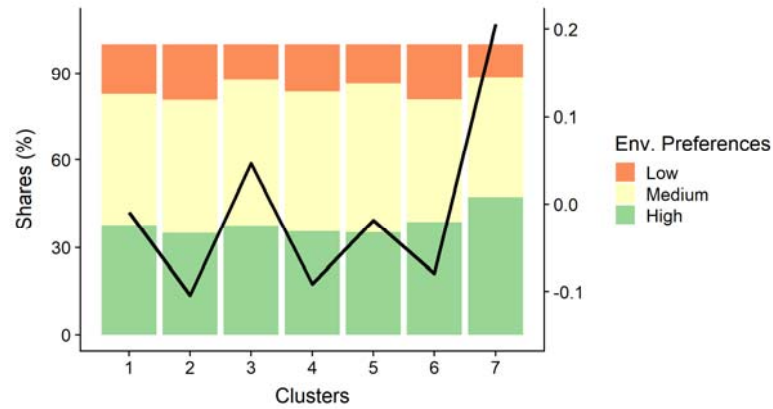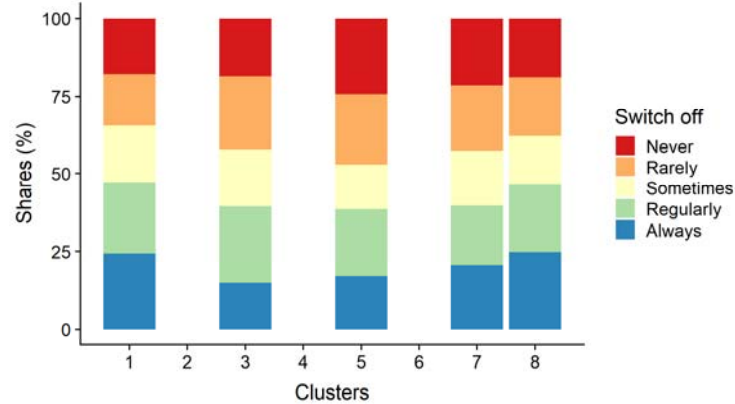
Cluster analysis: results

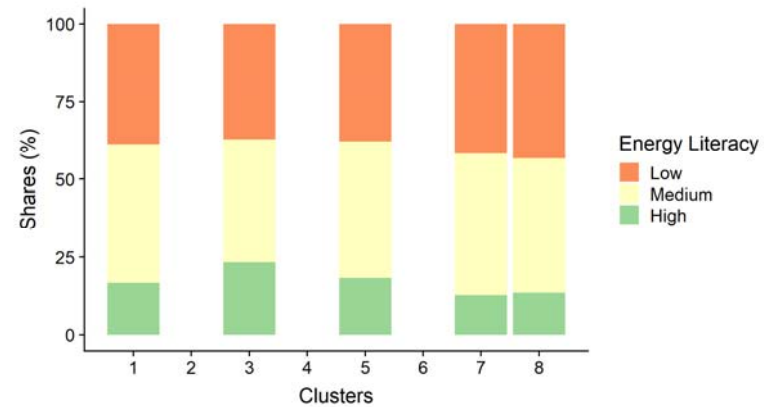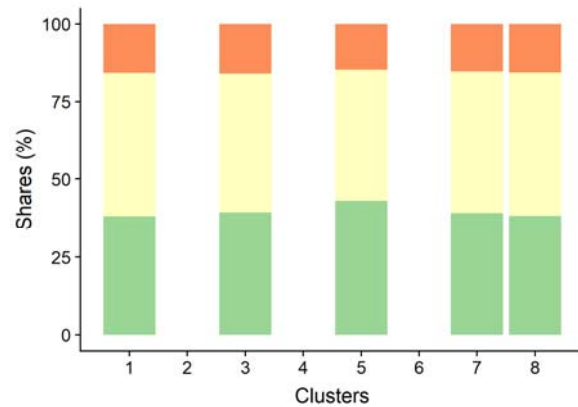# Cluster analysis: results

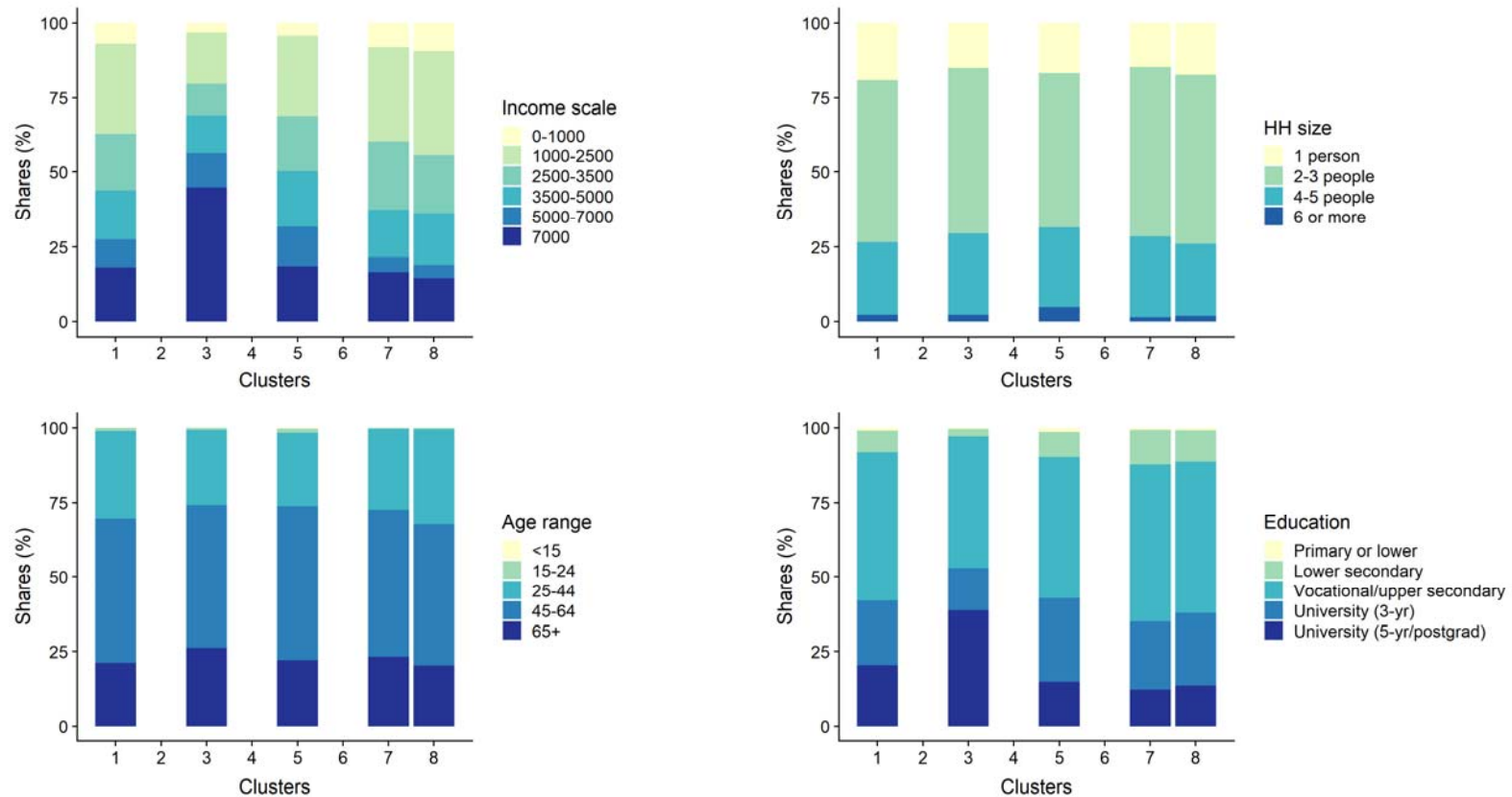# Cluster analysis: Energy variable based

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Next Steps & Conclusions

- Energy demand has great mitigation potential as well as co-benefits, but choice factors not well understood

- Agent based modelling seen as a promising modelling approach to understand transition drivers

- Household survey & Cluster analysis used to characterise the agents

- Income, Education related to energy service

- Energy efficiency choices do not seem to be related to conventional drivers

- However, size of energy efficiency effect across households is identified

- For the modelling: Gather EU data to identify groups, Integrate Stochastics on choice elements