Zurich University
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School of
Management and Law

Optimal design of grid tariffs

Building Competence. Crossing Borders.

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FESS Roundtable
03.11.2021

Agenda

- NETFLEX overview
- First results
  i. Cost-drivers
  ii. Tariff-acceptance
  iii. Tariff-impacts
- Conclusions

Overview of NETFLEX project

WP1:	• Grid expansion planning (conventional)
WP2	• Cost-driver analysis
WP3	• Tariff-acceptance and load-shifting cost
WP4	• Tariff-impacts and optimal tariff design
WP5	• Grid expansion planning (with flexibilities)

Further Infos: https://www.aramis.admin.ch/Texte/?ProjectID=44252

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i. Grid cost driven by number and location of connection points, as well as contributions to maximum grid load

DOSSIER | ENERGIENETZE

Kostenwahrheit im Verteilnetz

«Netflex» | Die ZHAW und Elena International gehen in einem vom Bundesamt für Energie geförderten Projekt gemeinsam der Frage nach, wie Netzentgelte verursachergerecht gestaltet werden können. Am Beispiel des Netzes von Eniwa werden in diesem Beitrag erste Zwischenergebnisse des nach wie vor aktiven Projekts aufgezeigt.

Quelle: VSE-Bulletin 2021-05

Einflussfaktor	Verursacher			
	Nutzer	VNB	Be	
1. Beitrag zur Netzhöchstlast: davon abhängig, welche Erzeugungsanlagen und Lasten ans Netz angeschlossen werden und wie flexible Lasten und Produktion gesteuert werden.	X			
2. Anzahl & Lage der Anschlusspunkte: davon abhängig, wo und über wie viele separate Anschlusspunkte Erzeuger und Verbraucher ans Netz angeschlossen werden.	X			
3. Gebietseigenschaften: davon abhängig, wo Stromverbraucher angeschlossen werden und wie das Gebiet anderweitig genutzt wird.	X			X
4. Geforderte Servicequalität: davon abhängig, welche Ansprüche die Nutzer, Netzbetreiber und Regulierung an die Servicequalität stellen.	X	X	X	
5. Mögliche Leitungsstrassen: davon abhängig, welche Trassenführung von der Regulierung zugelassen, von der Bevölkerung akzeptiert und bei der Planung berücksichtigt wird.		X	X	
6. Netzstruktur und Betriebsmittelwahl: davon abhängig, welche Strukturprinzipien und Betriebsmittel bei der Planung berücksichtigt und zugelassen werden.		X		
7. Planungs- und Betriebsmittelkonzept: davon abhängig, welche Ansätze für die Planung der Investitionen und des Betriebs verwendet werden.		X		
8. Beschaffung, Bau und Betrieb: davon abhängig, wie effizient Komponenten beschafft, errichtet und betrieben werden.		X		
9. Abschreibungsvorschriften und -praxis: davon abhängig, welche Abschreibungsansätze durch die Behörden genehmigt und von den Netzbetreibern angewendet werden.		X	X	
10. Externe Faktorpreise: davon abhängig, wie sich die Marktpreise für Rohstoffe, Bau und Betrieb entwickeln, und zu welchem Zeitpunkt Investitionen getätigt wurden.		X		X

Tabelle 1 Übersicht möglicher Kostentreiber.

~40% of grid cost?

~60% of grid cost?

More data needed for reliable quantification of cost impacts!

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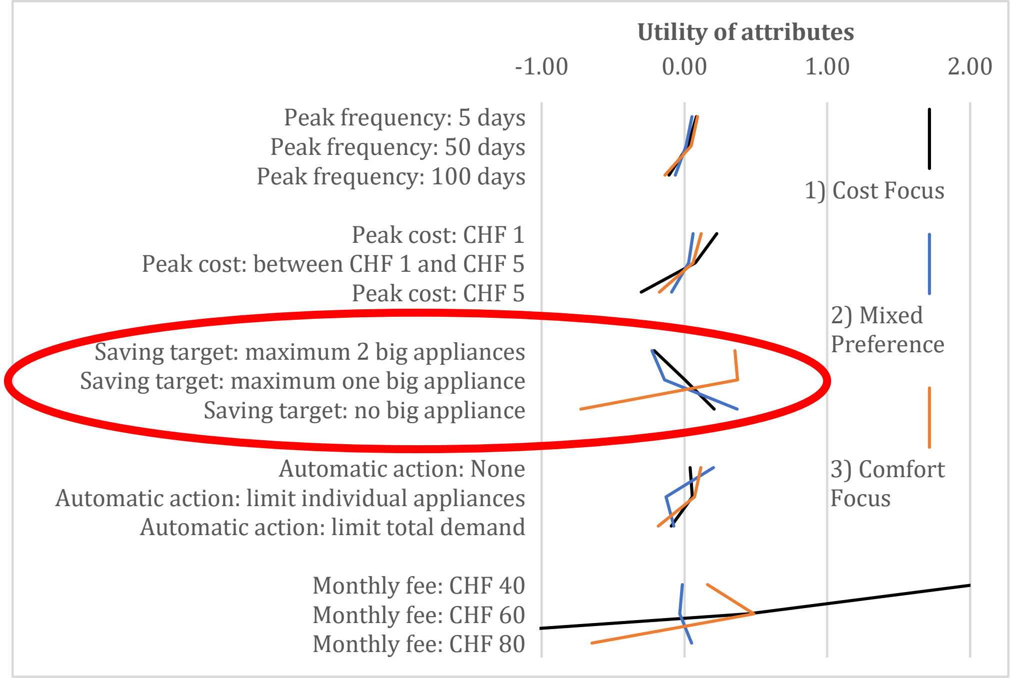
Overview of tariffs that were analyzed

1. Basecase: Uniform energy, grid and taxes/levies: uniform price per kWh (FLAT)
2. Grid: Time-of-use Tariff (ToU)
3. Grid: Critical-Peak Price during selected individual hours (CPP-h)
4. Grid: Critical-Peak Price during fixed times on selected days (CPP-d)
5. Grid: Capacity charge on individual peak-load (Capacity)
6. Grid: Continuous price signal, proportional to grid-load (Gridload)
7. Grid: Direct Load Control (DLC)
8. Energy: Spot-pricing (Spot)

ii. Some customers focus on cost, others on comfort

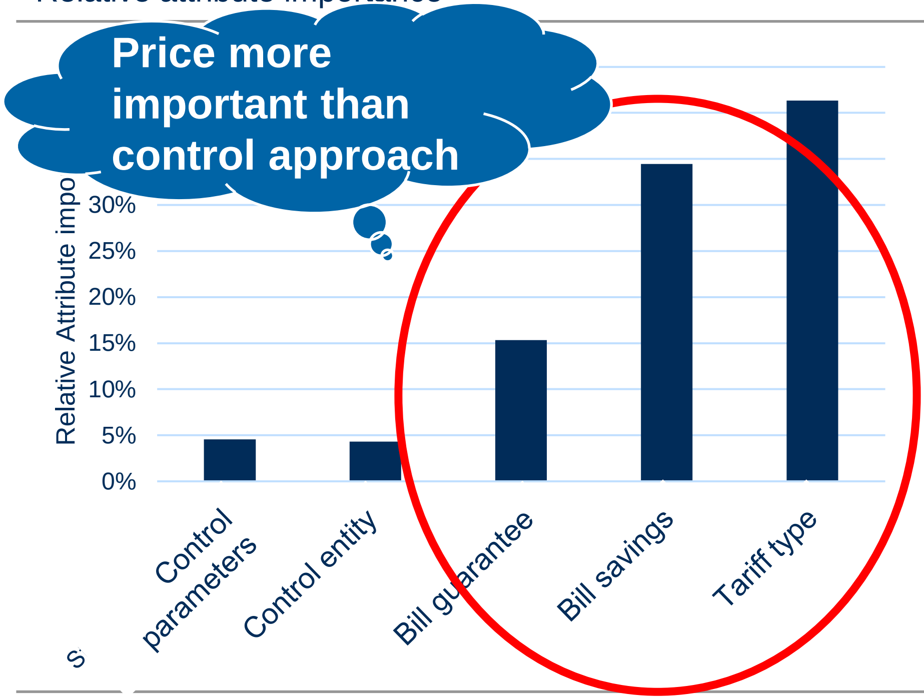
Customers with **cost-focus** welcome automatic load-control as means to avoid price peaks and lower their electricity bills.

Customers with **comfort-focus** prefer to pay more for an oversized grid to avoid price peaks and automatic load-control.

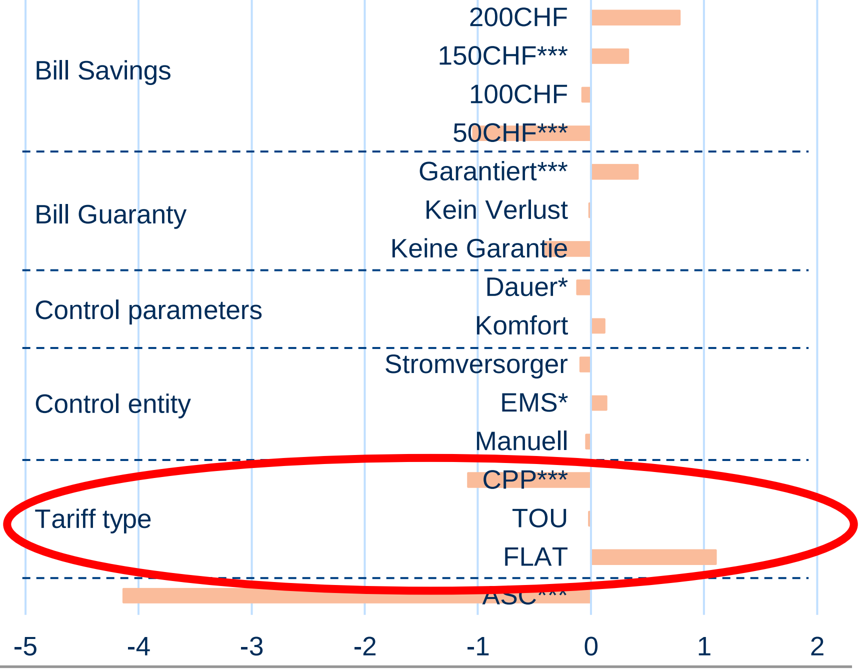


ii. Customers prefer tariffs with lower price volatility

Relative attribute importance



Mixed-Logit-Model Output



* p<0.05, ** p<0.01, *** p<0.001

ii. Recruitment strategy is more important than tariff-approach

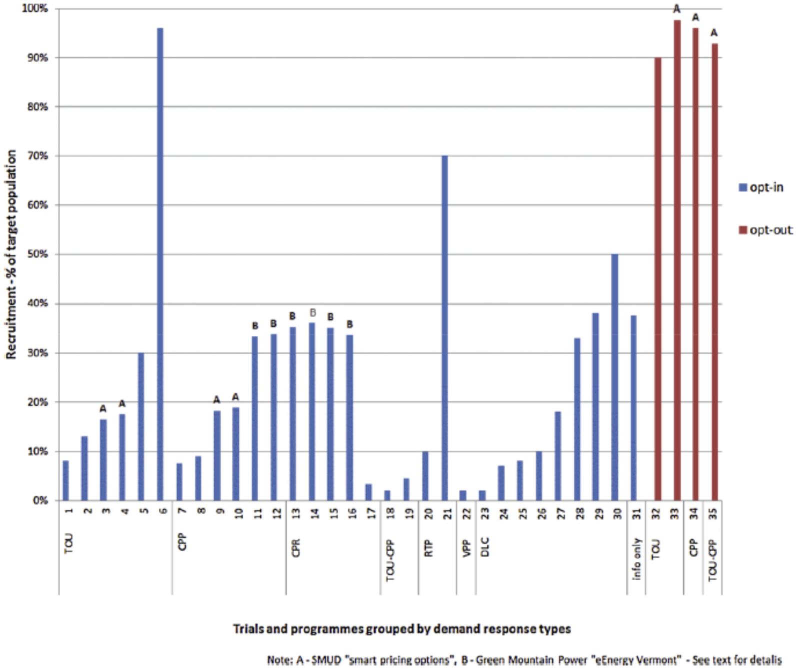


Fig. 3. Reported recruitment by type of demand response[5].

Variation between studies for different tariff approaches smaller than

a) Variation between studies of same tariff type, and
b) Variation between opt-in vs. opt-out recruitement

Source: Parrish, B., Gross, R., & Heptonstall, P. (2019). On demand: Can demand response live up to expectations in managing electricity systems? *Energy Research & Social Science*, *51*, 107–118. https://doi.org/10.1016/j.erss.2018.11.018

ii. Opt-out increases recruitement %, but reduces response %

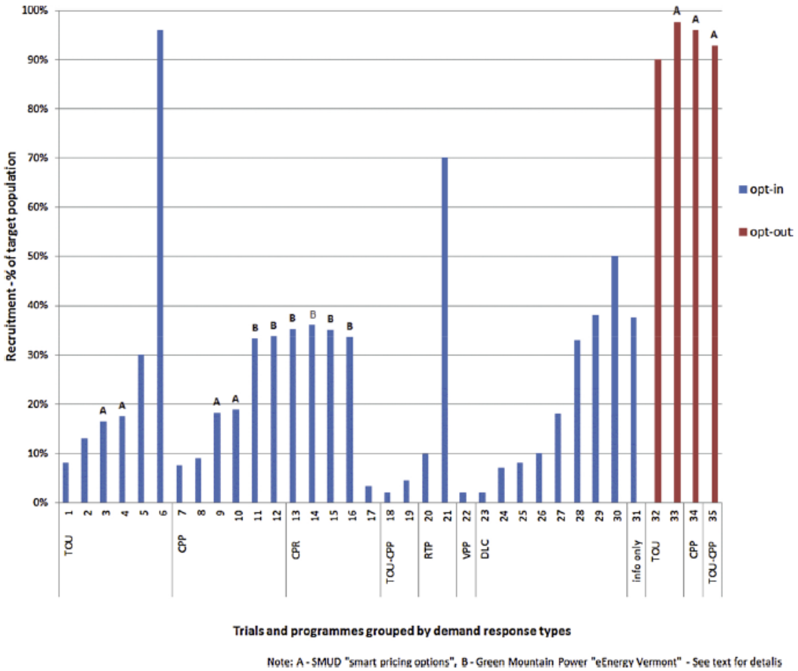


Fig. 3. Reported recruitment by type of demand response[5].

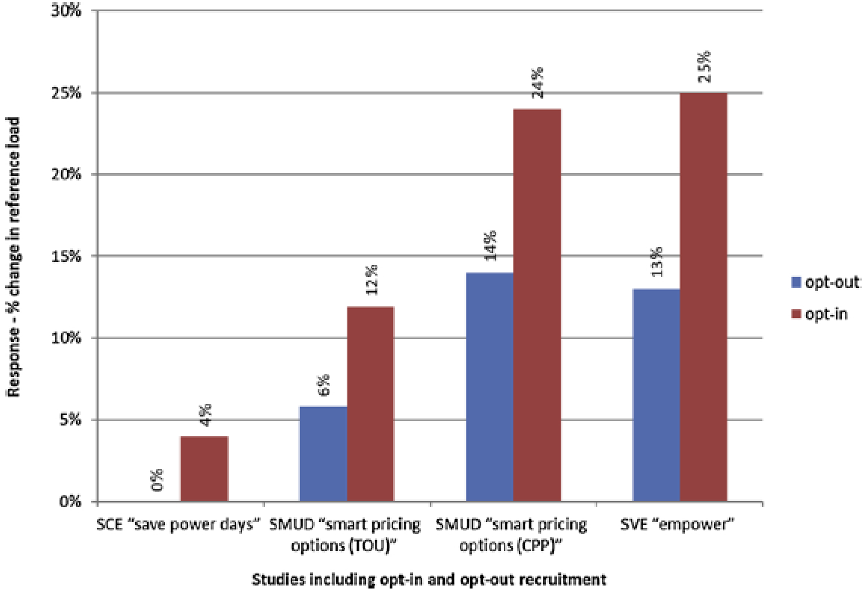


Fig. 6. The impact of opt-in and opt-out recruitment on reported responses [35,52,53].

Source: Parrish, B., Gross, R., & Heptonstall, P. (2019). On demand: Can demand response live up to expectations in managing electricity systems? *Energy Research & Social Science*, *51*, 107–118. https://doi.org/10.1016/j.erss.2018.11.018

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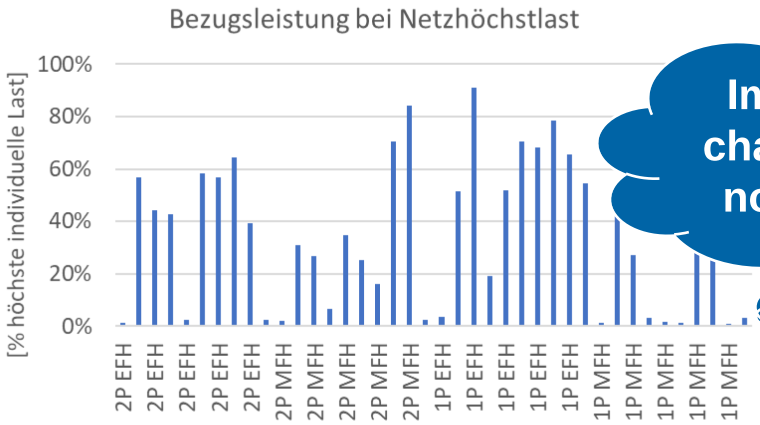
iii. Capacity tariffs hardly reduce maximum grid-load



Source: Own analysis.

Impact on EV charging power not included !

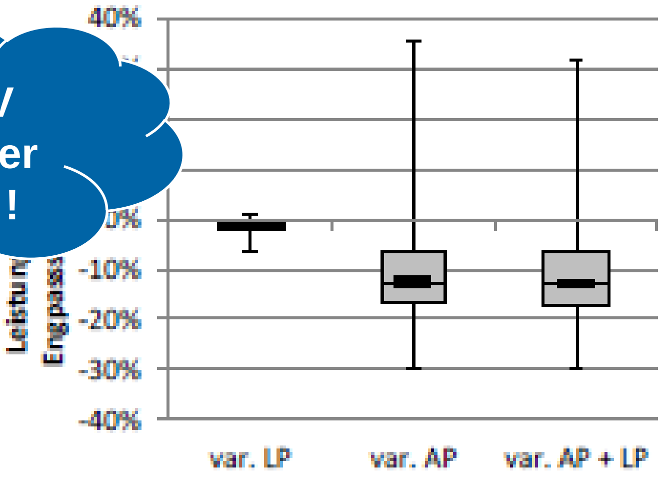
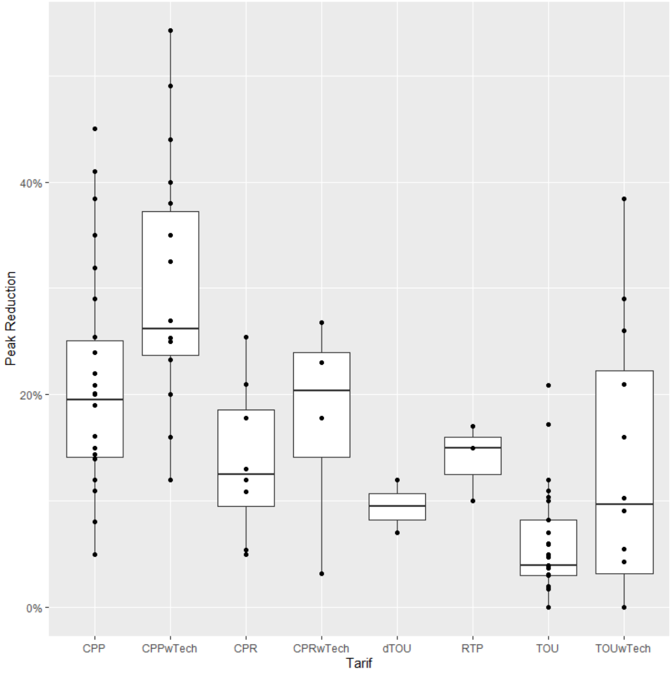


Abbildung 7.11: Box-Plot-Diagramme der Leistungsänderung in Engpass-situationen der betrachteten Szenarien

Source: Hayn, M. (2016). Modellgestuetzte Analyse neuer Stromtarife fuer Haushalte unter Beruecksichtigung bedarfsorientierter Versorgungssicherheitsniveaus. KIT Scientific Publishing.

iii. Automatic load-control and higher price peaks increase peak-reduction



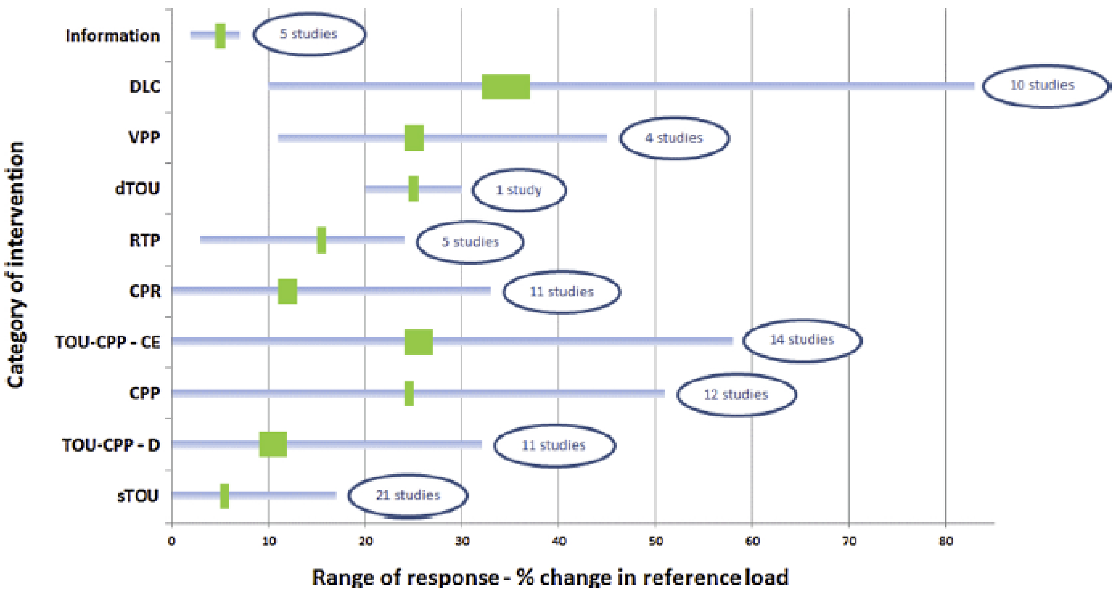


Fig. 4. Summary of reported responses, grouped by treatment type[6] .

Source: Own analysis by Patrick Ludwig.

Source: Parrish, B., Gross, R., & Heptonstall, P. (2019). On demand: Can demand response live up to expectations in managing electricity systems? *Energy Research & Social Science*, *51*, 107–118. https://doi.org/10.1016/j.erss.2018.11.018

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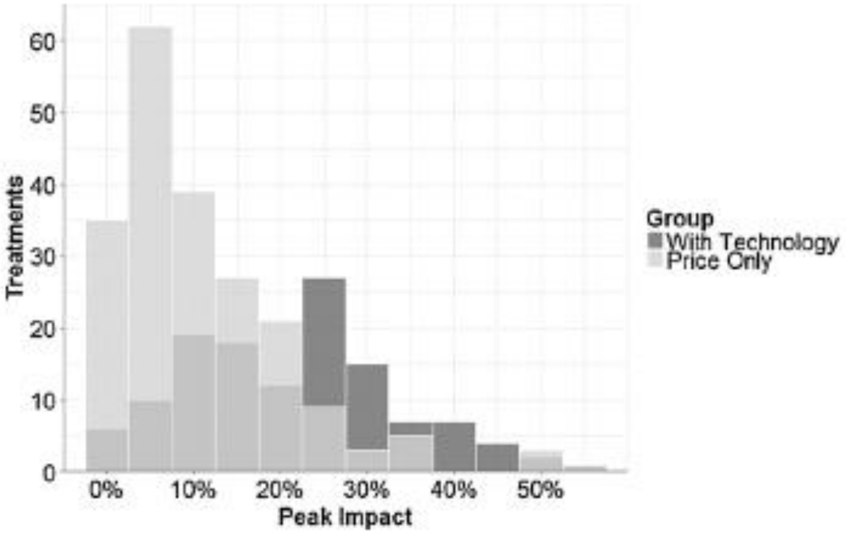


Fig. 8. Comparison of all treatments.

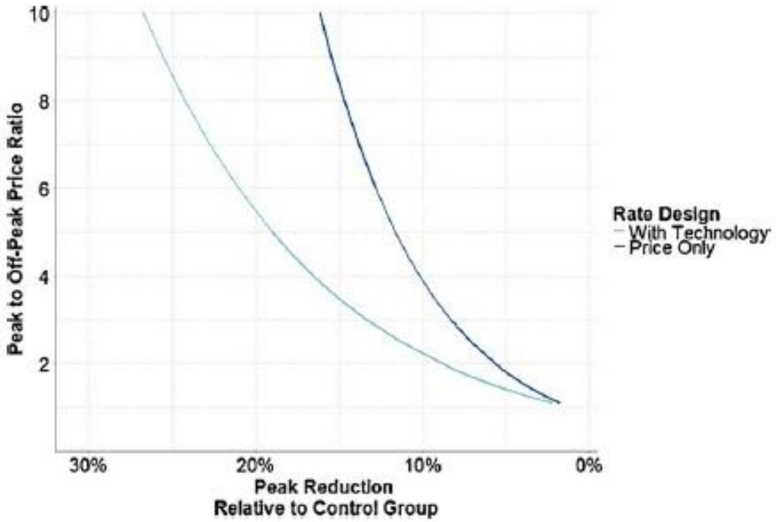
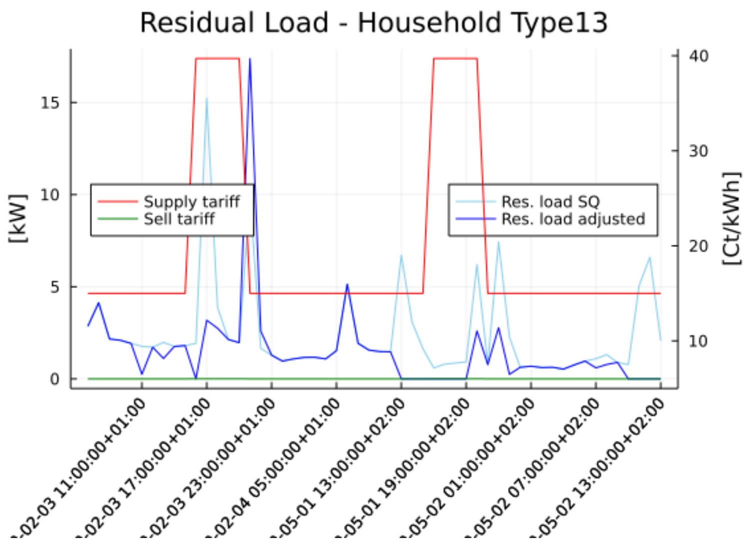
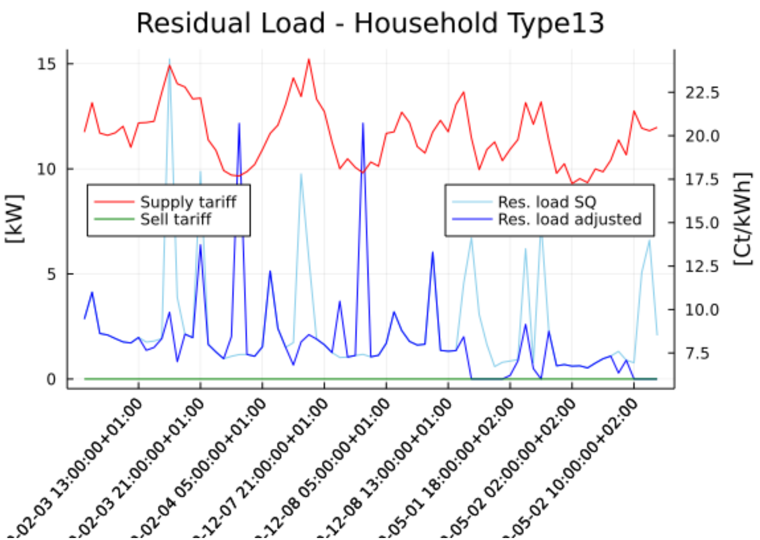


Fig. 14. The arc of price responsiveness.

Source: Faruqui, A., Sergici, S., & Warner, C. (2017). Arcturus 2.0: A meta-analysis of time-varying rates for electricity. The Electricity Journal, 30(10), 64–72. https://doi.org/10.1016/j.tej.2017.11.003

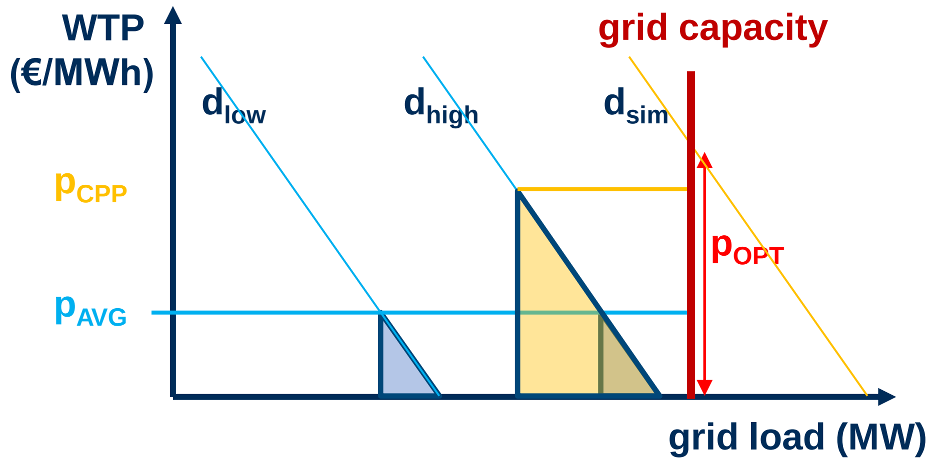
iii. Rebound peak can be reduced by continuous tariff signals





Source: Faruqui, A., Sergici, S., & Warner, C. (2017). Arcturus 2.0: A meta-analysis of time-varying rates for electricity. The Electricity Journal, 30(10), 64–72. https://doi.org/10.1016/j.tej.2017.11.003

iii. Direct load control avoids welfare losses of dynamic prices



- Oversizing grids is often economical (econ. of scale, lumpy investments)
- Optimal control: during scarcity: reliable, cost-based rationing
- Optimal control: all other times: no restriction

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Conclusions

Capacity tariffs:

- small impact on grid peak-load

-> *Limited benefits*

Time-varying prices:

+ decentral optimisation without need for coordination between flexibility users (TSO, DSO etc.)

- less popular than flat tariffs and may lead to rebound peaks (except in case of gridload tariff)

-> *Useful for customers that do not accept DLC*

Direct load control:

+ does not require (unpopular) volatile prices, avoids rebound peaks, minimizes welfare losses, and guarantees a reliable control during scarcity

- requires central optimisation and coordination between flexibility users (TSO, DSO etc.)

-> *Preferred option for customers that accept DLC*

Next steps

- **WP4: Quantify impact of different tariffs, for different scenarios in sample grid:**
  - **Original peak, rebound peak and resulting grid cost**
  - **Distributional impacts and profitability of new technologies (EV, PV, HP, Battery)**
- **WP5: Compare grid expansion need of concrete distribution grid for best performing tariffs**
- **Follow-up projects:**
  - **Different levels of service quality**
  - **Comparison with other incentives (flexibility markets etc.)**

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Thank you for your attention!