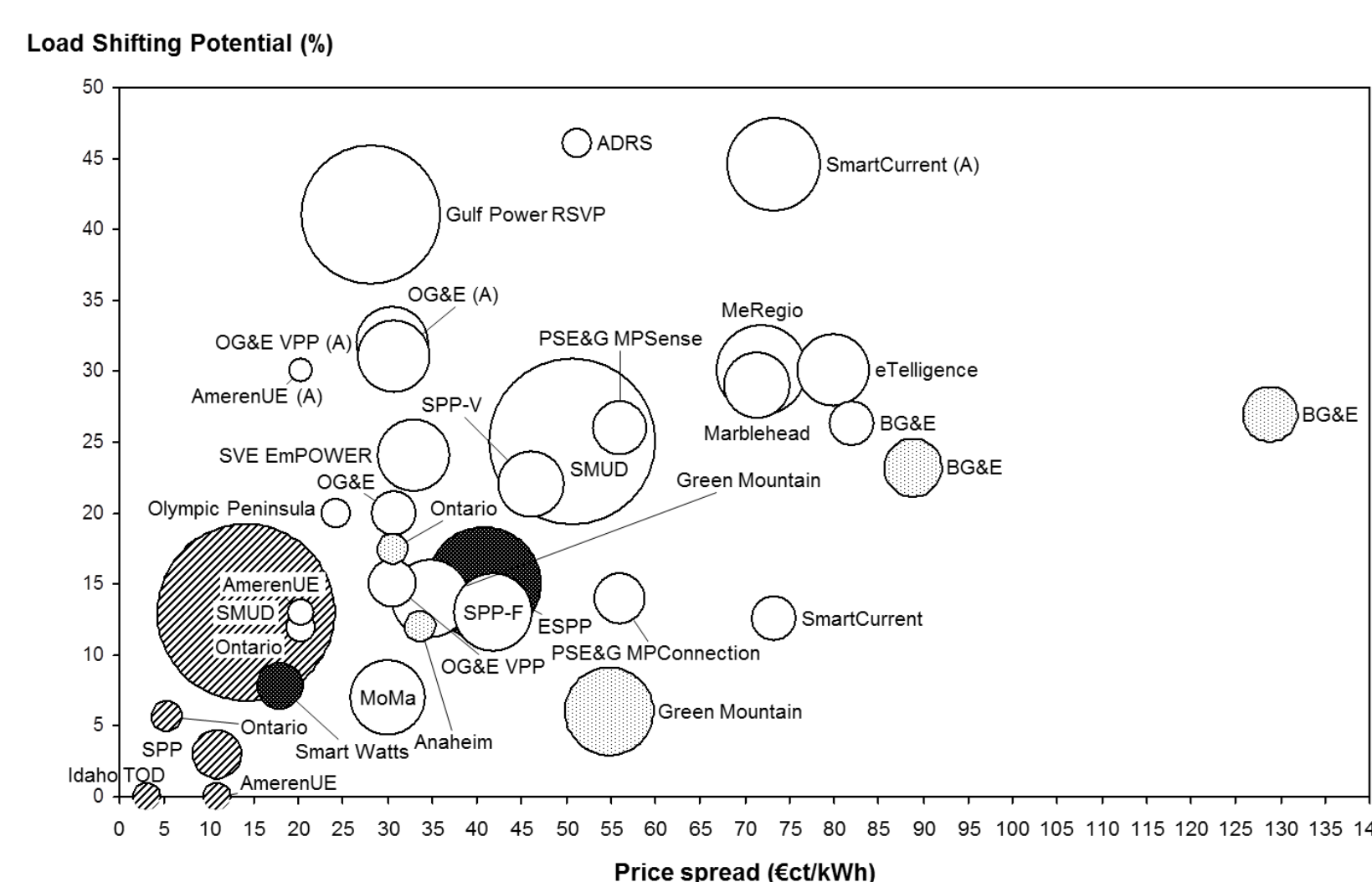


# Effects of Variable Electricity Rates on the Behavior of Residential Customers

## Definition and Motivation

- A variable rate is characterized by four fundamental properties: the price levels, the number of price levels, the minimum length of a price interval and the lead time, i. e. the time interval between information about the price and actual consumption.
- The expansion of renewable energy generation leads to an increasing volatility of supply in electricity networks. Aiming at grid relief, utilities already offer variable electricity rates to industrial customers.
- Variable electricity rates incentivize customers to shift electricity consumption from times of low electricity supply to times of high electricity supply.
- Applying modern technology (e. g., smart meters, automatization technology) enables easier implementation of variable rates.
- Previous field studies and pilot projects suggest that dynamic rates are well accepted by the majority of household customers and that these are an effective tool to incentivize them to significant behavioral changes (cf. illustration on the right).

## Overview of various projects and studies: Load shifting potential depending on the price spread

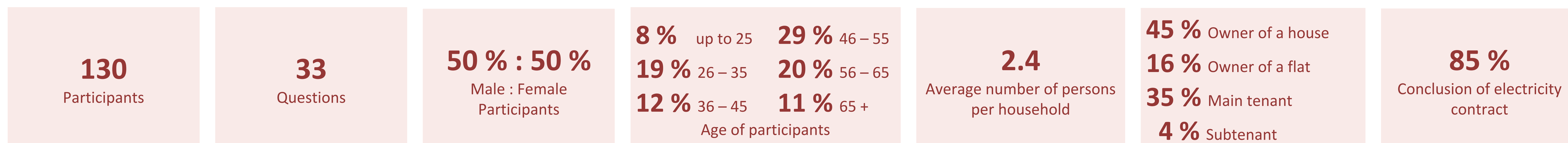


## Most common variable electricity rate structures

- Time-Of-Use (TOU):** different price levels at defined time intervals (seasonal, weekly, daily)
- Critical Peak Pricing (CPP):** like TOU rate with an additional critical peak price level. The critical peak price is considerably higher than the normal peak price and only valid for a predefined amount of time. The customer is informed at short notice (usually one day ahead) about critical peak events.
- Peak Time Rebate (PTR):** like CPP rate. Instead of a high critical peak price, a rebate is applied for reducing load during peak times.
- Real-Time-Pricing (RTP):** Price curve is adjusted in short intervals, usually based on spot market prices.

## The Willingness of Household Customers to Adapt their Behavior to a Variable Electricity Rate: Some Survey Results

### I. Survey and Sample Group



### II. Decision Criteria

#### Method

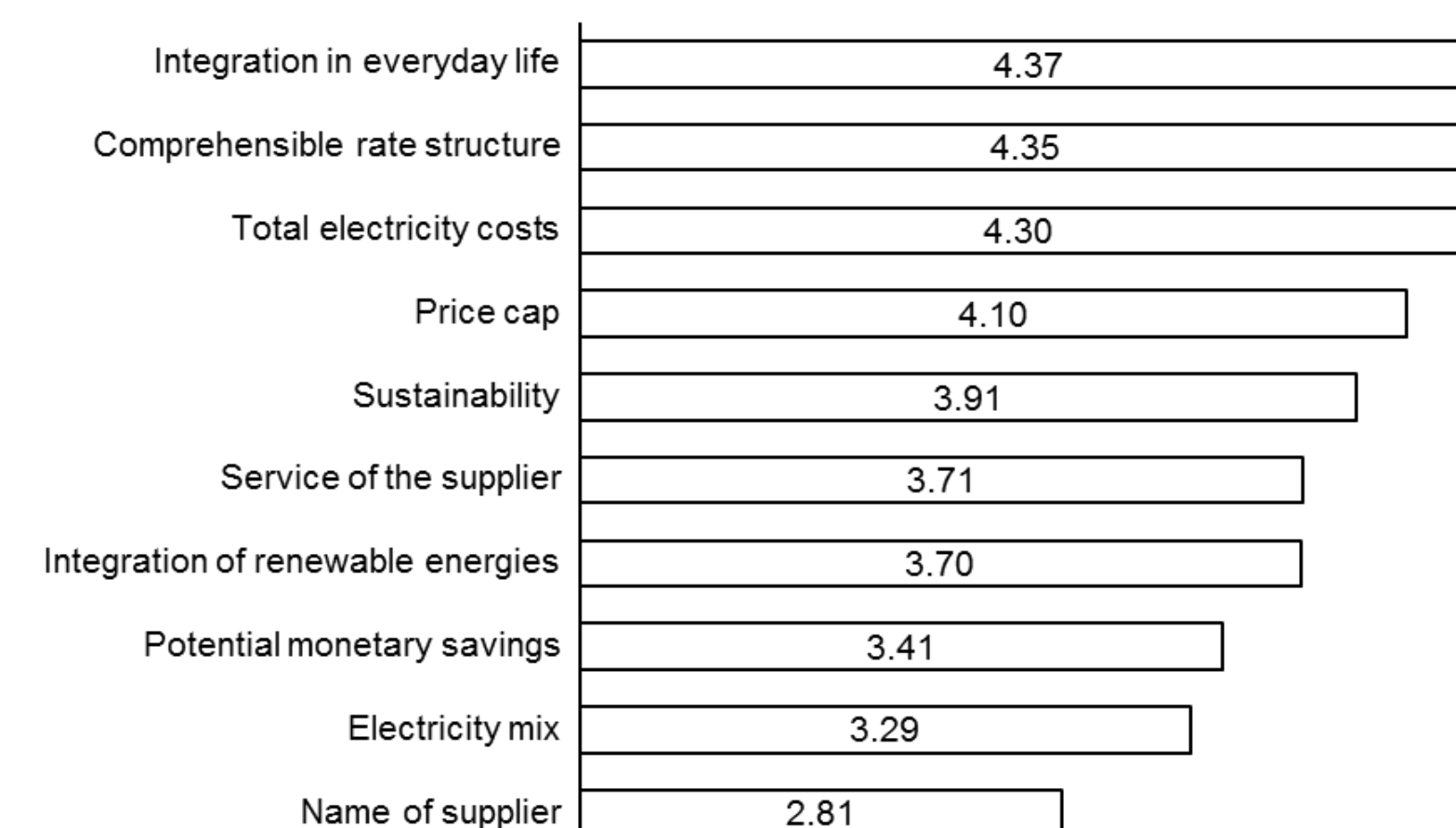
- Participants rate several criteria with regard to their importance for the decision process (1 – not important to 5 – very important).

#### Results

- Criteria regarding structure and resulting costs are essential.
- Ecological factors like sustainability and integration of renewables are also considered important.
- The actual supplier is quite insignificant for the choice.

#### Conclusions

- A transparent, comprehensible and comparable rate structure is recommended.
- Sustainable rate design can be a USP.



### III. Preferred Rate Structure

#### Method

- Every participant defines their preferred structure regarding the identified fundamental properties.

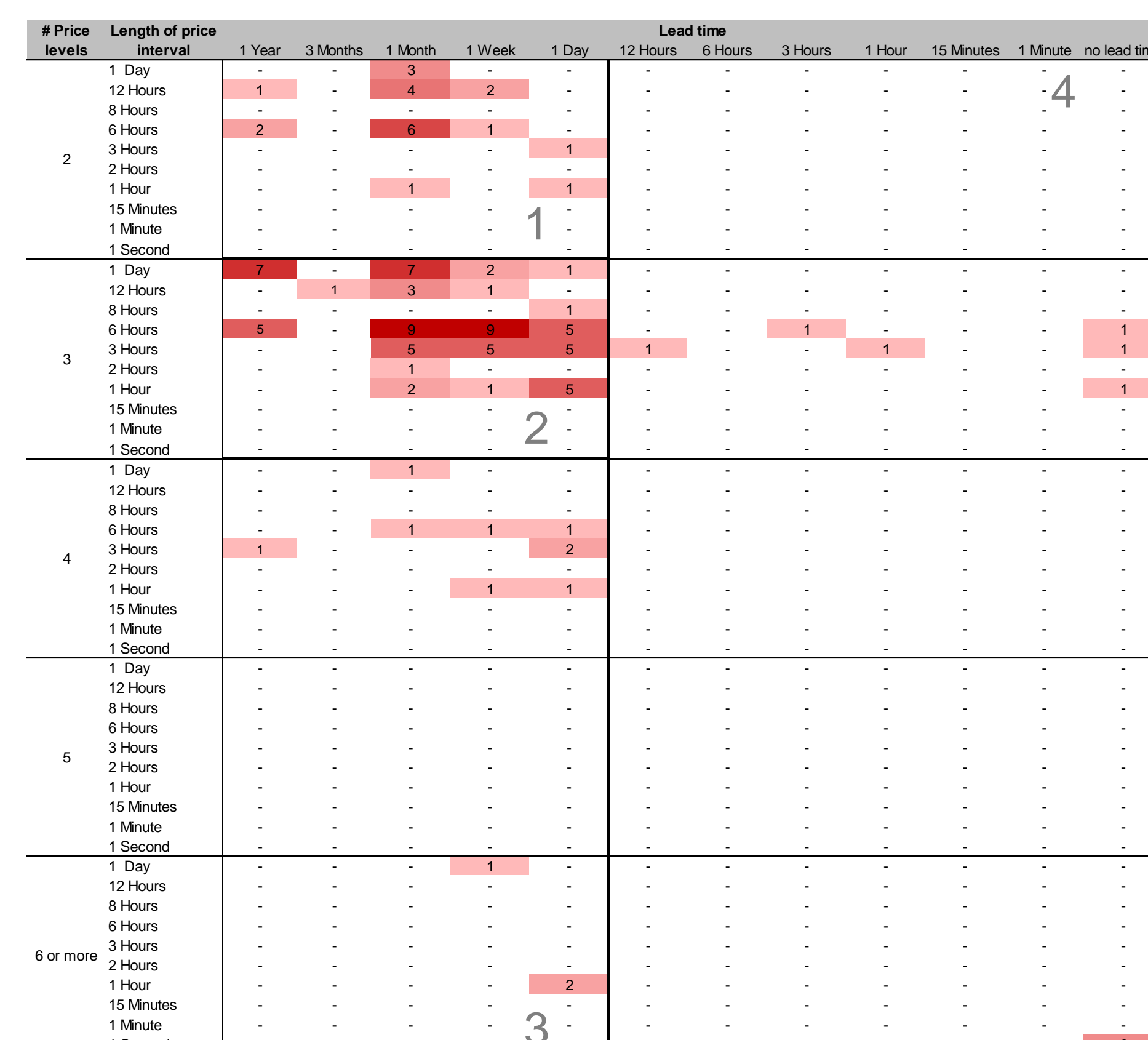
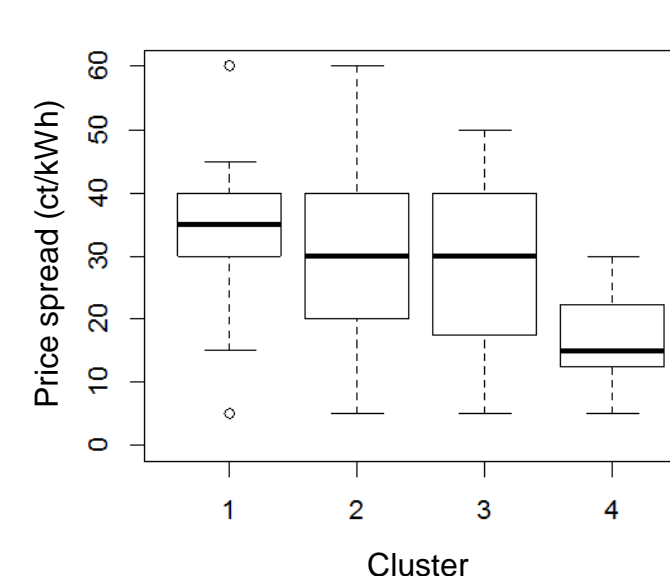
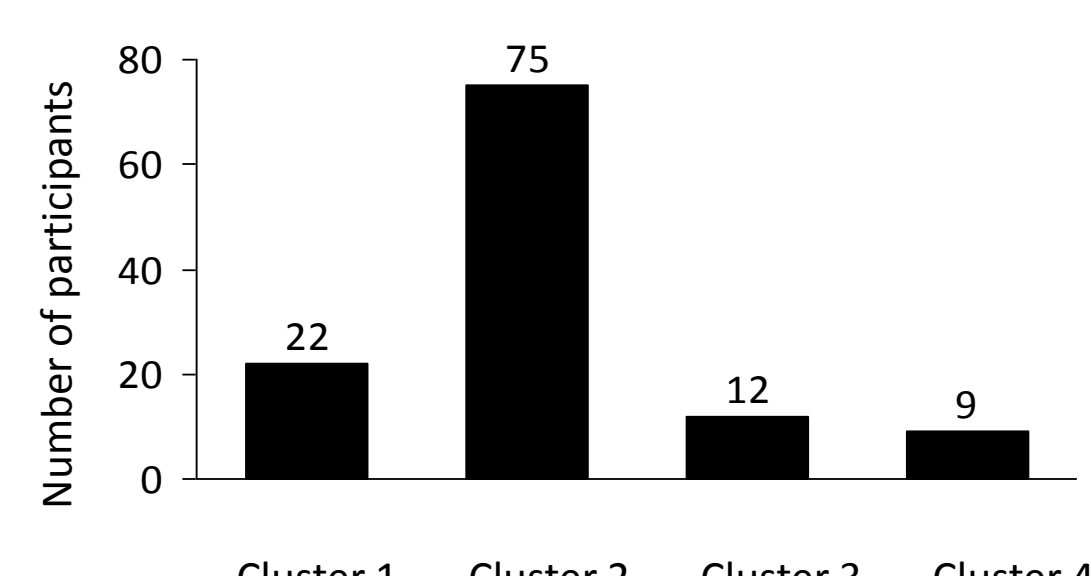
#### Results

- 69 % of participants prefer 3 price levels.
- Participants who want more dynamic rates (short intervals, short lead time) prefer smaller spreads.
- Price intervals below 1 hour are quite unpopular.

#### Conclusion

- 3 price levels in hourly structure and information at least one day ahead suits a majority of potential customers.

Cluster	Number of price levels	Length of price intervals	Lead time	Price spread (Median)
Cluster 1	2	≥ 1 hour	≥ 1 day	35 ct/kWh
Cluster 2	3	≥ 1 hour	≥ 1 day	30 ct/kWh
Cluster 3	≥ 4	≥ 1 hour	≥ 1 day	30 ct/kWh
Cluster 4	≥ 3	≤ 6 hours	< 1 day	15 ct/kWh



### IV. Load Shifting and Consumption Saving

#### Method

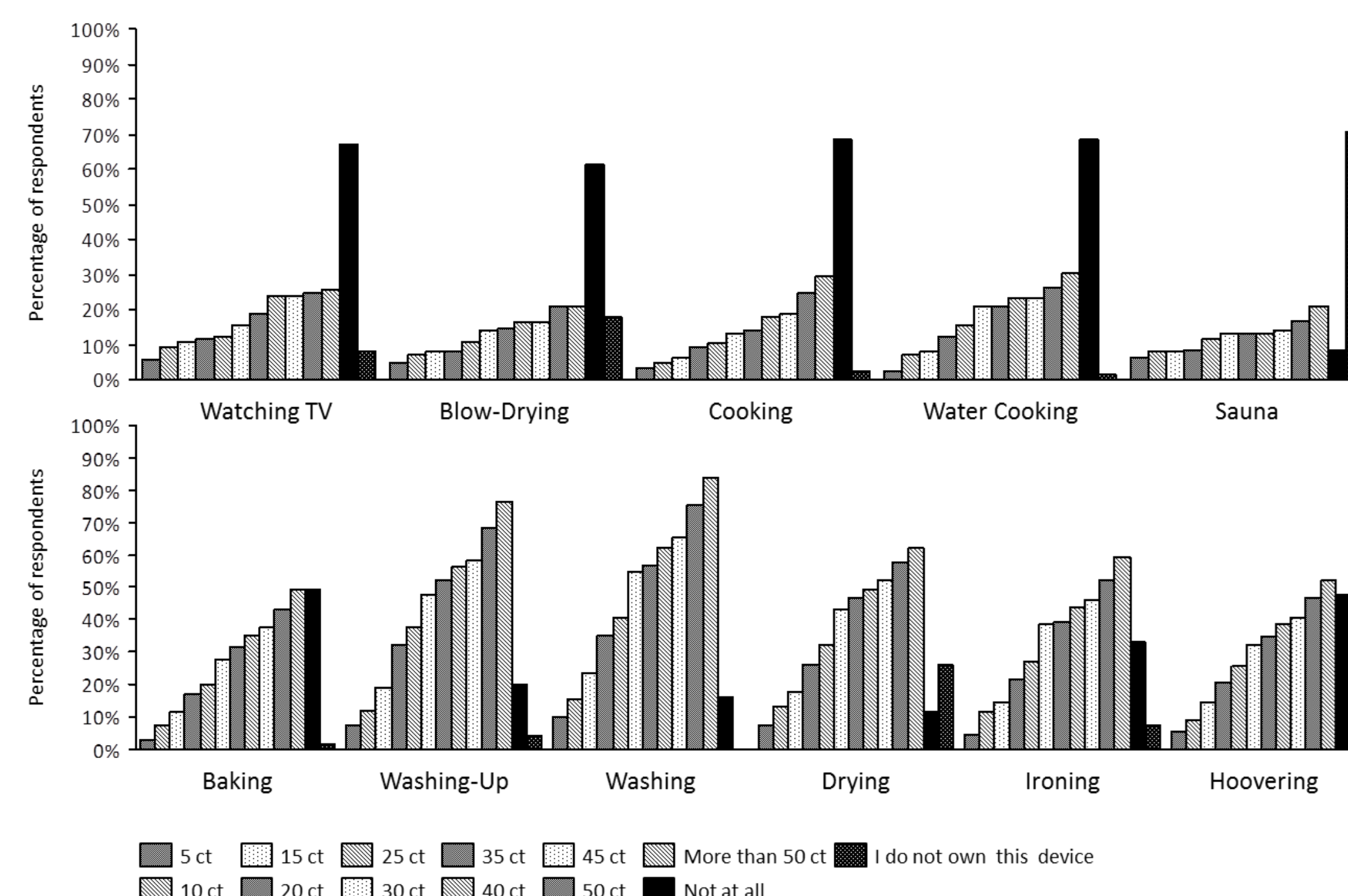
- Participants are asked about their willingness to shift various activities dependent on possible savings.
- Savings are quantified per „process“, e. g. per washing machine cycle, for simplicity.
- The graph shows cumulative data since willingness for smaller savings is assumed.

#### Results

- High acceptance of load shifting for specific activities (especially among younger participants).

#### Automated Control

- Additionally, the participants indicate their attitude towards automated control of household devices.
- High acceptance: 79 % of participants accept automated control of at least one device (mostly fridge and heating).
- Acceptance for automated control correlates with small necessary savings for shifting.



## Key results

- The four most important decision criteria in rate selection: Integration in everyday life, comprehensible rate structure, total electricity costs and price cap.
- The preferred variable rate consists of three price levels in hourly intervals, a price spread of 30 ct/kWh and at least day-ahead information.
- Participants show high acceptance for variable rates and willingness to change their behavior according to the price signals, even for quite small possible savings.

## Further information and survey results:

