



# Energy efficiency in the residential sector: The role of information, Energy and Investment literacy

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# Outline

- Potential for energy savings and the energy efficiency gap
- Role of information, energy and investment literacy
- Conclusions

# Energy efficiency

- **Improving energy efficiency using energy policy instruments** is one of the most cost-effective ways of
  - ↳ reducing CO<sub>2</sub> emissions and air pollution
  - ↳ increasing security of energy supply
- **Residential sector** (30 – 40 % of the final energy consumption) is identified as being one of the areas **with the greatest potential for energy savings**

# Estimation of potential energy saving



- Economic-engineering approach based on bottom-up models



- Microeconomic production theory and on the estimation of energy demand stochastic frontier  
*Filippini and Hunt (2011)*

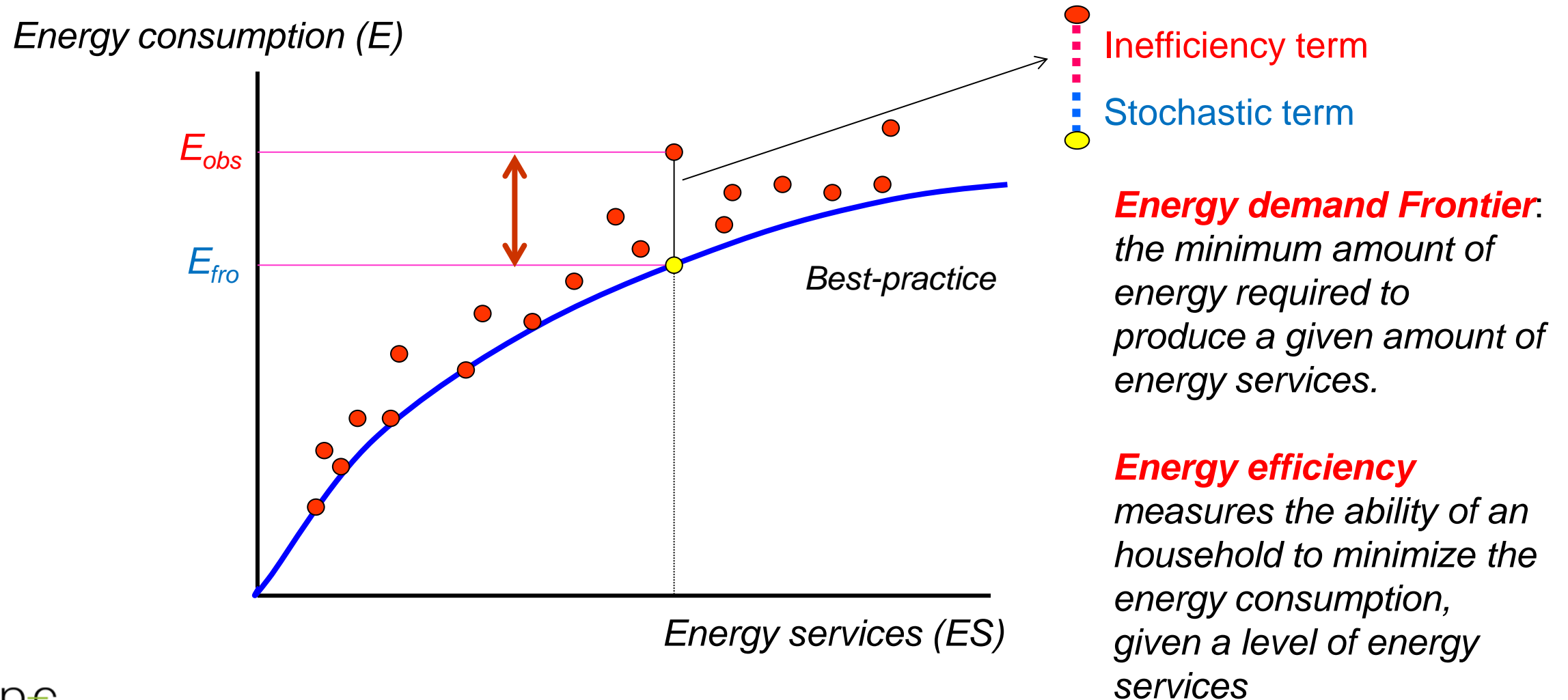
# Potential for energy saving in the US and Switzerland using a bottom-up approach



- **For Switzerland**
  - ↳ *Prognos (2011) ~20%*

- **For the US**
  - ↳ *McKinsey (2009) ~ 20-30 %*

# Estimation of an energy demand frontier model



# Estimation of an energy demand frontier model for the Swiss and US residential sector

$$\ln E_{it} = \alpha_i + \alpha^P \ln P_{it} + \alpha^Y \ln Y_{it} + \alpha^S \ln SIZE_{it} + \alpha^R \ln ROOMS_{it} + \alpha^H \ln HDD + \dots + v_{it} + u_{it}$$

Using statistical and econometric methods, estimation of an indicator of the level of energy efficiency based on  $u_{it}$  for each household

## Study with US DATA

~11,400 households 1997 to 2009

~ 25-30%

## Study with SWISS DATA

~ 450 households 2010 to 2014

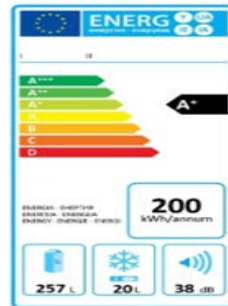
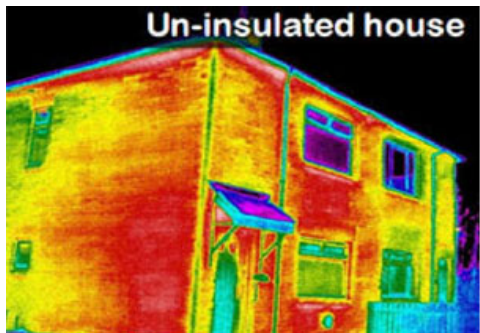
~30%

(preliminary results)

# Inefficiency 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*





## Energy efficiency gap (*electrical appliances*)

### 'Energy-efficiency gap' :

*Individual decision-makers do not choose the most energy-efficient appliance, even if this appliance is also the most cost-efficient choice (minimizing lifetime costs).*

#### Market failures

*Negative externalities*

**Lack of information** (*information not salient enough, only kWh,..*)

*Asymmetric information*

.....

#### Behavioral failures

*Status quo bias*

**Bounded rationality**

.....

# Bounded rationality

## Bounded rationality

- ↪ Appliance choice involves intertemporal optimization, an investment calculation (based on upfront price and assumptions about energy price, frequency and intensity of use, consumption and lifetime)
- ↪ Consumers have difficulties to do an investment analysis → cognitive constraint in processing information, tend to process only part of the available information → observe a deviation from rationality

# Experiment : Fridge choice

Assume that you need to replace your fridge.  
In a shop you find the following fridges which are identical in terms of size and cooling service.

*Which of the two fridges you would choose?*

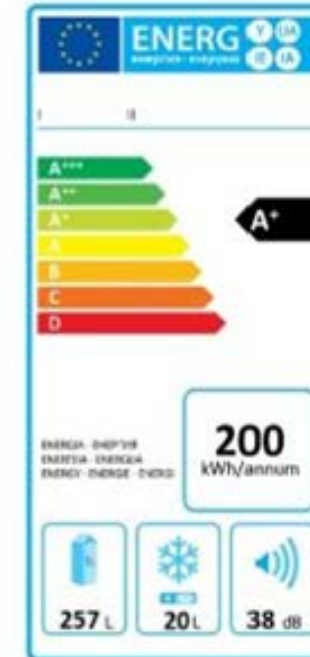
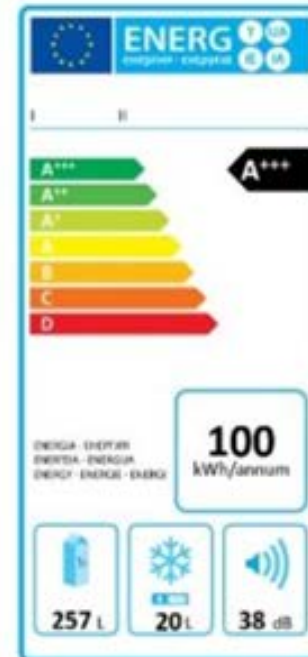
Price:

3300 CHF

Electricity consumption: 100 kWh/annum

2800 CHF

200 kWh/annum



- The fridge for 3300 CHF.
- The fridge for 2800 CHF.

# Different decision-making strategies



## Rational consumer

### Optimization

- ↪ Perform an investment analysis
- ↪ Choose the appliance that minimizes lifetime usage cost

## Bounded-rational consumer

### Heuristic decision-making

- ↪ Choosing by comparing purchase prices
- ↪ Choosing by comparing efficiency-rating on energy label
- ↪ Choosing by comparing information on energy consumption
- ↪ ...

# The role of information, Energy and Investment literacy

# Research Questions

- What is the level of energy and financial literacy of the Swiss households?
- What are the decision-making strategies used by the Swiss households?
- What is the specific role of energy and investment literacy for the choice of cost-efficient appliances?
- How should energy consumption be displayed to enable consumers to identify the most cost-efficient appliances?

Based on a theoretical model we developed some hypothesis

Collected data on Swiss households through an online survey ( $N \sim 6500$ )

Socioeconomic factors,  
Energy, financial literacy,  
energy consumption,  
appliances,...

Online randomized control experiment  
Choice of an appliance

**Treated group** with  
information on annual  
expenditure for electricity  
**Control group** with  
information on kwh

Econometric methods → the impact of energy and financial literacy and information on the probability to choose the cost-minimizing appliance

$$CHOICE = x_2' \beta_1 + \alpha_{EN} ENLIT\_IN + \alpha_{MA} INVLIT + \alpha_{TINF} INFO + \alpha_{INV} INVCALC + u_{it}$$

# What is the level of energy and financial literacy of the Swiss households? (First results)

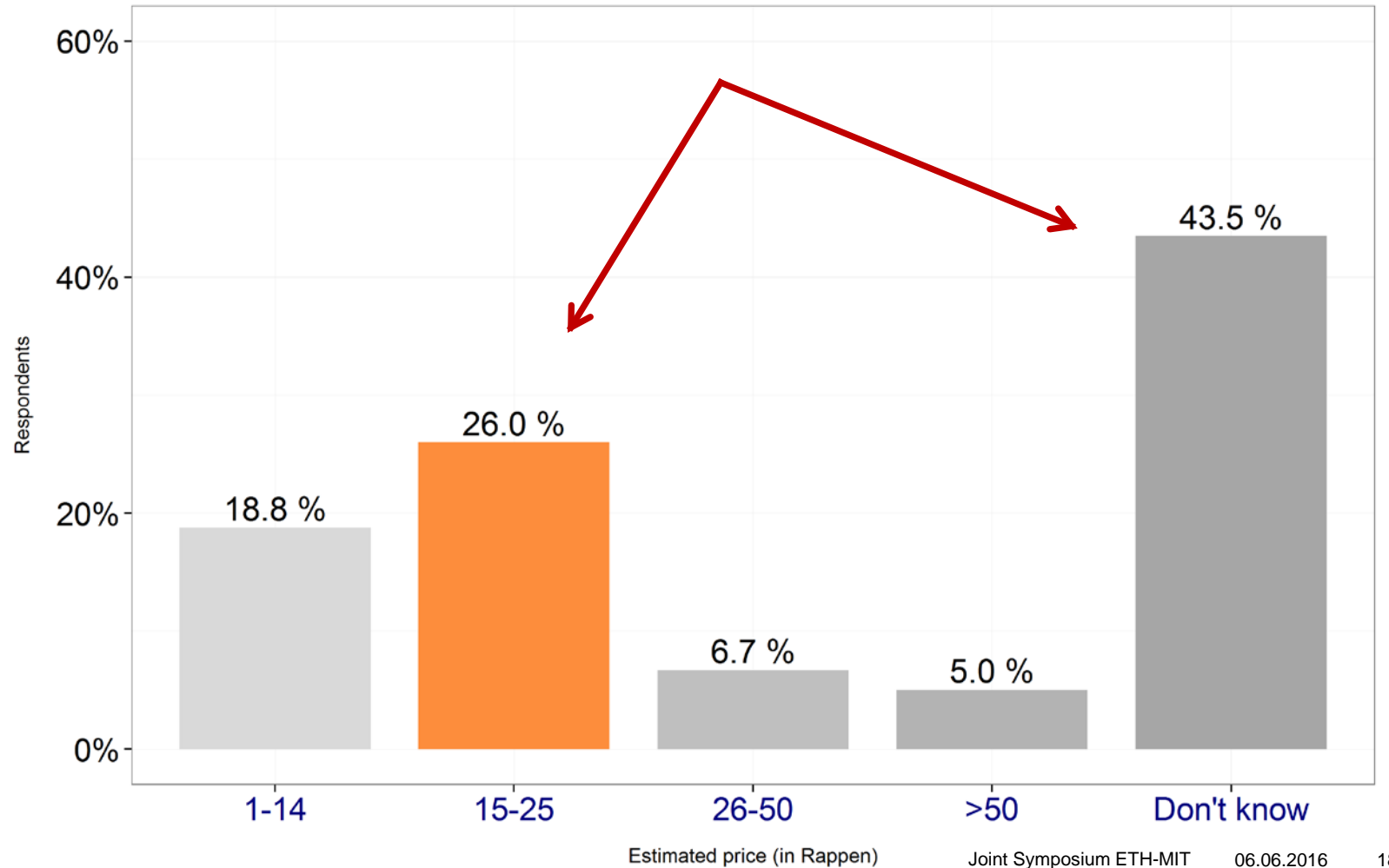


# Energy and investment literacy

- **Energy literacy** (knowledge of energy-related issues):
  - ↪ knowledge of average price of a kWh in Switzerland
  - ↪ knowledge of usage cost of household appliances
  - ↪ knowledge of electricity consumption of household appliances
  - ↪ ...
- **Investment literacy** (knowledge of investment-calculation)
  - ↪ knowledge on how to perform an investment analysis
  - ↪ Knowledge of how to perform compound interest calculation
  - ↪ ...

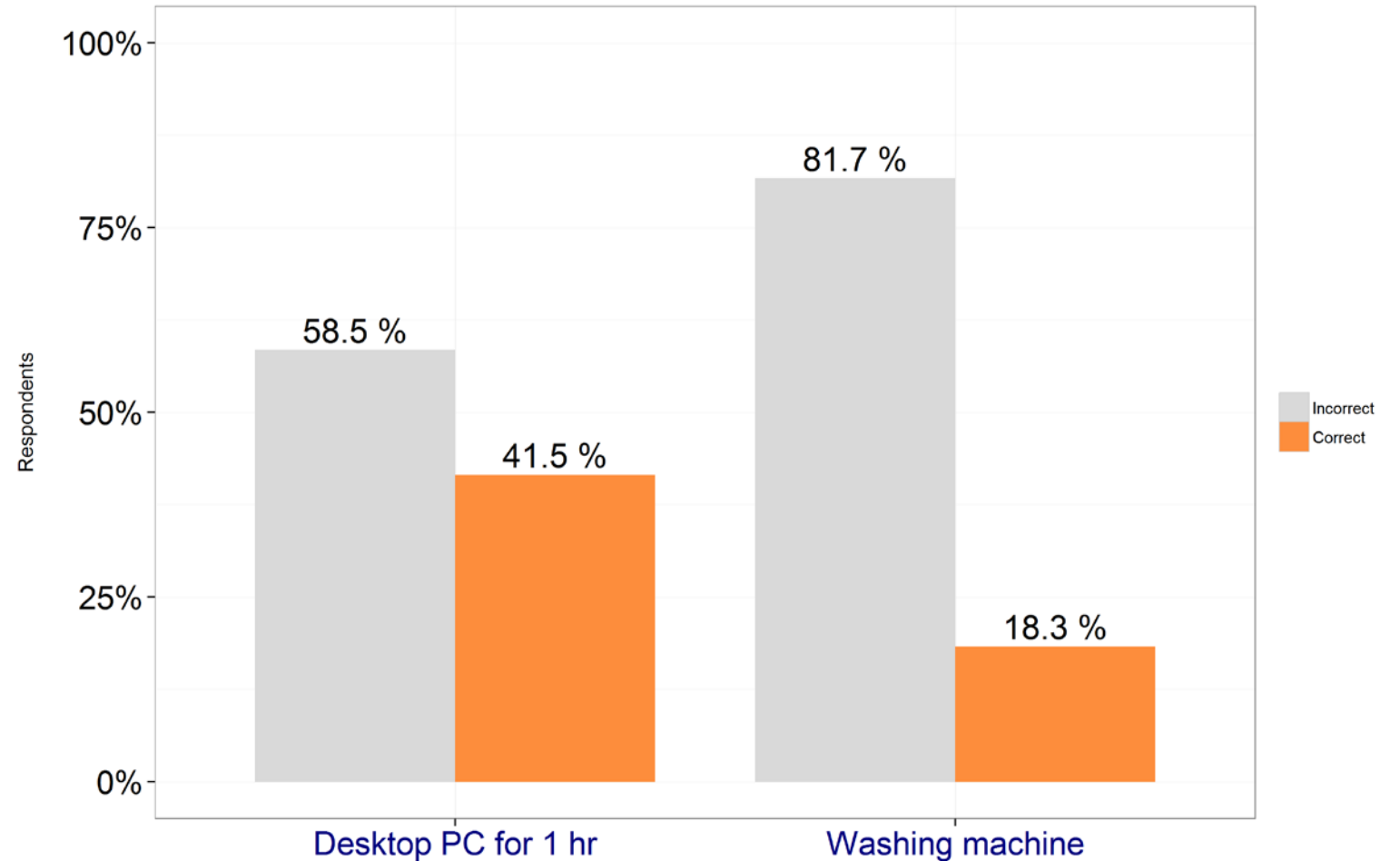
## Energy literacy (based on N=2835)

- Only 26% know the cost of 1 kWh of electricity



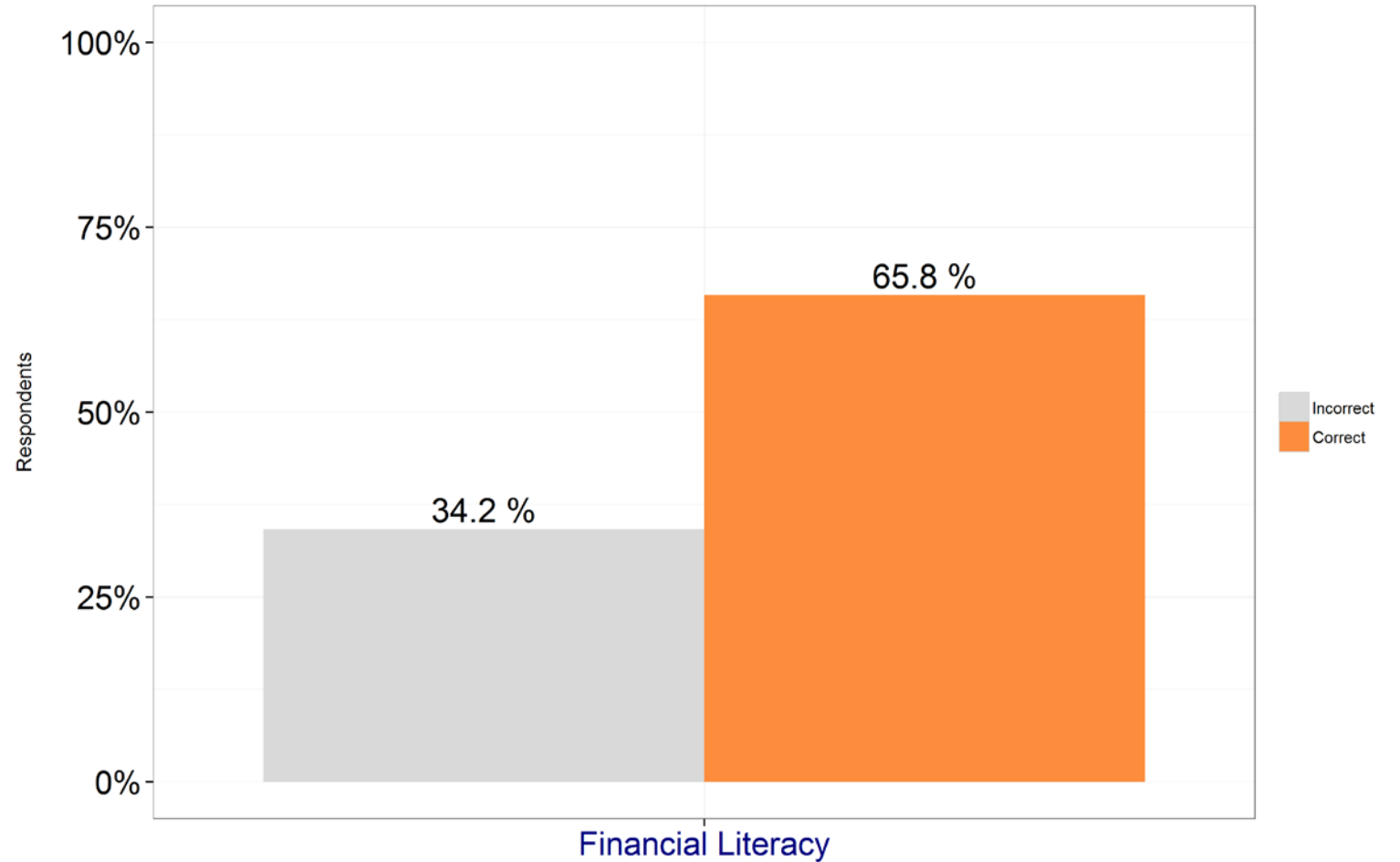
- Only 18% - 41% have some knowledge of usage cost of household appliances

## Knowledge of usage cost of household appliances



- 66% can correctly perform a compound interest calculation.

### Ability to perform a compound interest calculation

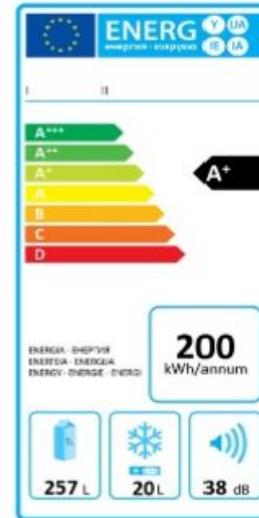
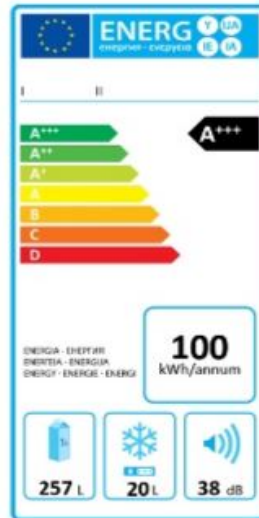


# What are the decision-making strategies used by the Swiss households?

# Experiment : Fridge choice

Assume that you need to replace your fridge. You expect that you live in your current residence for another 10 years. In a shop you find the following two fridges which are identical in terms of size and cooling service.

Price:	3300 CHF	2800 CHF
Electricity consumption:	100 kWh/annum	200 kWh/annum

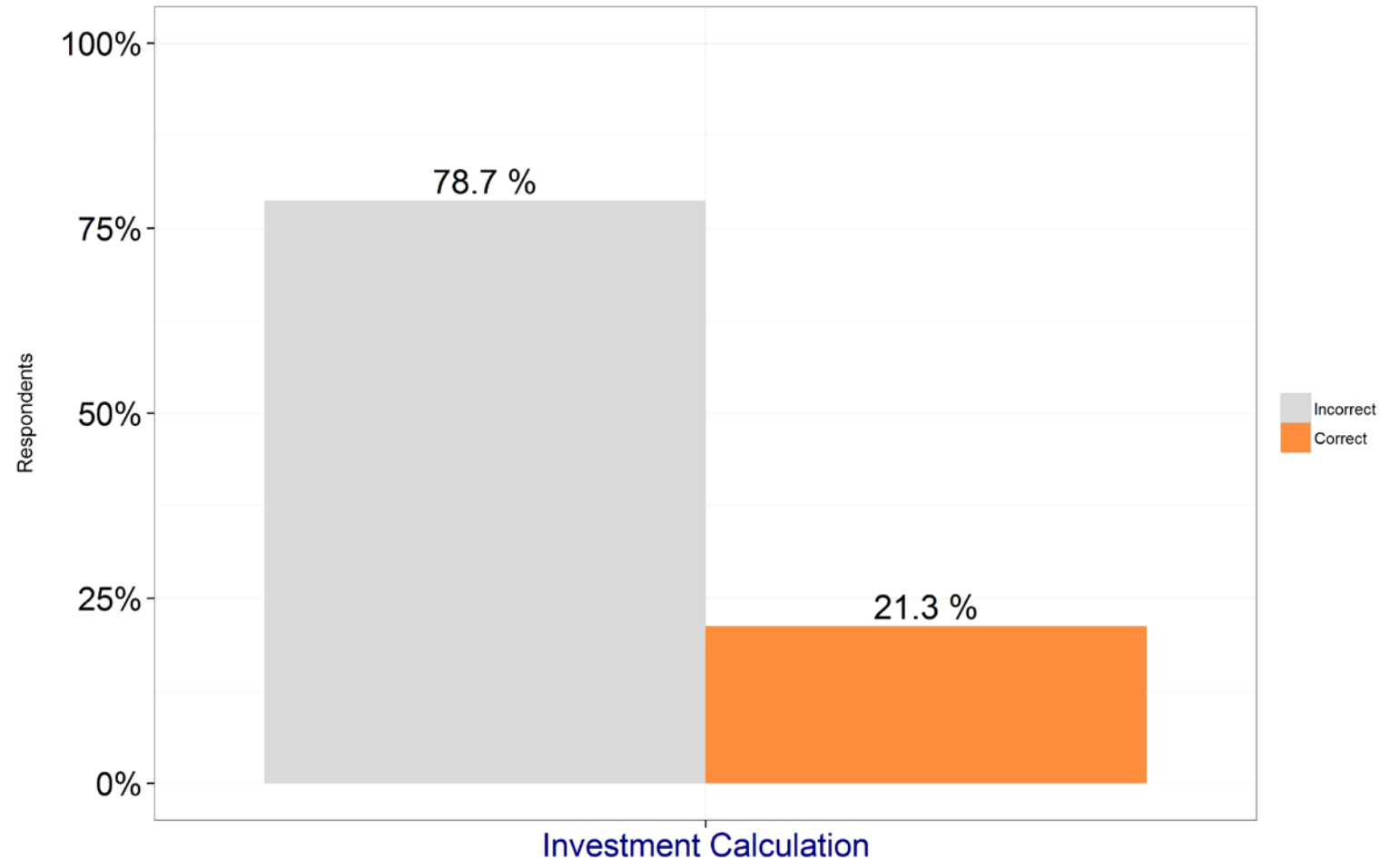


Which of the two fridges minimizes your expenditure for cooling food and beverages during the 10 years?

- The fridge for 3300 CHF.
- The fridge for 2800 CHF.

- Only 21% opt for investment calculation as the decision strategy
- Majority adopted an heuristic decision-making strategy

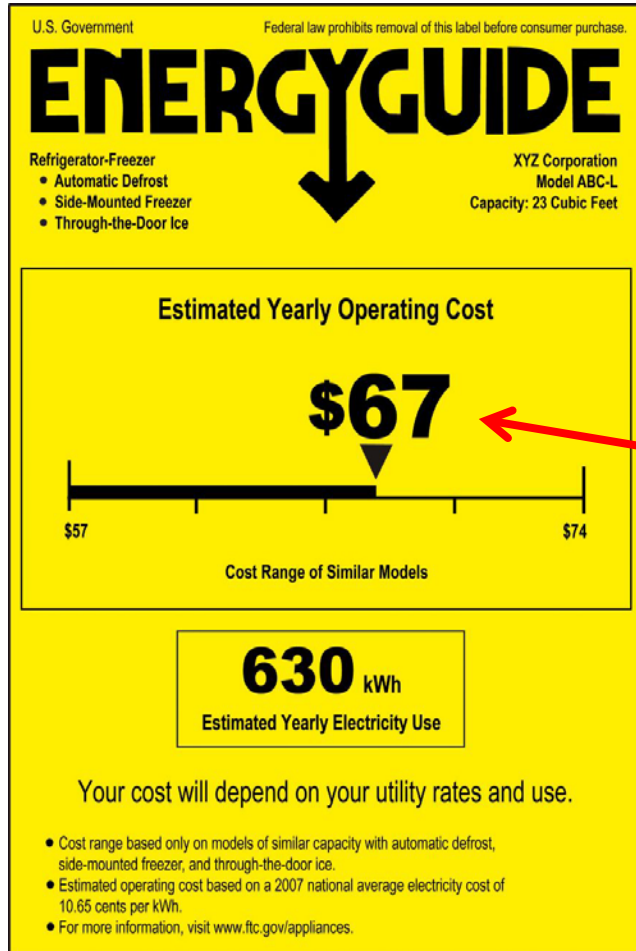
## Choosing Investment Calculation as the Decision Strategy



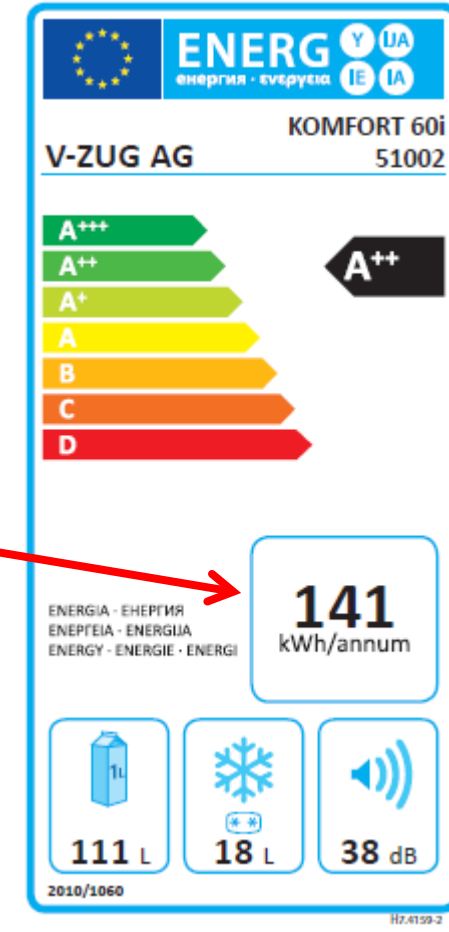
**How should energy consumption be displayed to enable consumers to identify the most cost-efficient appliances?**



# Energy label



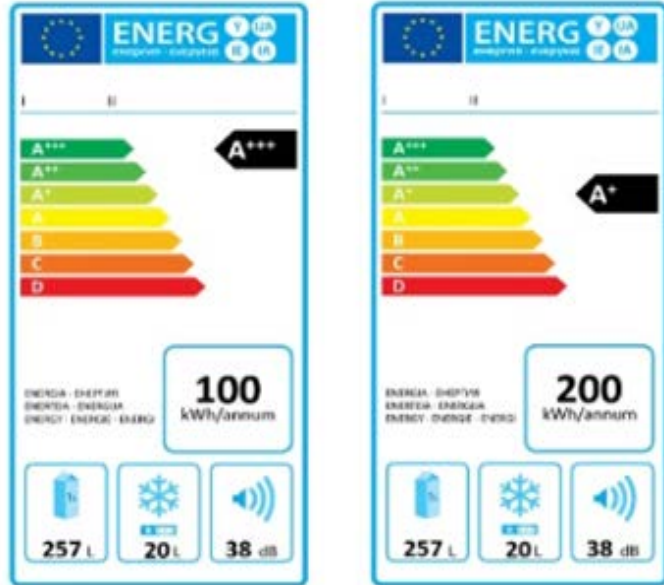
Expenditure or consumption?



# Randomized experiment : Fridge choice

Assume that you need to replace your fridge. You expect that you live in your current residence for another 10 years. In a shop you find the following two fridges which are identical in terms of size and cooling service.

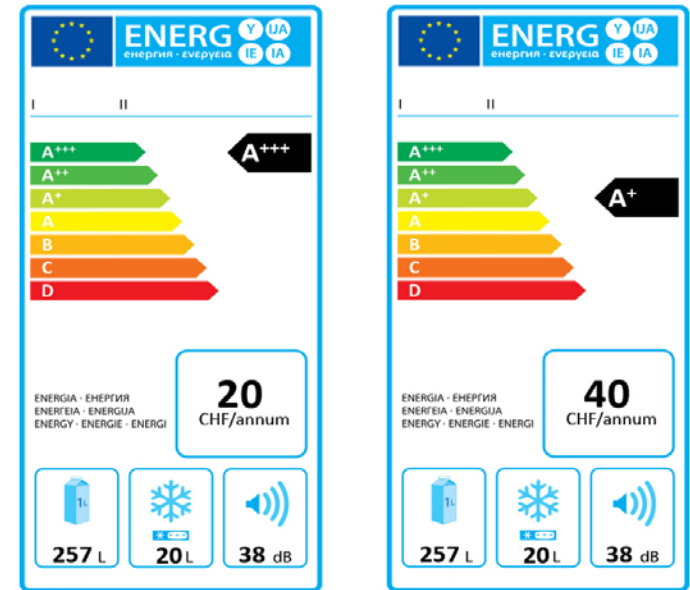
Price: 3300 CHF      2800 CHF  
Electricity consumption: 100 kWh/annum      200 kWh/annum



**Control group**

Assume that you need to replace your fridge. You expect that you live in your current residence for another 10 years. In a shop you find the following two fridges which are identical in terms of size and cooling service.

Price: 3300 CHF      2800 CHF  
Electricity cost: 20 CHF/annum      40 CHF/annum



**Treated group**

**Probability to choose the cost-efficient appliance increases significantly**

# What is the specific role of energy and investment literacy for the choice of cost-efficient appliances?

Probability to choose the cost-efficient appliance increase significantly with an increase of

↪ Investment literacy

↪ Energy literacy

↪ Investment calculation as decision strategy

# Conclusion

- To increase the level of energy efficiency we need the consumers to be able to identify the most cost-efficient appliance
- Rational choice of appliances can be improved by
  - ↳ the **provision of monetary information** on yearly energy consumption
  - ↳ Improvement of the **level of energy and investment literacy**

# Conclusion

- From an energy policy point of view the results suggest that to improve, at least partially, the level of energy efficiency we could
- Oblige the producers of electrical appliances to provide **monetary information** on yearly energy consumption
- Promote **educational training** on energy and investment related topics
- Provide **decision support tools** (e.g. investment calculators) at the point of sale for **empowerment of the consumers**

# Thank you for your attention!

- For further reference:
  - Alberini, A., Filippini, M., 2015. Transient and Persistent Energy Efficiency in the US Residential Sector: Evidence from Household-level Data. CER-ETH Working Paper No. 220.
  - Blasch, J. E., Filippini, M., Kumar, N. 2016. Boundedly rational consumers, energy and investment literacy, and the display of information on household appliances. CER-ETH Working Paper No. 249.