Zurich University
of Applied Sciences

School of
Management and Law

Customer Acceptance of Smart Electricity Tariffs

-

Preliminary results of a choice experiment

Building Competence. Crossing Borders.

Christian Winzer, Karoline Gamme, Hongliang Zhang

winc@zhaw.ch 30.01.2020

Agenda

1. **Research Question and Context:**

2. **Method: Survey design, choice models**

3. **Results:**
   - Descriptive statistics,
   - Consistency checks
   - WTP for contract attributes
   - Respondent Clusters

4. **Implications for smart-meter roll-out**

Research Question and Context

– *Should smart meters include load-limiting device functionality?*

Quelle: https://web.smart-me.com/

Smart Meter Rollout by 2027:

734.71 Elektrische Anlagen

4*a*. Abschnitt:[91]
Übergangsbestimmung zur Änderung vom 1. November 2017

Art. 31*e* Einführung intelligenter Messsysteme

[1] Bis zehn Jahre nach Inkrafttreten der Änderung vom 1. November 2017 müssen 80 Prozent aller Messeinrichtungen in einem Netzgebiet den Anforderungen nach den Artikeln 8*a* und 8*b* entsprechen. Die restlichen 20 Prozent dürfen bis zum Ende ihrer Funktionstauglichkeit im Einsatz stehen.

Quelle: Bundesrat, 2008. Stromversorgungsverordnung (StromVV).

734.71 Elektrische Anlagen

Art. 8*a*[35] Intelligente Messsysteme

[1] Für das Messwesen und die Informationsprozesse sind bei Endverbrauchern, Erzeugungsanlagen und Speichern intelligente Messsysteme einzusetzen. Diese bestehen aus folgenden Elementen:[36]

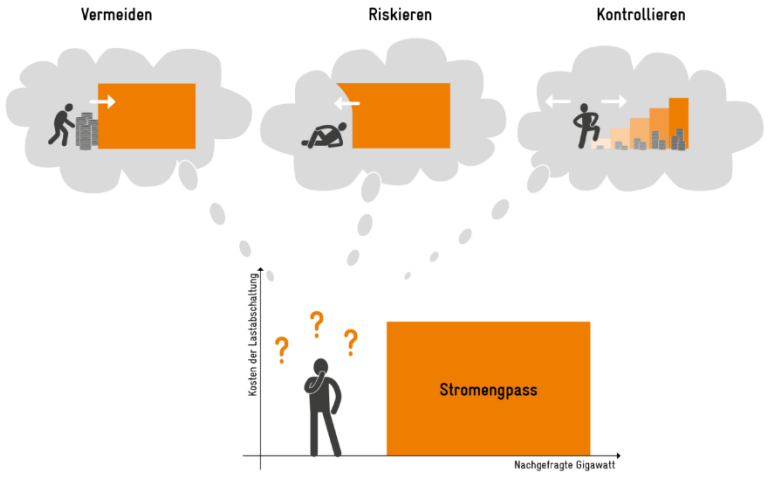
a. einem beim Endverbraucher, bei der Erzeugungsanlage oder beim Speicher installierten elektronischen Elektrizitätszähler, der:[37]
   1. Wirkenergie und Blindenergie erfasst,
   2. Lastgänge mit einer Periode von fünfzehn Minuten ermittelt und mindestens sechzig Tage speichert,
   3.[38] Schnittstellen aufweist, insbesondere eine für die bidirektionale Kommunikation mit einem Datenbearbeitungssystem und eine andere für den betroffenen Endverbraucher, Erzeuger oder Speicherbetreiber, die ihm mindestens ermöglicht, Messwerte im Moment ihrer Erfassung sowie die Lastgänge nach Ziffer 2 abzurufen, und
   4. Unterbrüche der Stromversorgung erfasst und protokolliert;
b. einem digitalen Kommunikationssystem, das die automatisierte Datenübermittlung zwischen dem Elektrizitätszähler und dem Datenbearbeitungssystem gewährleistet; und
c. einem Datenbearbeitungssystem, mit dem die Daten abgerufen werden.

Research Question and Context

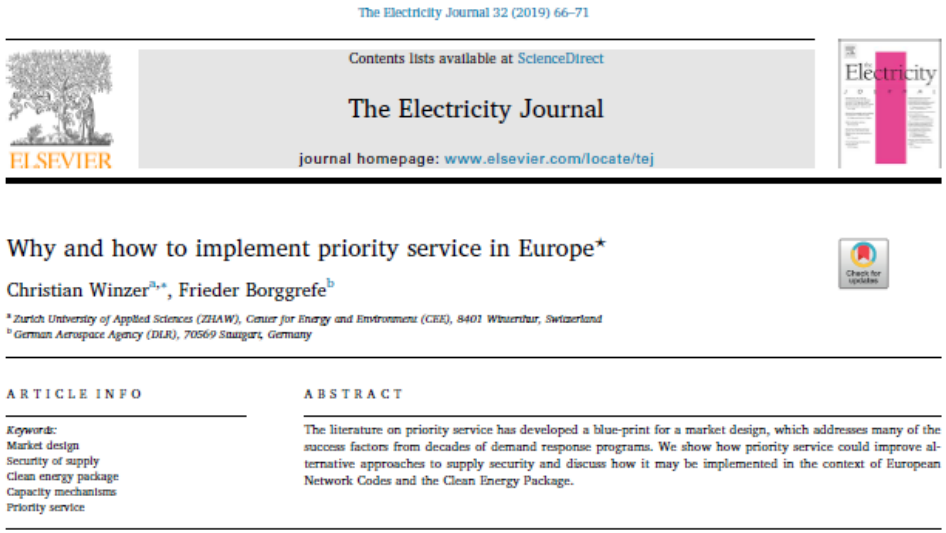
– *Should smart meters include load-limiting device functionality?*

Quelle: https://web.smart-me.com/

Market Design Implications:



Source: Avenir Suisse, https://www.avenir-suisse.ch/massgeschneiderte-versorgungssicherheit/



The Electricity Journal 32 (2019) 66–71

Contents lists available at ScienceDirect

The Electricity Journal

journal homepage: www.elsevier.com/locate/tej

Why and how to implement priority service in Europe*

Christian Winzer[a,*], Frieder Borggrefe[b]

[a] Zurich University of Applied Sciences (ZHAW), Center for Energy and Environment (CEE), 8401 Winterthur, Switzerland
[b] German Aerospace Agency (DLR), 70569 Stuttgart, Germany

ARTICLE INFO

Keywords:
Market design
Security of supply
Clean energy package
Capacity mechanisms
Priority service

ABSTRACT

The literature on priority service has developed a blue-print for a market design, which addresses many of the success factors from decades of demand response programs. We show how priority service could improve alternative approaches to supply security and discuss how it may be implemented in the context of European Network Codes and the Clean Energy Package.

Quelle: Winzer, C., Borggrefe, F., 2019. Why and how to implement priority service in Europe. The Electricity Journal 32, 66–71. https://doi.org/10.1016/j.tej.2019.05.014

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2. **Method: Survey design, choice models**

3. **Preliminary Results:**
   - Descriptive statistics,
   - Consistency checks
   - WTP for contract attributes
   - Respondent Clusters

4. **Potential implications for smart-meter roll-out**

Method: Choice Attributes

Attribute	Levels
Peak Frequency	5 peak periods per year
	50 peak periods per year
	100 peak periods per year
Additional cost during peak periods	CHF 1 per kWh
	CHF 5 per kWh
	Between CHF 1 and CHF 5per kWh
Saving Target	Up to 2 large appliances
	Up to 1 large appliance
	No large appliances
Automatic action	None
	Limit Total demand
	Limit specific appliances
Monthly base fee	CHF 40 per month
	CHF 60 per month
	CHF 80 per month

Method: Survey design

Sample Choice Task: Control Group

Random assignment:

- 1 of 14 „blocks“ containing 6 choice tasks
- control or treatment group

Mouseover information:

- Duration and advance notice of peak periods
- Cost per peak period for avg. 2 pers. household
- Resulting consumption (kWh) per peak period
- Delay after which, devices are switched off.
- Resulting price per kWh for average 2 person household

Method: Choice model and calibration

Random Utility Framework: (Train, 2003)

$$U_{itj} = \beta_I \mathbf{x}_{itj} + \varepsilon_{ijt} \quad \Rightarrow \quad \Pr(choice = j1) = \frac{\beta_i \cdot x_{itj1}}{\sum_{j \neq j1} \beta_i \cdot x_{itj}}$$

Random Variables:

- ***U***: Utility of alternative ***j*** in choice task ***t*** for individual ***i***
- β_i: Part-worth of contract attributes (for individual ***i***)
- ε_{ijt}: Random utility component of alternative ***j*** in choice task ***t*** for individual ***i***

Constant Variables:

- $\mathbf{x}_{itj}$: Contract attributes of alternative **j** in choice task **t** for individual **i**

Assumed distributions:

- Logistic
- Normal
- Mixed Logit

Calibration methods:

- Hierarchical Bayes
- Latent Classes
- Maximum Likelihood
- K-Means and other clustering algorithms?

Quality metrics:

- Akaiken Information Criterion
- Bayesian Information Criterion
- Log likelihood
- Pseudo R-squared
- Hit-rate (in and out of sample)

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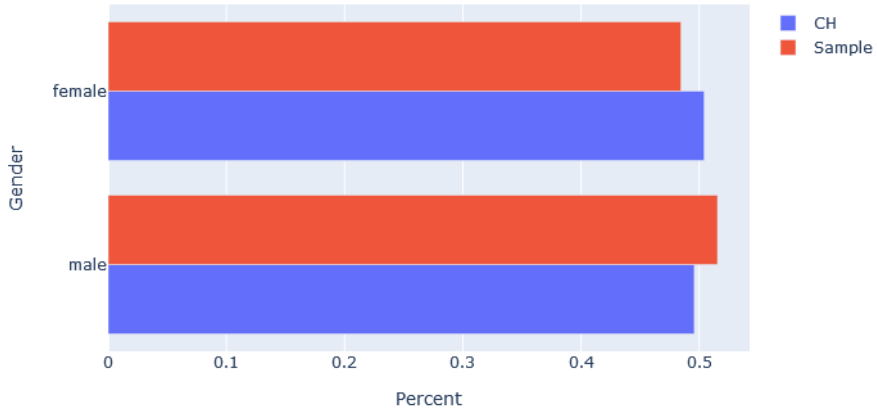
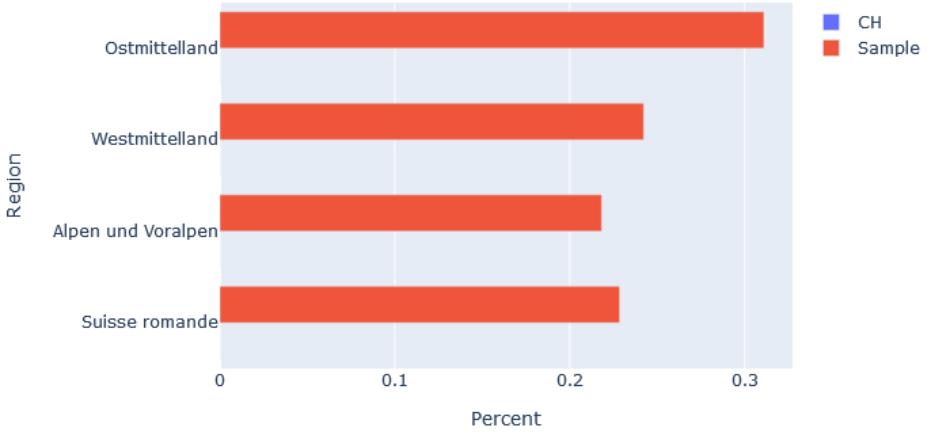
Preliminary Results: Descriptive statistics: Survey sample

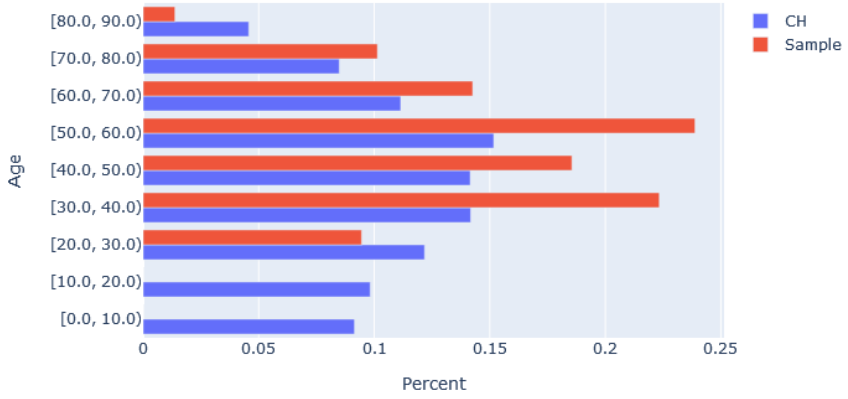
Gender of respondents in the sample and Switzerland as a whole



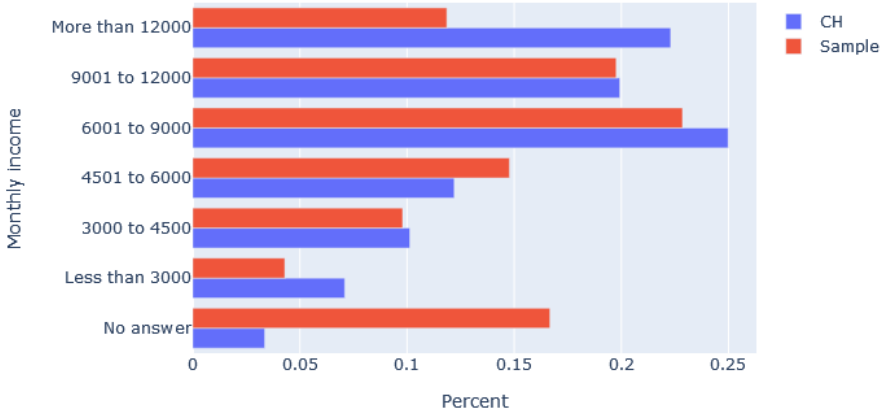
Region of respondents in the sample and Switzerland as a whole



Age of respondents in the sample and Switzerland as a whole



Monthly income of respondents in the sample and Switzerland as a whole



Preliminary Results: Descriptive statistics: Frequency of attributes

Attribute	Levels
Peak Frequency	5 peak periods per year
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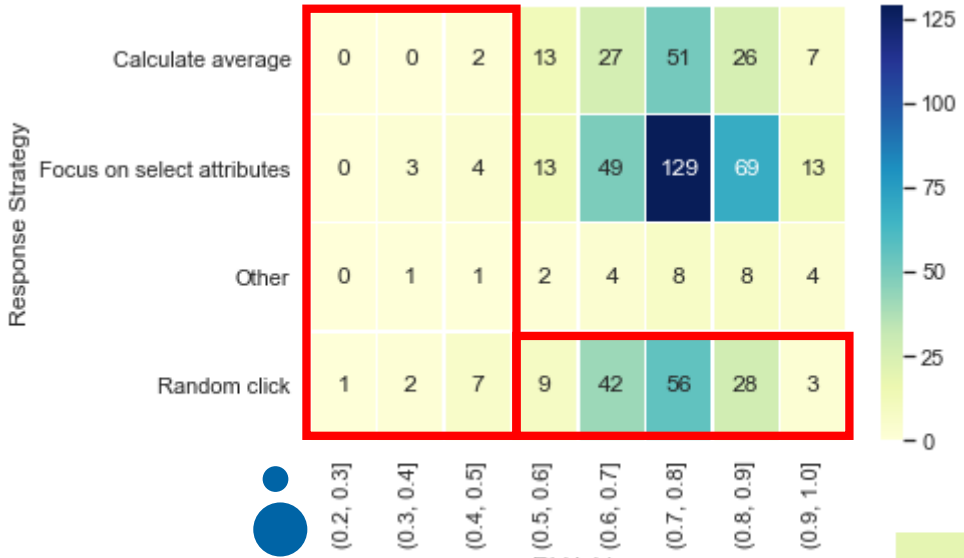
Different sequence of attribute levels for “additional cost”, “saving target”, and “automatic action”

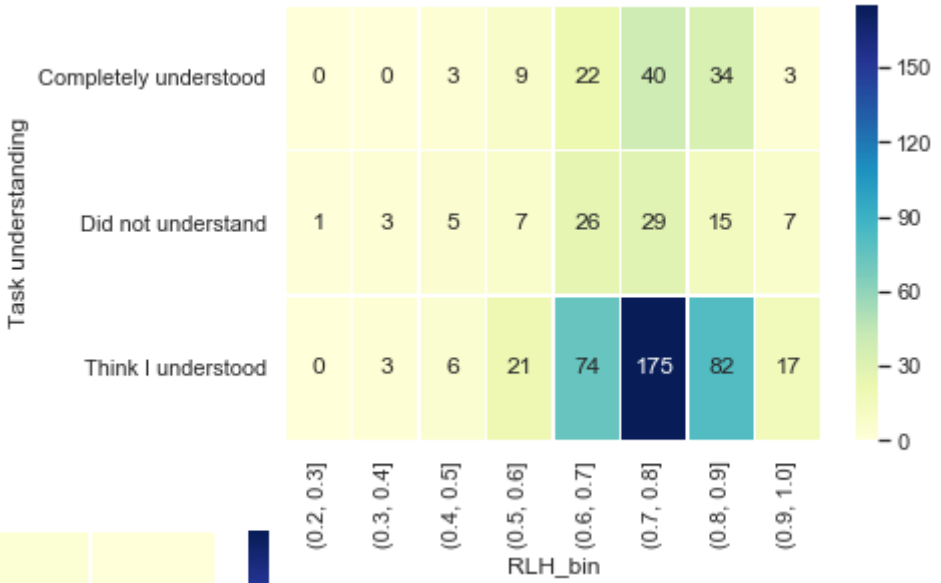
“no large appliances” significantly selected less often

Moderate aversion towards limiting total demand

Large difference of frequency for monthly price levels

Preliminary Results: Consistency checks





Drop 21 respondents with RLH below 0.5 + 138 further respondents who randomly clicked??

Other filter criteria? (e.g. repeated left clicks)

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Preliminary Results: Average willingness to pay (WTP) for different attribute levels (Using Hierarchical Bayes)

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Frequency of 50 peaks per year does not create disutility; *Aversion to 100 peaks per year*

Expected sequence for peak price

Limiting demand to 1 device is preferred; *Aversion to using "no large appliances"*

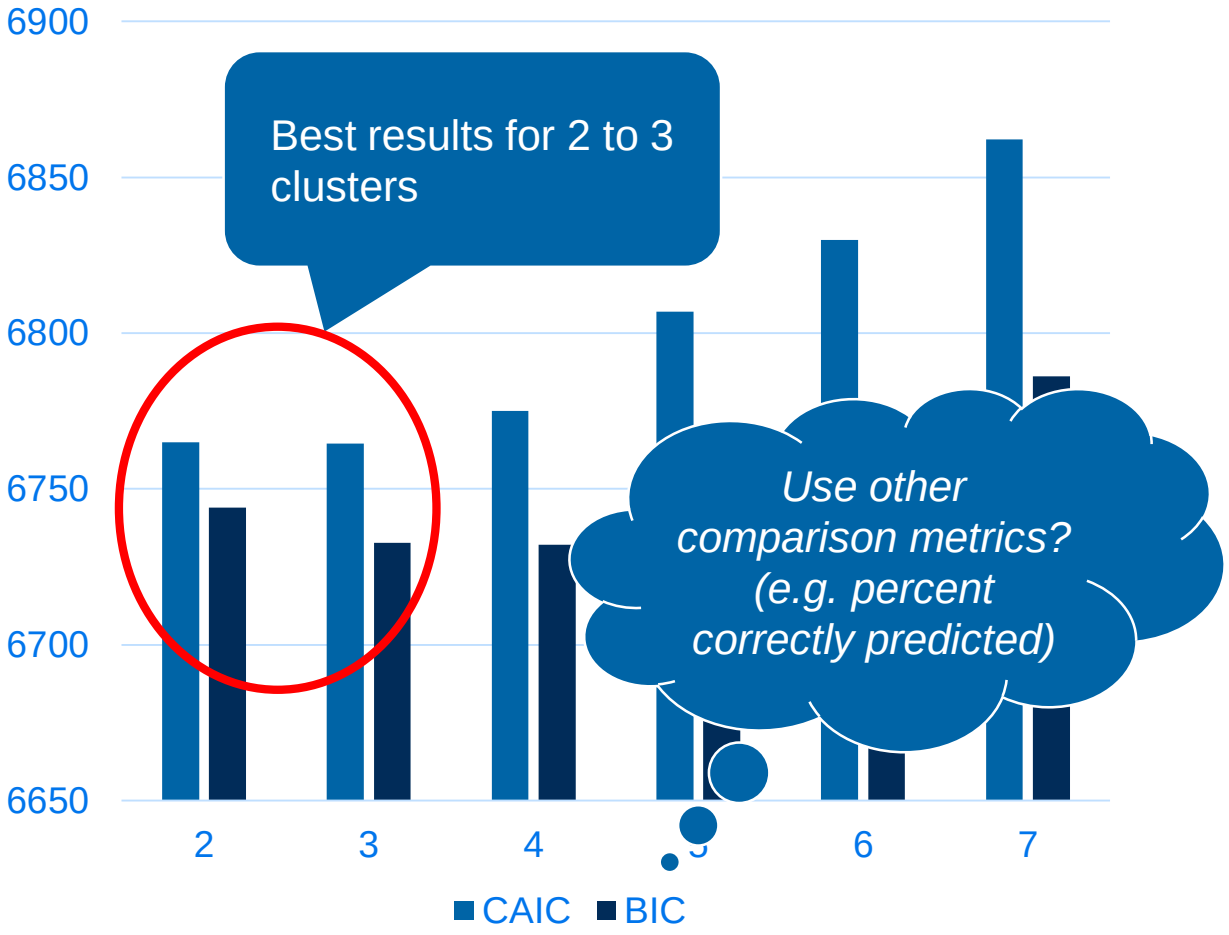
Users prefer limitation of specific appliances

Monthly fee is most important criterion *Strong aversion to high monthly fees*

Preliminary Results: Respondent Clusters (Using Latent Class Analysis)

Test other clustering methods?

Akaiken Information Criterion (AIC) and Bayesian Information Criterion for Different number of groups:



Number of respondents in each group:

3 Groups

2 Groups	1	2	3	Total
1	0	6	172	178
2	313	86	5	404
Total	313	92	177	582

3-Group solution divides largest group from 2-group solution

Preliminary Results: Willingness to pay (WTP) for different attribute levels (Using Latent Class Analysis)

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	kWh
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Automa	
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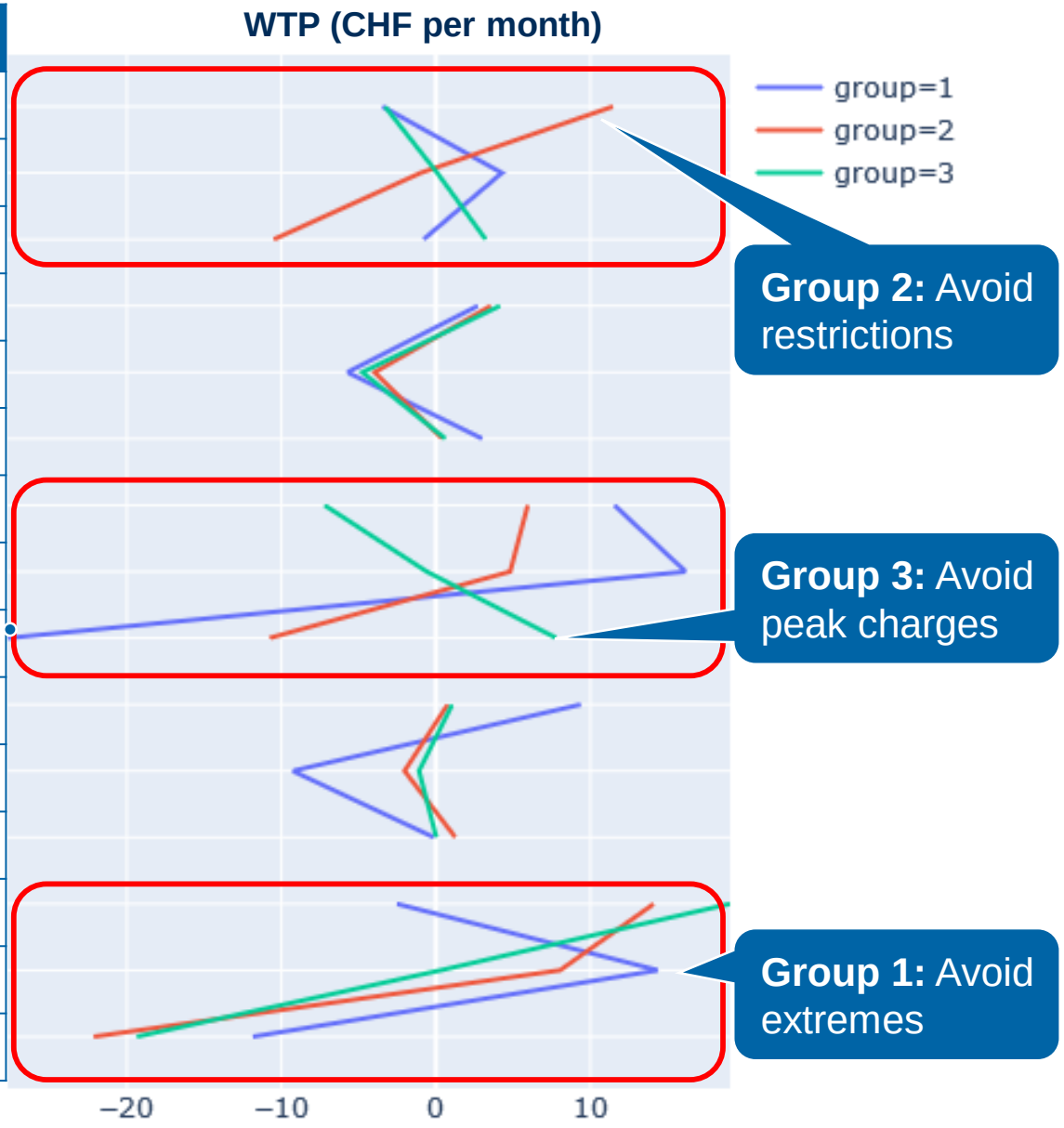
Does disutility depend on: frequency, additional during peak periods?

To what extent can utility be explained by demographic variables?



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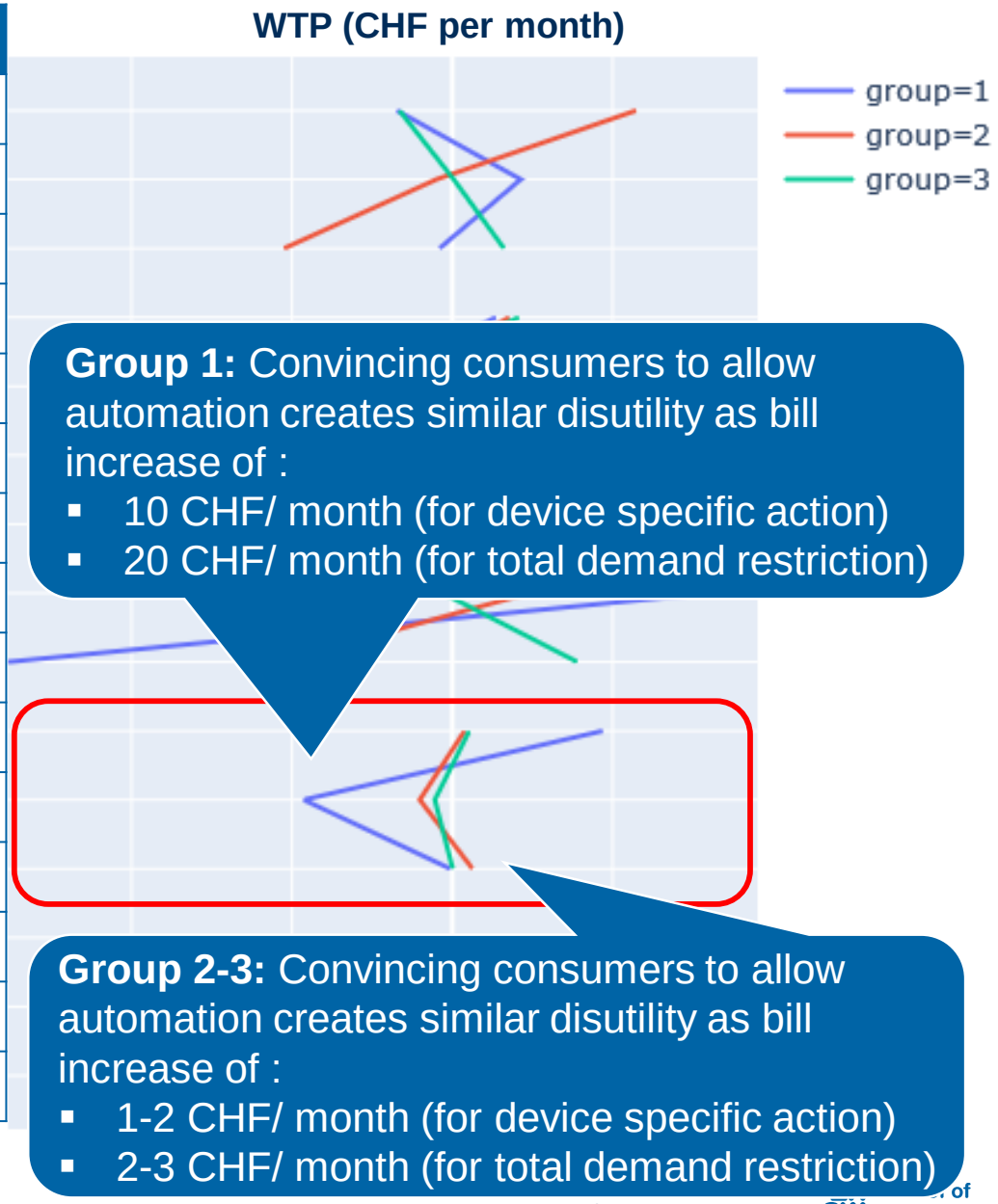


Group 1: Convincing consumers to allow automation creates similar disutility as bill increase of :

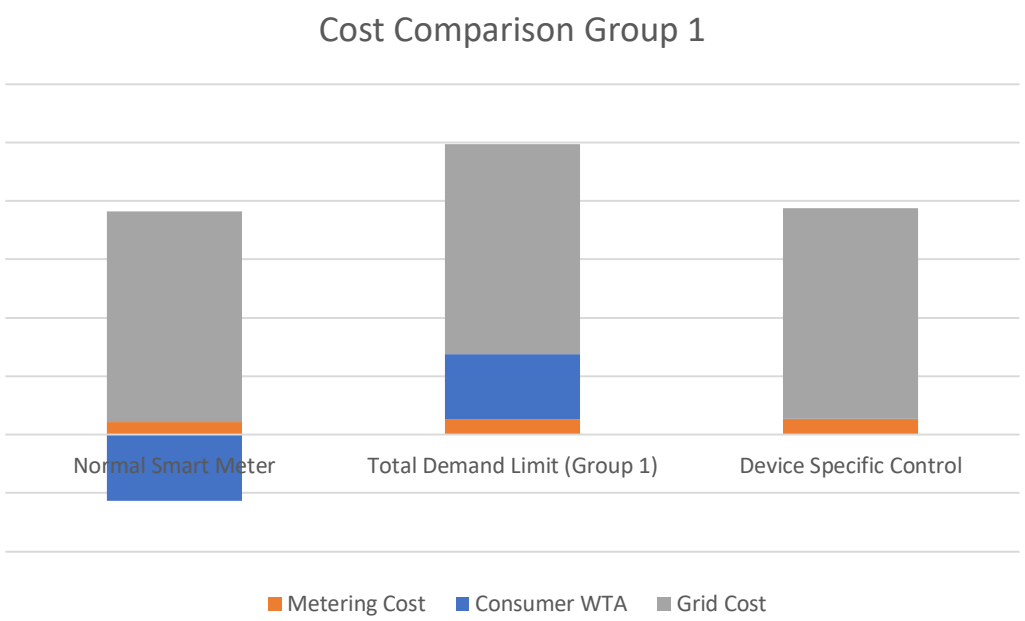
- 10 CHF/ month (for device specific action)
- 20 CHF/ month (for total demand restriction)

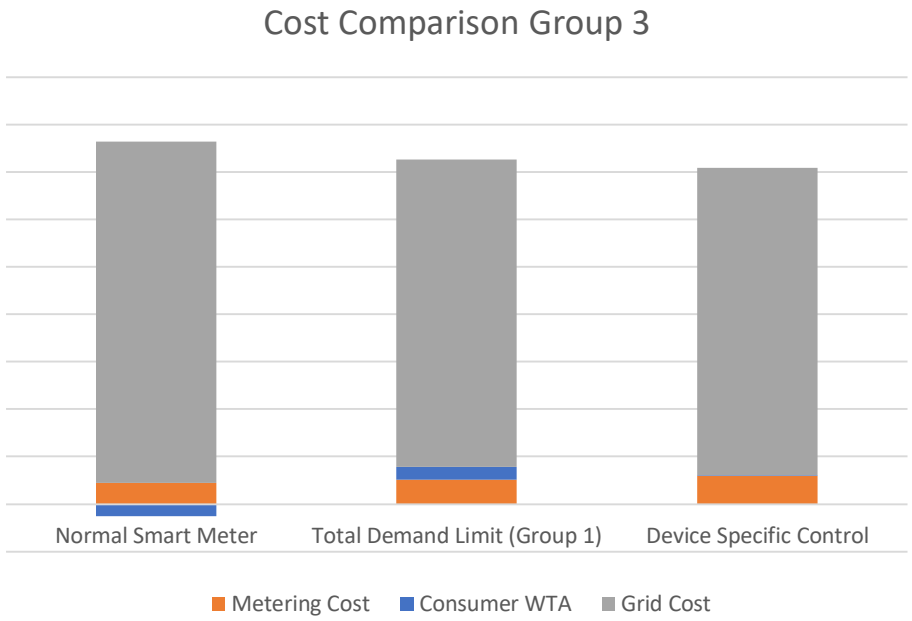
Group 2-3: Convincing consumers to allow automation creates similar disutility as bill increase of :

- 1-2 CHF/ month (for device specific action)
- 2-3 CHF/ month (for total demand restriction)

Potential implications for smart-meter roll-out

Efficiency of load limiting devices depends on sum of:
metering cost + consumer WTP + grid expansion cost…





- Consumers prefer device specific control
- Grid expansion cost is much larger than the other cost components
- What is strategic value of „ability to introduce load limitations if needed“?

Thank you.