Decision on electric vehicle charging tariffs: Investigating the trade-off between system friendliness and convenience'

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Agenda

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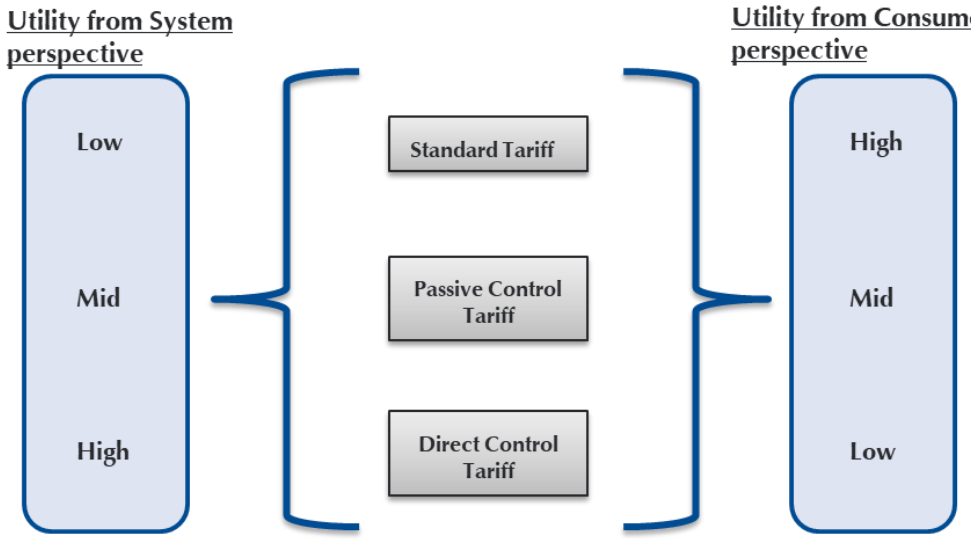
Motivation

- **Problems of system operators**
  - Growing peak demand
  - Sector coupling
  - Renewable integration (E-Transition)
- **Reasons for problems:**
  - Imbalance between financial costs supply & price actually paid by customers
- **(Theoretical) solution**
  - Cost reflective pricing - price signals to shift demand
  - Improved network efficiency, reduced infrastructure costs, and lower average market prices, reduced risk (producer) & demand
  - Active control (optimized, smart charging – third party access)



1. **Do consumers prefer simple electric vehicle charging tariffs over more complex ones?**
2. **If yes, how can we change their preferences towards overall beneficial tariffs?**

- **Perspective of consumers, i.e., households**
  - Cognitive biases in decision making process – *principle of simplicity*
  - Use of heuristics and "short-cuts" and rule of thumbs → be satisfied, even if result is economically not optimal
  - Consumer prefer standard tariffs
- **Observation (to date)**
  - Cost-reflective pricing
    - low uptake rates
    - Users are (to date) a unique small subset
    - Possible price inelasticity (high level of optimization)
  - Active control
    - Preferences for active control rather than flat-rate and cost-reflective for **static applications**
      - loss of control is outweighed by the gain in convenience
    - No generalisation because acceptance of automated devices is highly appliance-specific

Design

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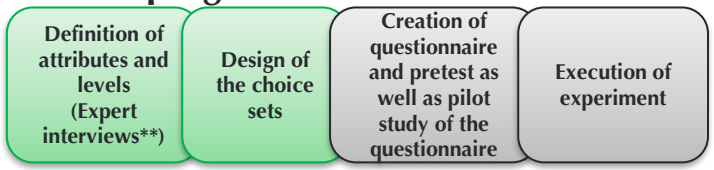
- Discrete choice model
  - Software: Sawtooth
  - Recruitment in University*, via Social Networks (Strommarktgruppe etc.)
  - ~ 330 respondents
  - Concepts per choice task = 3 (No opt out)
  - Choice tasks in study = 7
  - Reward via lottery
  - Stated preferences / May I assume a hypothetical situation? -> Discussion
  - Possible treatment: Social norms (social comparison), information given by public authorities, framing, default settings

Work in progress



Attributes	Levels								
Pricing scheme	Grundpreis: 20 € p.M. Arbeitspreis: 0,30 €/kWh	Grundpreis: 20 € p.M. Arbeitspreis Tag (07-19) 0,40 €/kWh	Arbeitspreis Nacht (19-07) 0,20 €/kWh	Grundpreis: 20 € p.M. Arbeitspreis M (07-15) 0,40 €/kWh	Arbeitspreis D (15-23) 0,30 €/kWh	Arbeitspreis N (23-07) 0,20 €/kWh	Grundpreis: 20 € p.M. Arbeitspreis Tag (07-19) 0,40 €/kWh	Arbeitspreis Nacht (19-07) Exakter Marktpreis*	Grundpreis: 20 € p.M. exakter Marktpreis ist zeitabhängig[1]
Control mode	Owner	+ Contractor		-			-		-
Contractor	Electricity discounter	Municipal utilities		National electricity producer			-		-
Discount	0%[2,3]	5%[3]		10%[3]			15%[3]		-
Priority charging (SoC|+Contractor)	0%	20%		40%			-		
Yrl. Costs	Depending on the stated mileage from prior question								

We would set the focus on unidirectional charging

* Kind of classroom experiment
**DSOs, OEMs, Universities and research institutes

[1]The estimated value is on average 0,XX €/kWh (graph) - Day/Night (SS/WS, WE/WW
[2]This value applies for DumbTarif (status quo)
[3] Discount for performance of complex tariffs to status quo tariff

- Sociodemographics:
  - Age, gender, education, income, occupation, marital status, geographic location, household size
- Questions regarding (E-)mobility, smart home, smart technologies

House of Energy Markets & Finance

Method (empirical)

- Random Utility Model (RUM) theory
  - Part-worth utility estimation*

$$U_{jm} = \beta_j X_m + \varepsilon_{jm}$$

  - Where
    - U_{jm} = utility plus random error for the j_{th} respondent and m_{th} alternative
    - β_j = vector of part-worth utilities for respondent j
    - X_m = vector of design codes describing alternative m
    - ε_{jm} = IID (Independent and Identically Distributed) rightskewed Gumbel distributed random variable
  - WTP estimation

$$WTP = -\frac{\beta_j}{\beta_{price}}$$

*We might control for "left-right effect" by using alternative specific constant (asc)

- Multinomial Logit

$$P_i = \frac{e^{U_i}}{\sum_{k=1}^{K} e^{U_i + \cdots + e^{U_k}}}, \textit{ where}$$

  - P_i = probability of choosing alternative *i*;
  - U_i = utility of the ith alternative;

- Latent Class Choice Model

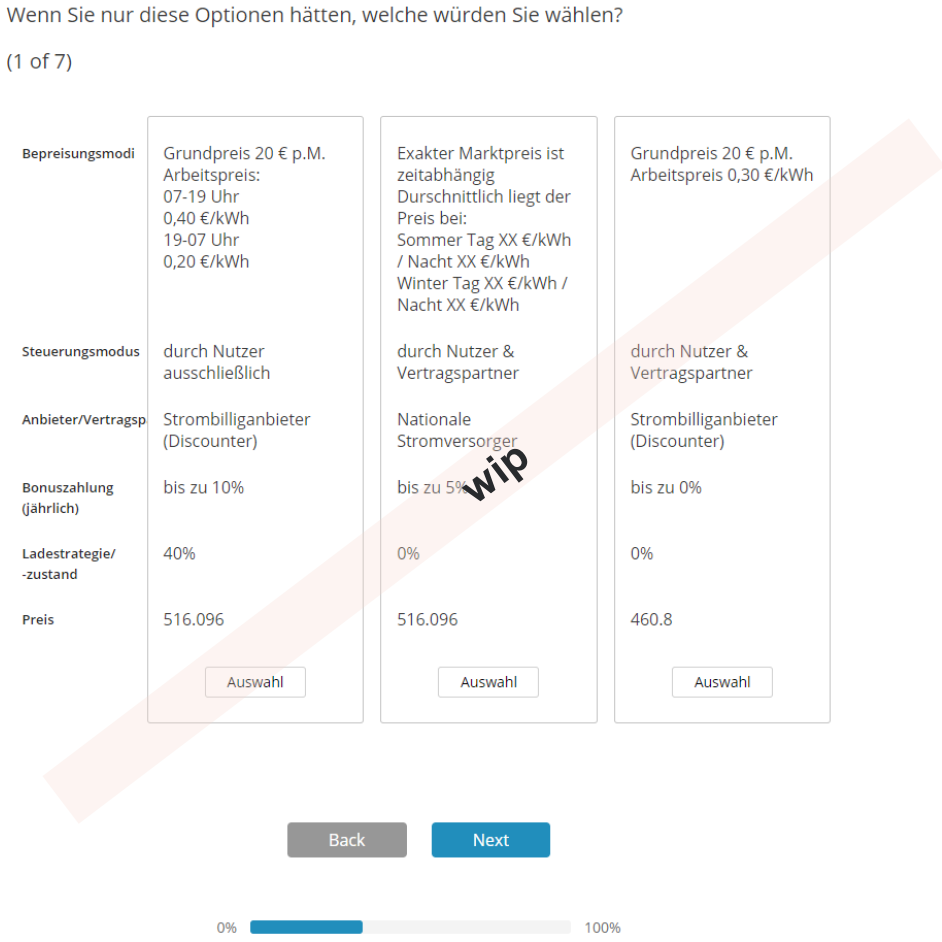
$$P_n(i) = \sum_{s=1}^{S} P_n(i|s)\, Q_n(s), \textit{ where}$$

  - $P_n(i)$ = probability of individual *n* choosing alternative *i*;
  - $Q_n(s)$ = probability of individual *n* belonging to latent class *s*;
  - $P_n(i|s)$ = probability of individual *n* choosing alternative *i* given *n* belonging to class *s*;
  - S = number of latent classes ;

- Hierarchical Bayesian Estimation
  - ability to obtain respondent-level utilities
  - appropriate for choice models when respondents are faced with multiple choice tasks
  - Two (hierarchical levels)
    - Upper level: Assumption that individuals' part-worths are described by a multivariate normal distribution (vector of means and matrix of covariances)
    - Lower level: Assumption given an individual's part-worths, that his probabilities of choosing particular alternatives are governed by MNL

Method (survey)

- Survey Structure
  1. Introduction
  2. Storyline and information (definitions)
  3. Now try to put yourself in the following (fictitious) situation
  4. Parking space, wallbox and car
  5. Rel. time charging at home overnight
  6. Driving profile
  7. CBC
  8. Sociodemographic
  9. Link for participation in lottery



Embedding of experiment in broader project context

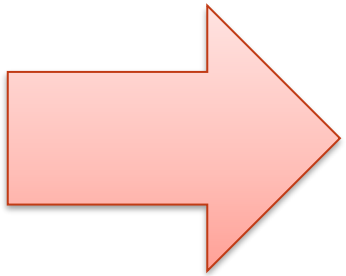
Energy economic analysis from a stakeholder perspective

Decision making on investment

Decision making on charging

Regional market ramp-up model with consideration of used car flows

Discrete-choice experiment on decision-making for EV-charging-tariff



Energy system analysis [Electricity-, heat- and gas market model]

Value of flexibility

Interplay of different flexibilities

Feedback effects on the energy system

RE integration

Analysis on operational (short-term) and investment level (long-term)

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Thank you for your attention

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