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Transient and Persistent efficiency in residential electricity consumption in Switzerland and the role of energy literacy and energy saving behaviour

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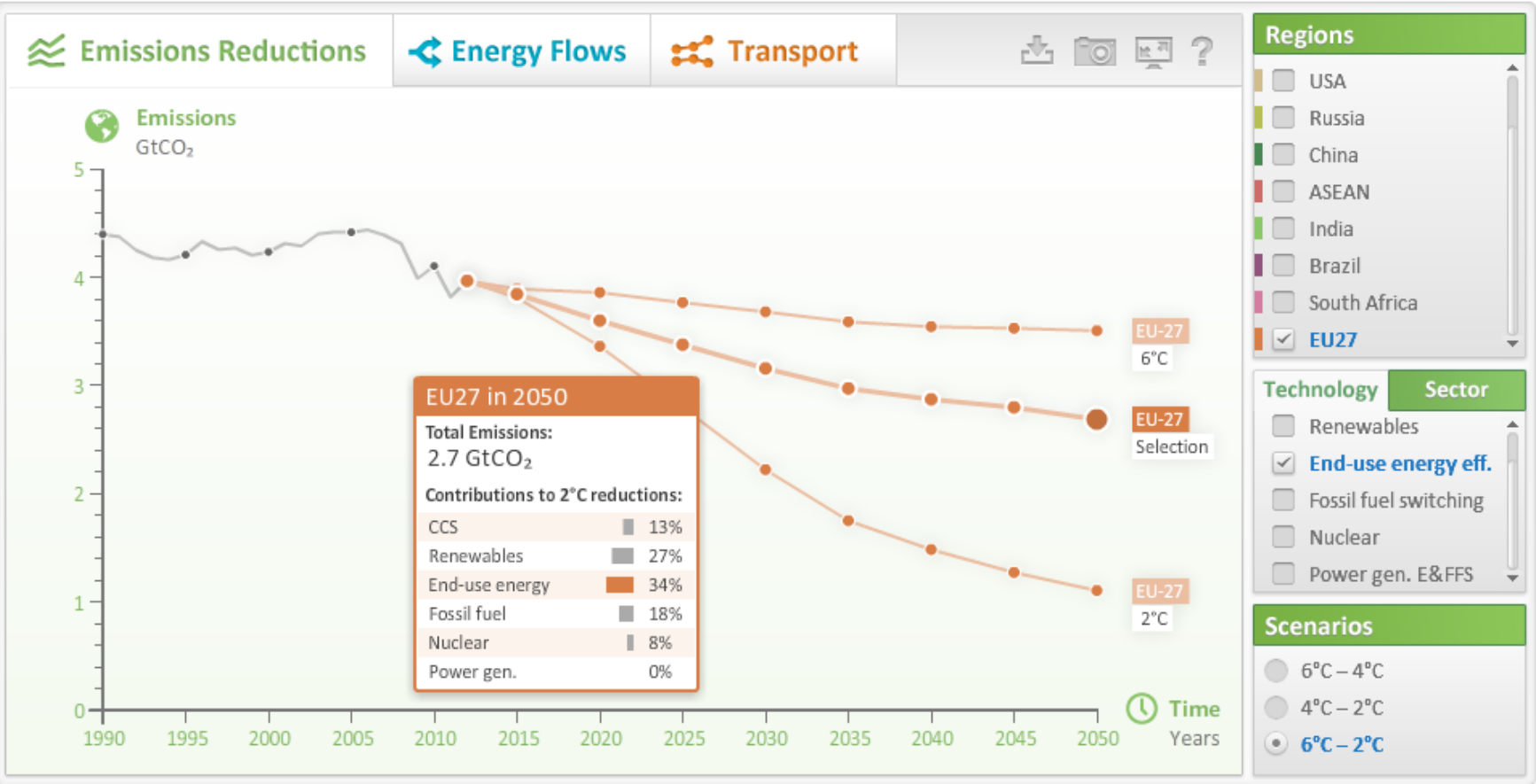
Outline

- Introduction
- Empirical Methodology
- The Household Survey
- Preliminary results
- Conclusion

IEA Projections



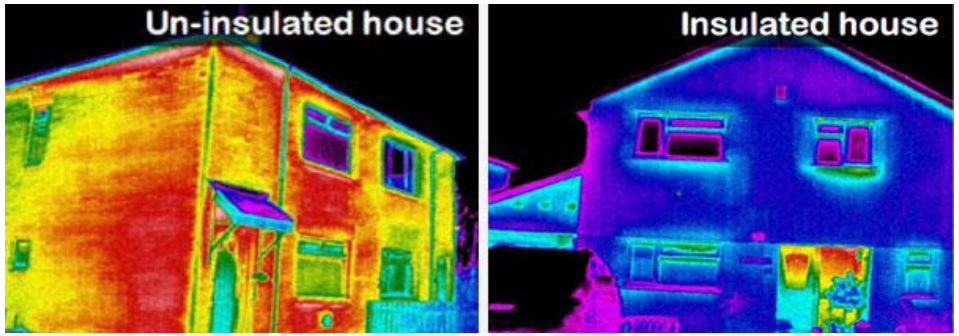
Source: IEA: 2016, Energy Technology Perspectives : ETP 2015 Data Visualization, web: http://www.iea.org/etp/explore/

Introduction

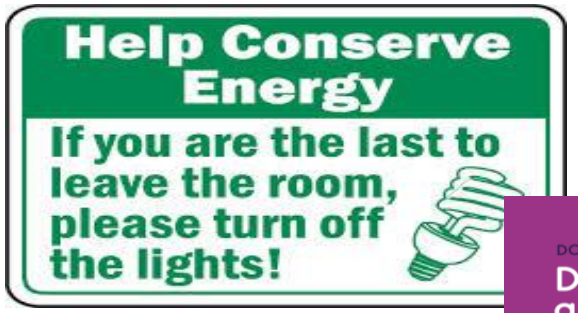
- Residential sector consumes nearly 25 – 35% of total final energy consumption
- Empirical evidence of the presence of inefficiency in the use of energy
- Improving energy efficiency using energy policy instruments is recognized as one of the most cost-effective ways of
  - Reducing CO_2 emissions
  - Increasing security of energy supply

Inefficiency in the use of energy (waste of energy) may be due to

low adoption of new energy-efficient technologies *(energy efficiency gap)*



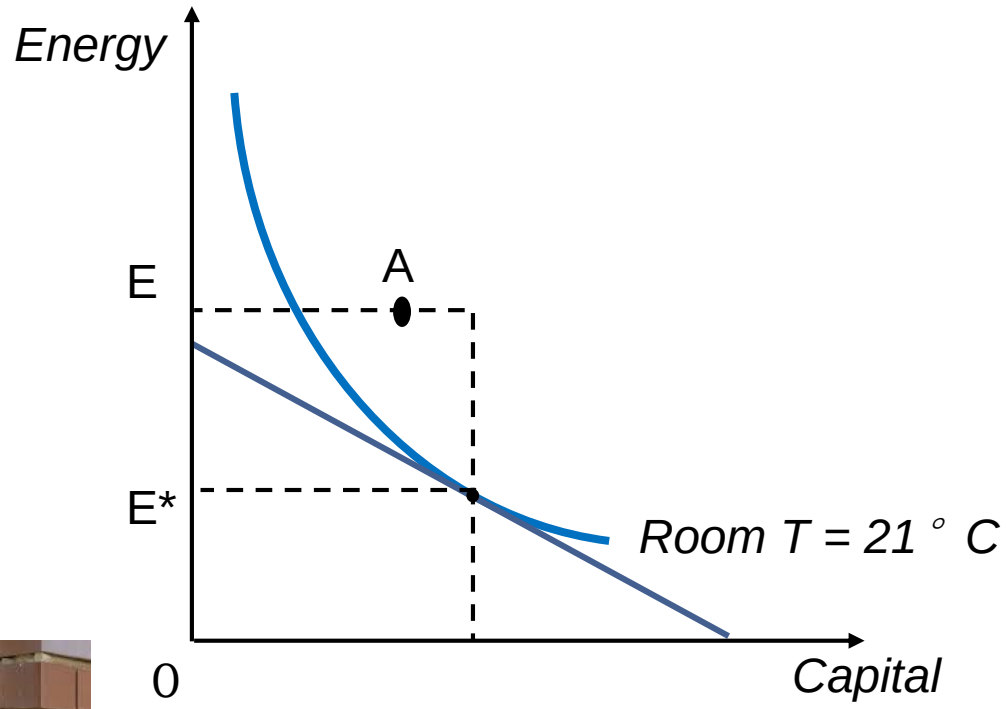
inefficient use of electrical appliances / heating system



Inefficiency in the use of inputs

Microeconomics approach

- **Situation 1**: Household is using the inputs in an inefficient way
  - ***Behaviour***:
    - amount of time windows are opened
    - use of a heating/cooling system
  - ***Substitution of energy with capital***:
    - Installing a device on an heating system
    - Substitution of the windows
    - Improving insulation of the building

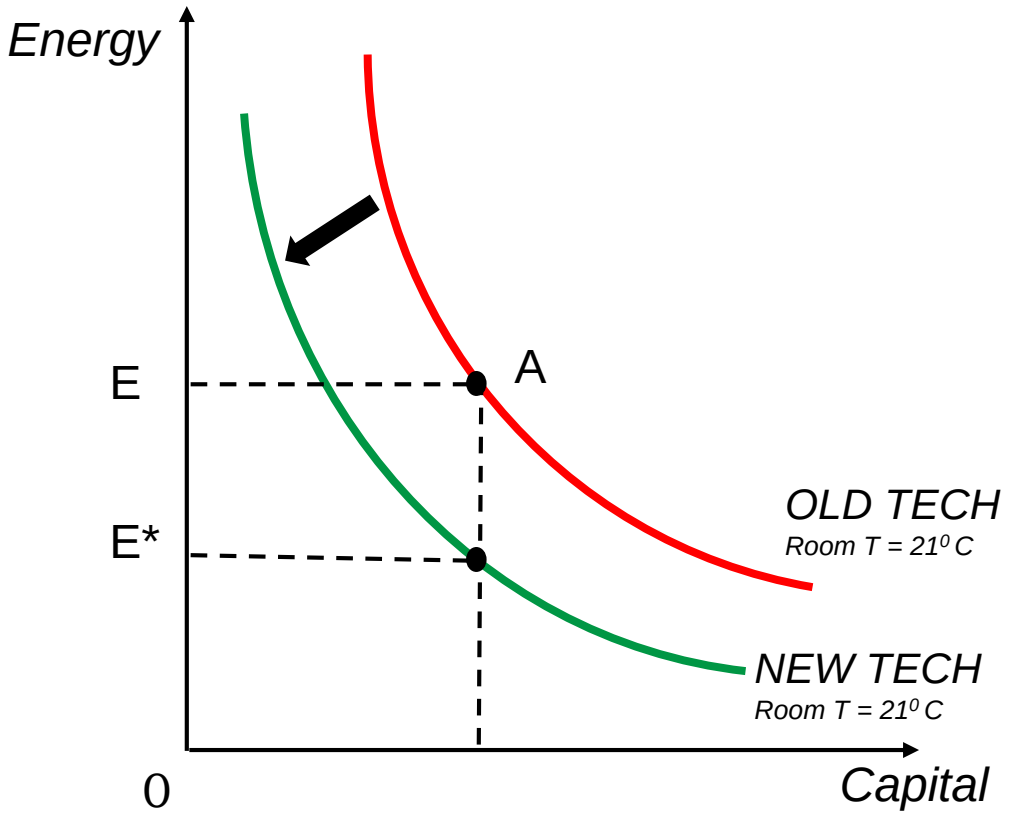


Inefficiency in the use of inputs

Microeconomics approach

- **Situation 2**: Household is using an old technology → inefficient use of input(s) → energy efficiency gap

- ***Adoption of a new technology***
  - new building technology
  - more efficient appliances



Research questions

- Estimating the potential for energy savings in the Swiss residential sector
- Identifying the differences in the level of *En.Eff.* between Swiss households and what drives them
  - role of **behavioral factors**
  - role of **energy literacy**
- Examining the role of technological change for the reduction of energy consumption in Swiss households

Energy Literacy and Energy Saving Behaviour

- Energy literacy index accounting for:
  - average price of 1 kWh
  - usage cost of household appliances (2 Qs)
  - Consumption of household appliances (3 Qs)
  - compound interest calculation
- **Energy literacy score in: 0 –14**

- Energy saving behaviour index
  - completely switching off electronic appliances after use (no standby)
  - running washing machine only on full load
  - washing clothes on a lower water temperature
  - dishwasher cycle based on level of dirtiness
- **Energy saving index score in: 0 – 4**

Table 3: Summary statistics

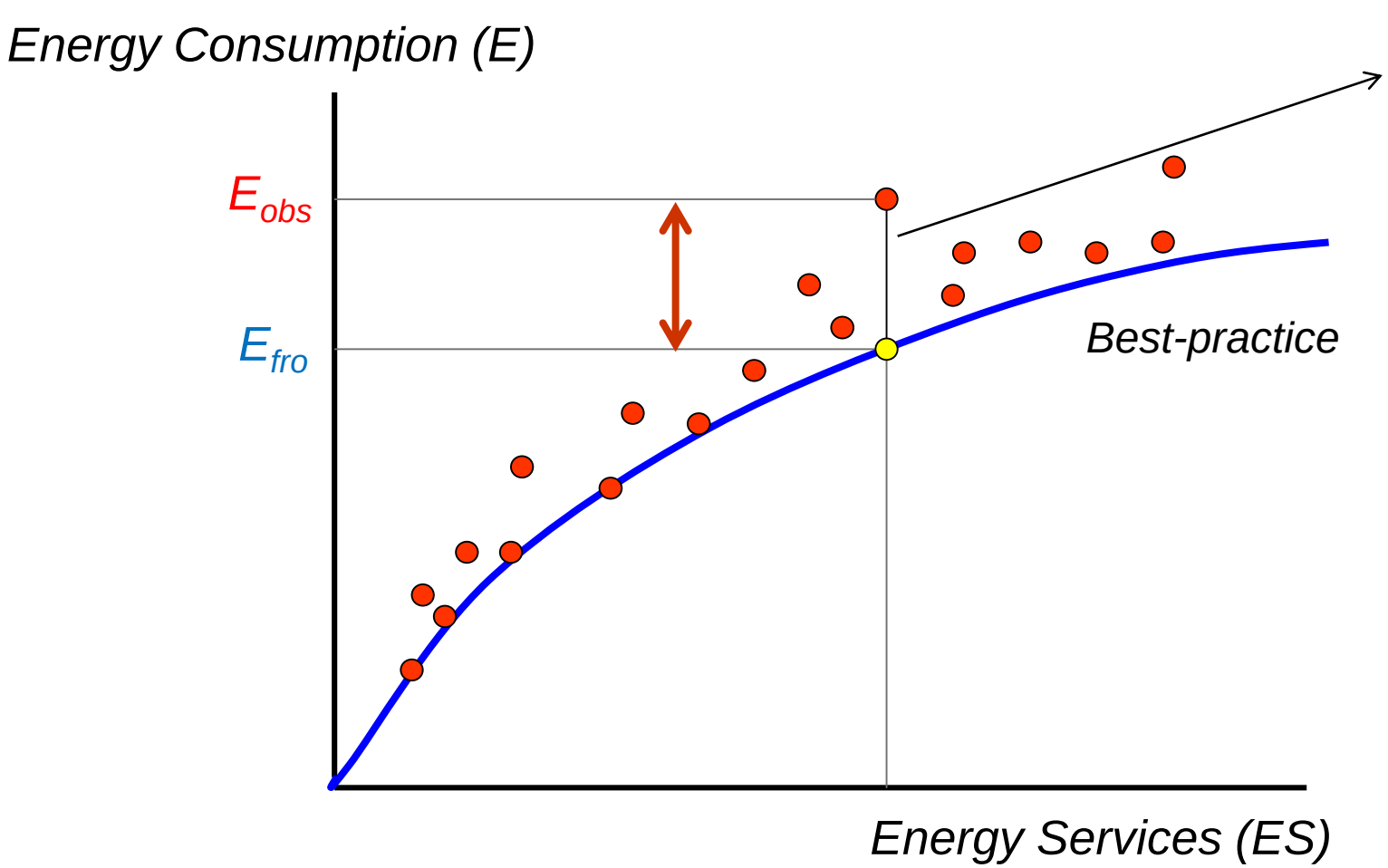
Variable	Mean	Std. Dev.	Min.	Max.	N
Energy literacy score	6.55	3.46	0	14	5658
Energy saving behaviour index	2.3	1.04	0	4	5658

Econometric Estimation

Theory/Methodology

- Frontier functions are used to estimate the level of input specific efficiency
- Parametric approaches (Stochastic Frontier Analysis: SFA)
  - Allow for unobserved heterogeneity among different economic agents
  - A pre-specified (but flexible) functional form
  - Separates inefficiency from noise
- GTRE model – *Filippini and Greene (2015)*
  - **Persistent** inefficiency (Structural issues / systematic behavioural failures)
  - **Transient** inefficiency

Estimation of an energy demand frontier model

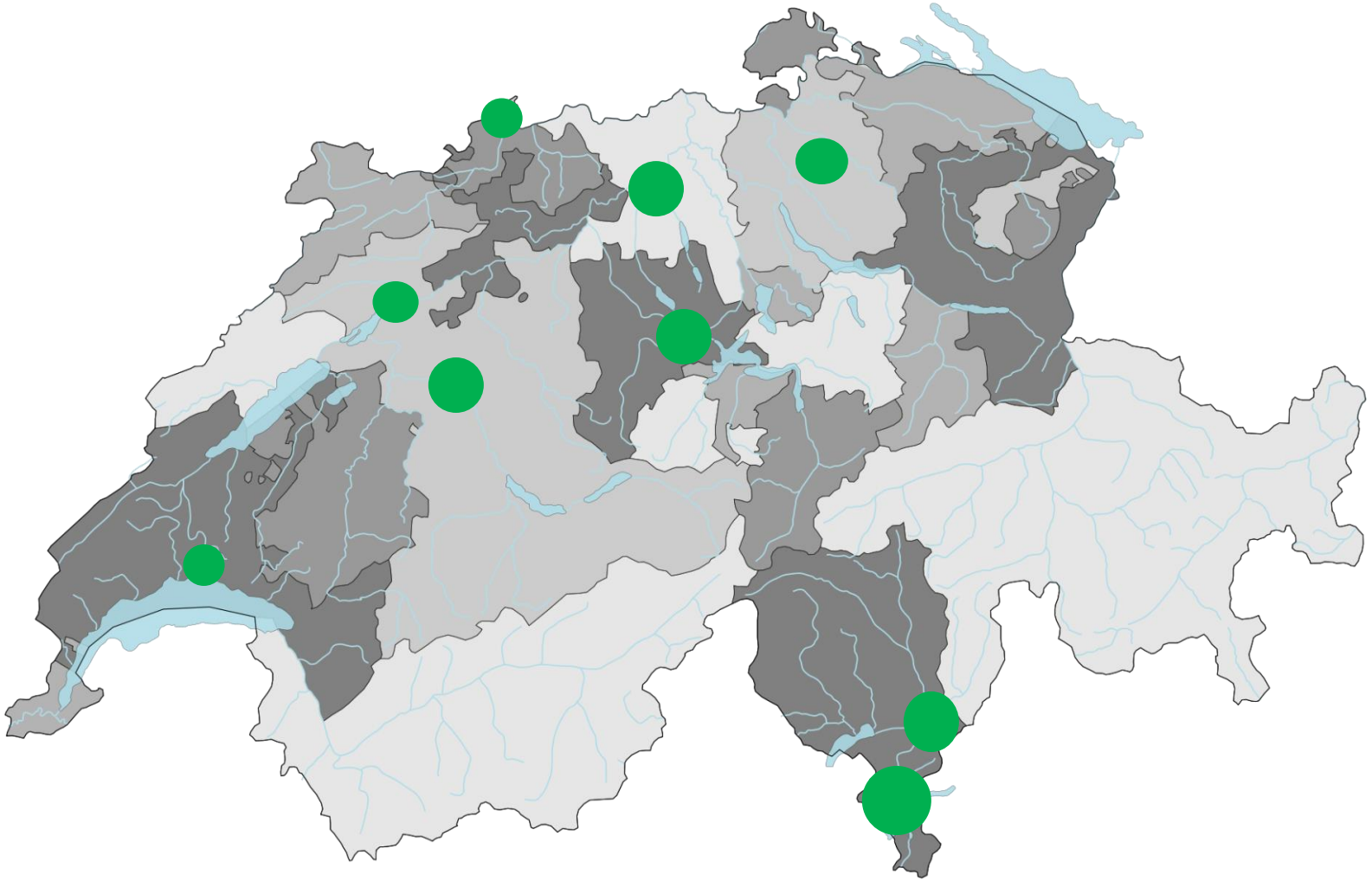


Energy demand Frontier
the minimum amount of energy required to produce a given amount of energy services.

Energy efficiency
measures the ability of an household to minimize the energy consumption, given a level of energy service

Data

Household Survey on Energy Usage



- 9 Swiss Electric and Gas utilities
- Survey organization
  - Online survey in 2015 - 2016
  - Randomly chosen sample
  - Response rates: 3.2% - 7.6 %
  - Consumption data: 2010 - 2014
- Dataset used here:
  - 3 utilities: Aarau, Winterthur and Lugano
  - ~1245 households

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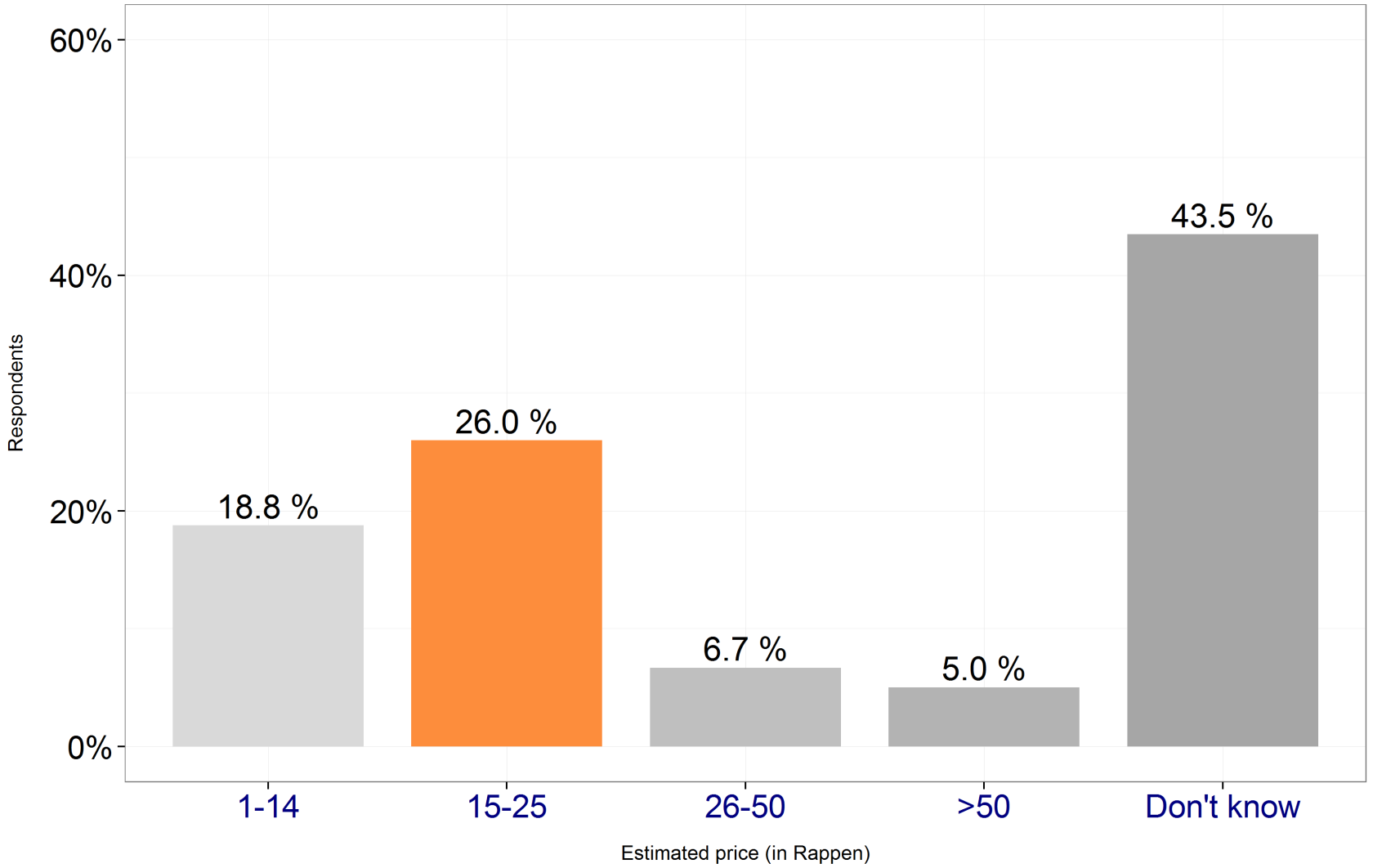
Questionnaire

- House/apartment characteristics
- Socio-demographics
- Appliance stock and energy services
- Attitudes towards environment
- Energy-related behaviour
- Energy related knowledge (energy-literacy)

- *Representativeness*:
  → gender, age and income groups are sufficiently covered

- Share of respondents who donated money to an environmental organization in line with Swiss average → limited self-selection of pro-environmental households

Knowledge about the cost of 1 kWh of electricity in Switzerland



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Preliminary Results

Estimation results

	GTREM 2 (With literacy/behavioral)	
	Coefficient	*Standard error*
log(avg.marg. price)	−.241 89***	.03919
Dwelling characteristics		
log(dwelling size in m2)	.347 21***	.00869
single-family hh	.193 75***	.00724
built in 1940-1970	−.030 21***	.00861
built in 1971-2000	.039 65***	.00791
built after 2001	.014 91	.00954
cooking with electricity	.150 81***	.00874
electric water heater	.472 71***	.00732
Household characteristics		
log(no. of hh members)	.248 98***	.00754
age >60 years	.089 85***	.00642
children	.103 18***	.00791
hh income 6k-12k CHF	−.014 51**	.00679
hh income >12k CHF	−.041 47***	.00861
Appliances		
2nd-fridge	.034 03***	.00650
separate freezer	.246 09***	.00611
dishwasher	.099 80***	.00891
washing machine	.007 39	.00810
dryer	.082 75***	.00660
high share of LED	.054 43***	.00951
number of TVs	.020 64***	.00336
number of PCs	.015 90***	.00273
Location, Weather and Time		
Aarau	.272 98***	.01854
Winterthur	.219 91***	.01766
log(cooling degree days)	.011 39	.01375
time trend	-.009 00***	.00208
Energy literacy and Behaviour		
energy literacy score	-.011 53***	.00082
energy-saving behaviour index	-.071 73***	.00258
Constant α	5.686 07***	.15927
σ_w	.377 56***	.00270
λ	1.857 21***	.05784
σ	.288 36***	.00300
σ_h	1.700 85***	.02308
Number of observations:	5639	
Log Likelihood:	-415.43	

***, **, * ⇒ Significance at 1%, 5%, 10% level. Note: 'hh' is an abbreviation used for 'household'.

Estimation results

Table 5: Efficiency scores (transient and persistent)

Efficiency type	*Median*	*Mean*	*Std. Dev.*	*Minimum*	*Maximum*
	GTREM 2 (With literacy/behavioral)				
Transient	.8535	.8389	.0674	.2397	.9700
Persistent	.7575	.7573	.0066	.6833	.8426

Conclusions

- Estimation of an indicator of the level of energy efficiency for each household
  → Measure of efficiencies (median values)
  - **Persistent efficiency**: **76 %**
  - **Transient efficiency**: **85 %**

- **Higher persistent inefficiency**
  - structural problems faced by household
  - systematic behavioural shortcomings

- **Positive role of energy related literacy and energy saving behaviour**
  - Electricity consumption is lower in households exhibiting energy saving behaviours
  - Higher level of energy literacy is associated with lower electricity consumption

Thank you for your attention!

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