

From solar prosumers to flexible prosumers? On incentives for solar prosumers from power grid tariffs to provide flexibility for smart grids

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In cooperation with the CTI

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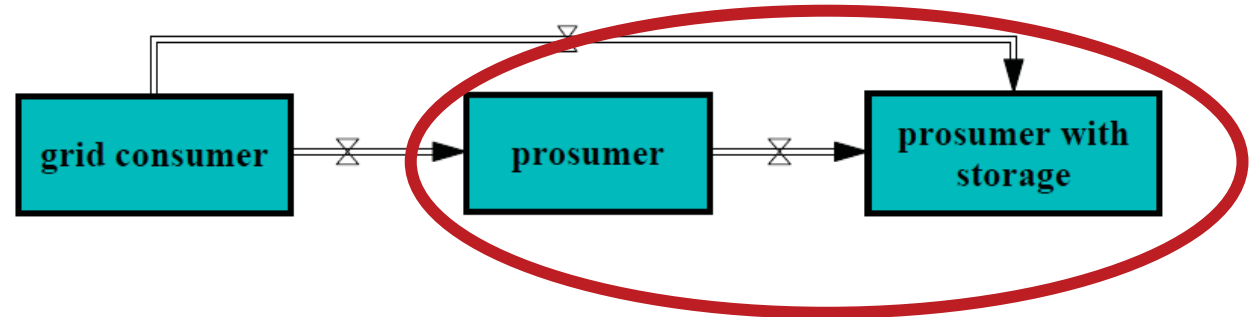
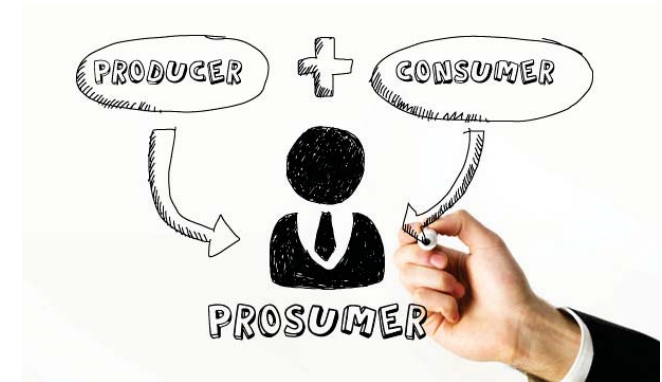
Emergence of a new concept – solar prosumers



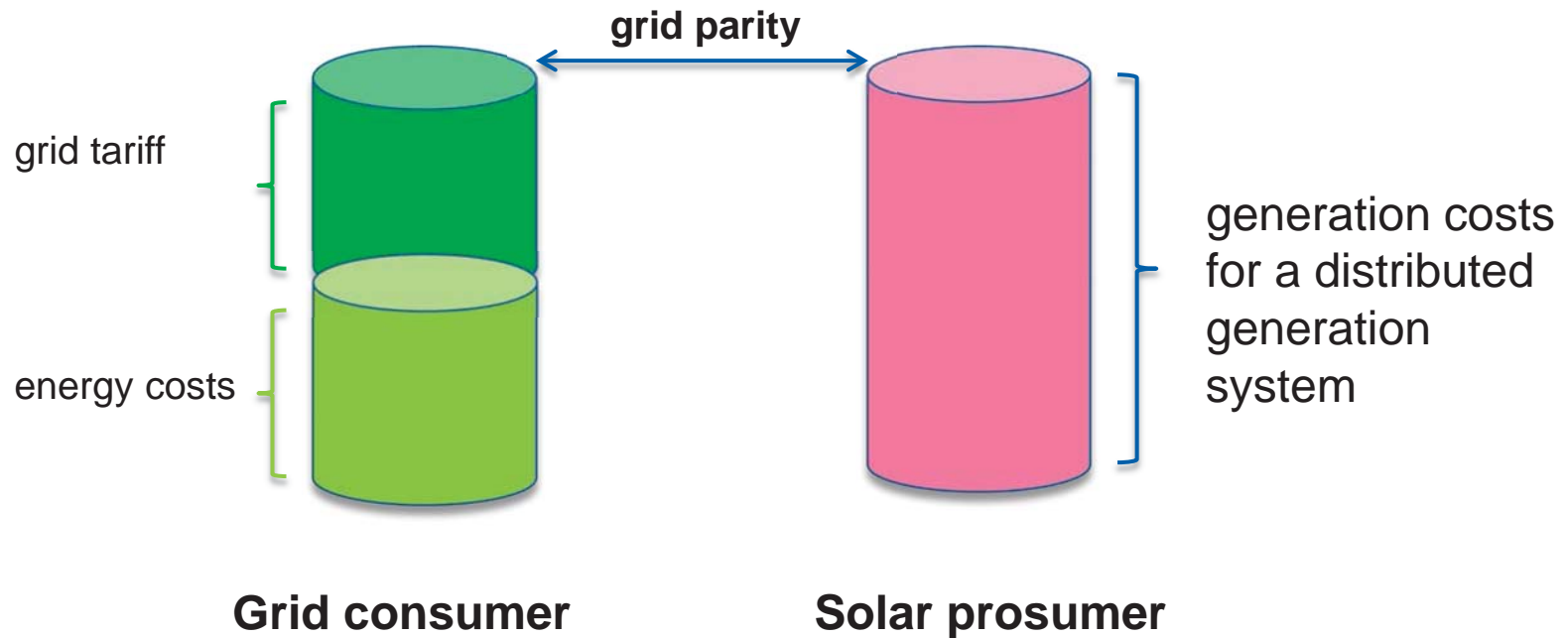
Work Package 1: Energy, Innovation, Management



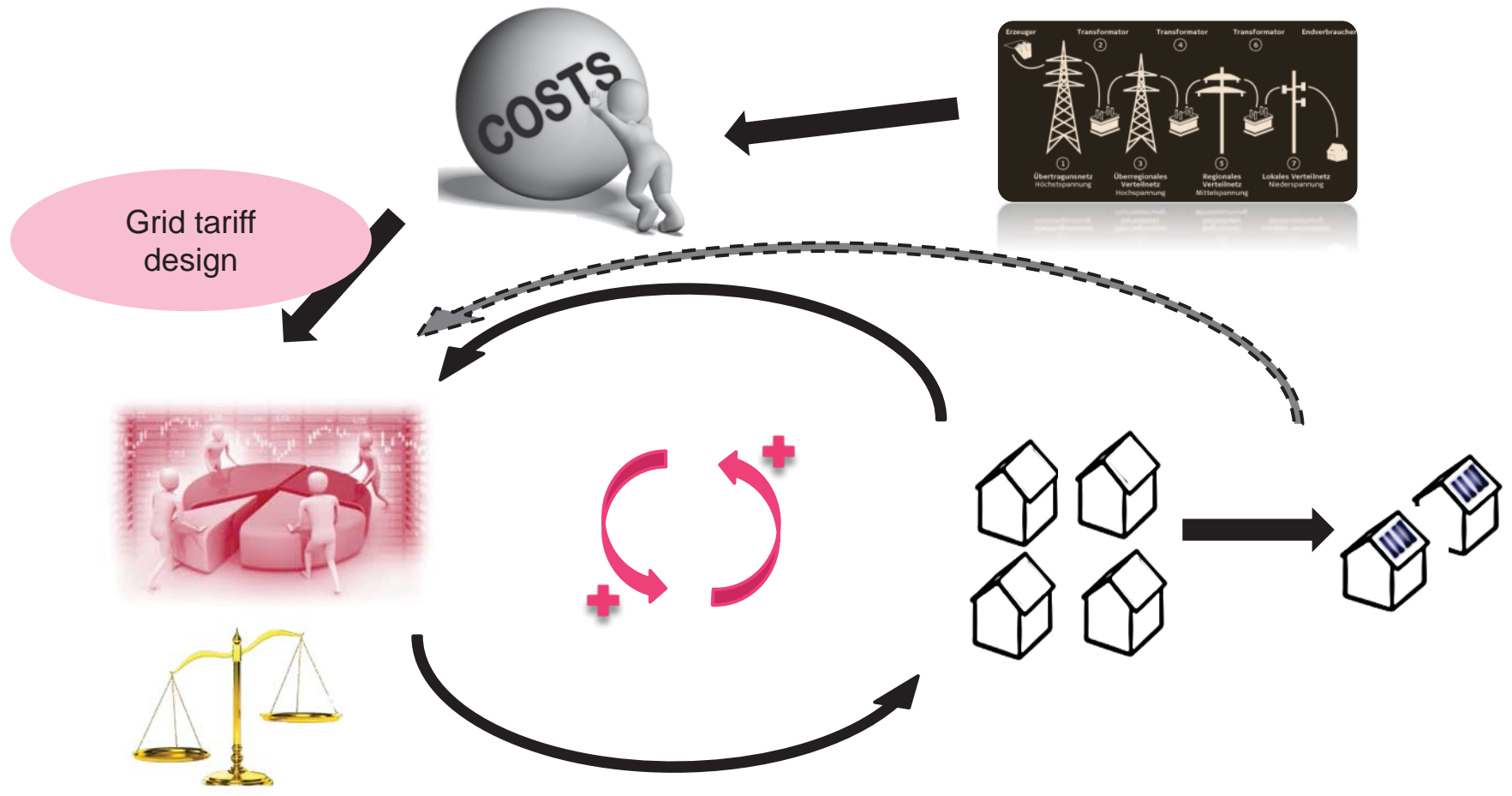
Task 1.3.1: Transition of regional energy systems



Economic benchmark for solar prosumers? – Grid parity



Impact of solar prosumers on cost-recovery of distribution grids



Dilemma – two perspectives



vs.



➤ **Death spiral**

For cost-recovery of grid operators
and electric utilities

➤ **Sunny circle**

For energy politic targets, solar
industry, self-consumers

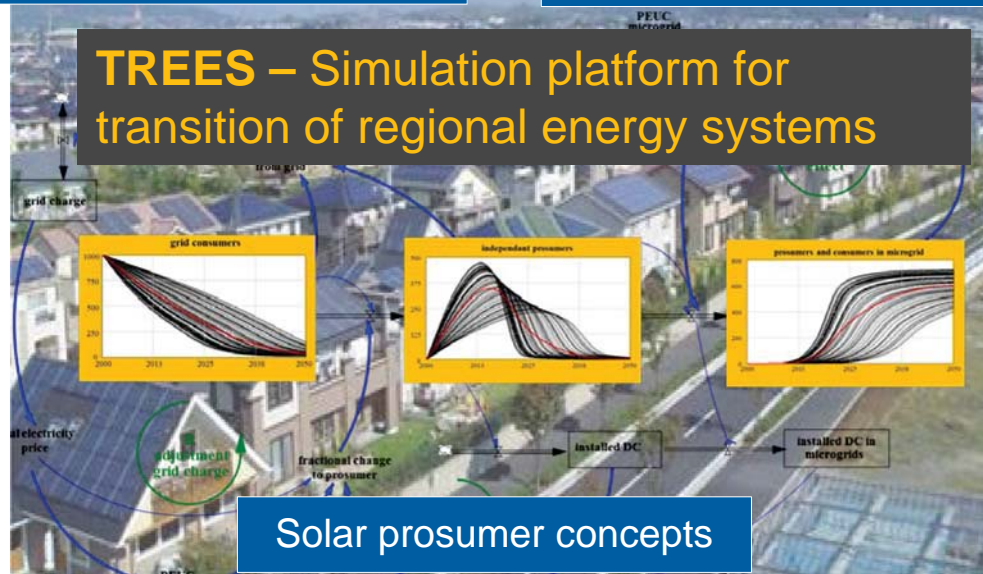
Research question

1. What is the impact of variants in **grid tariff designs** on the **diffusion of solar prosumers**?
2. Are solar prosumers tending to adapt a **peak demand optimized behavior** under a **capacity grid tariff**?

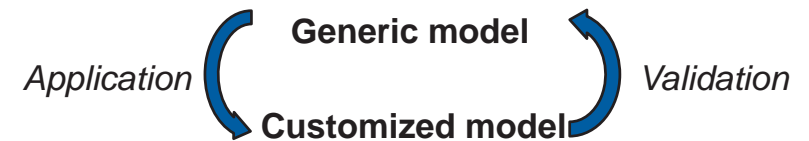
Our approach: Virtual strategy experiments with TREES

Decentralization dynamics

Flexibility business models



Desktop-Research & Empiricism



Workshops with stakeholders



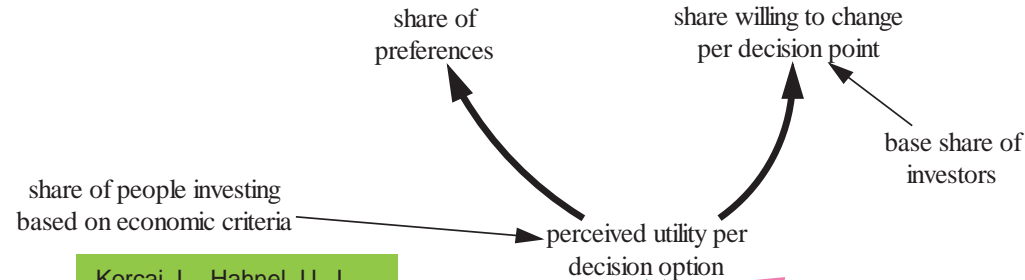
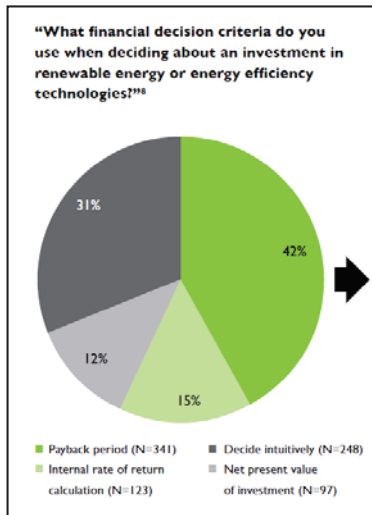
Reference: Ulli-Beer, Kubli, Zapata et al. (2017, forthcoming)

System Dynamics simulation model for virtual experiments

Main model components:

- **Cost recovery:** Adjustment of the grid tariff
- **Peer effects:** Positive effect on perception through neighbour hood effects
- **Investor-roof match:** Probability that an interested investor also has a suitable roof
- **Scarcity effect:** Limited potential of solar PV

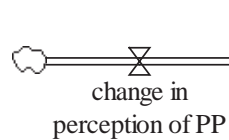
Modelling of the investment decision with insights from empirical research



“... respondents were asked to ‘leave aside cost’ whilst considering installing solar thermal or solar PV. On this basis, **23%** of households were ‘very likely’ to consider it, with another **34%** ‘fairly likely’.” Balcome et al (2014)

Korcaj, L., Hahnel, U. J. J., & Spada, H. (2015)

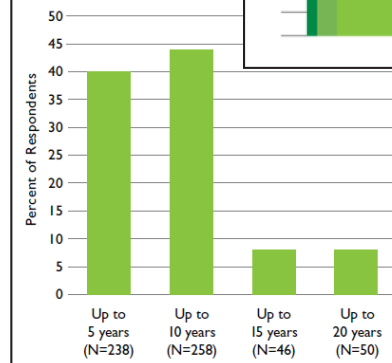
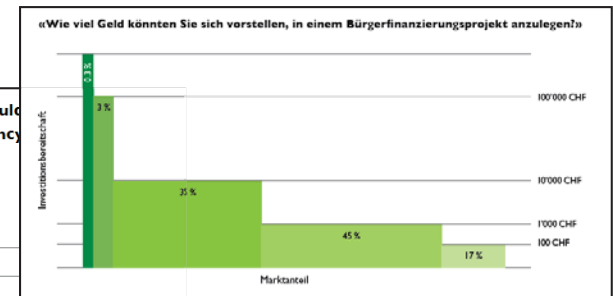
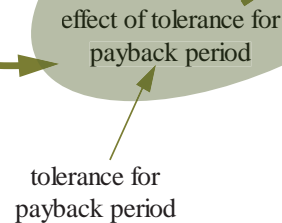
look up effect of ppp on green investors



effect of ppp on green investors




perceived utility by economic investors

“In how many years should energy or energy efficiency itself back?”



Quelle: Kundenbarometer 2014 & 2015, Institut für Wirtschaft und Ökologie, Uni St. Gallen

Solar prosumer concepts in the model

| | Installed capacity | Share consumption from grid ^[1] | Net demand in kWh/a ^[2] | Share excess energy ^[1] | Peak demand in kW ^[3] | Optimized peak demand ^[3] ^[4] | |
|---|-------------------------------|--|------------------------------------|------------------------------------|----------------------------------|--|---------|
|  | Grid consumer [SFH] | | 4'520 | | 6 kW | 5.5 kW | |
| | Grid consumer [MFH] | | 24'408 | | 25 kW | 23 kW | |
| | Grid consumer [CC] | | 90'000 | | 100 kW | 90 kW | |
|  | Prosumer [SFH] | 10 kW PV | 65% | 2'938 | 80% | 6 kW | 5 kW |
| | Prosumer [MFH] | 20 kW PV | 70% | 17'086 | 65% | 25 kW | 21 kW |
| | Prosumer [CC] | 30 kW PV | 70% | 63'000 | 10% | 90 kW | 72 kW |
|  | Storage prosumer [SFH] | 10 kW PV 9 kWh battery | 25% | 1'130 | 60% | 4.2 kW | 3 kW |
| | Storage prosumer [MFH] | 20 kW PV 35 kWh battery | 38% | 9'275 | 75% | 17.5 kW | 12.5 kW |
| | Storage prosumer [CC] | 30 kW PV 35 kWh battery | 65% | 58'500 | 0% | 70 kW | 50 kW |



SFH: Single-family house
MFH: Multi-family house
CC: Commercial customer

^[1] [Weniger et al., 2014](#)

^[2] BKW Energie AG for their supply area. The consumption of a commercial customer is an assumption.

^[3] [Santos et al. \(2014, p. 259\)](#)

^[4] [Veldman et al. \(2013\)](#)

Overview on simulation scenarios

Application context:

- Supply area of BKW, Switzerland
- Current regulations of Switzerland
- Technology learning curves for PV and batteries
- Increase of distribution grid costs as estimated by the Swiss Federal Office of Energy

| Scenarios | (1) Volumetric tariff | (2) Capacity tariff | (3) Capacity tariff with option for peak reduction |
|--------------------|--------------------------------|--------------------------------|--|
| Grid tariff design | Volumetric | Capacity | Capacity |
| Metering design | Net purchase and sale | Net purchase and sale | Net purchase and sale |
| PV Reimbursement | Investment grant for PV of 30% | Investment grant for PV of 30% | Investment grant for PV of 30% |



Scenario (1): Volumetric grid tariff

There is a clear trend towards self-consumption. Besides the solar prosumer concept, also solar prosumer with storage diffuse widely.

Unpublished research
(Forthcoming publication in the journal «Energy Policy»)

Scenario (2): Capacity tariff

The capacity tariff hampers the diffusion of self-consumption concepts. Solar prosumers with storage becomes relatively more attractive, as the peak demand can be reduced. Despite additional storage the self-consumed power is less than under the volumetric tariff.



Unpublished research
(Forthcoming publication in the journal «Energy Policy»)

Scenario (3): Capacity tariff with option for peak demand reduction

Assumptions

- Peak reduction of 8% for grid consumers, 18% for prosumers, 50% for storage prosumers (compared to the initial peak demand) (Veldman et al (2013)).
- Reduction of self-consumption of storage prosumers by 20% (Santos et al, 2014)
- Costs of peak reduction control are ignored

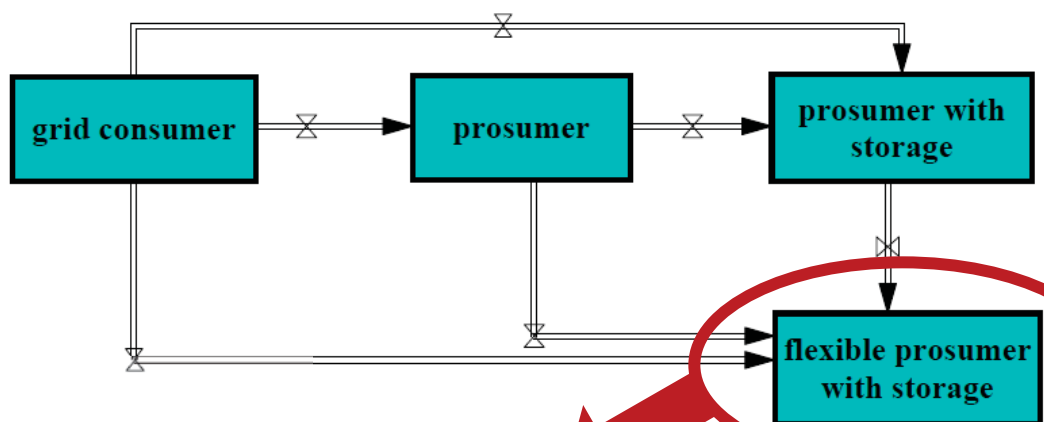
Scenario (3): Capacity tariff with option for peak demand reduction

Most solar prosumers change the optimization strategy – from self-consumption maximization to peak demand reduction.
For commercial consumers a peak optimized consumption is only profitable from 2025 on.



Unpublished research
(Forthcoming publication in the journal «Energy Policy»)

Research avenues: Integrating solar prosumers in flexibility business models



SCCER joint activities



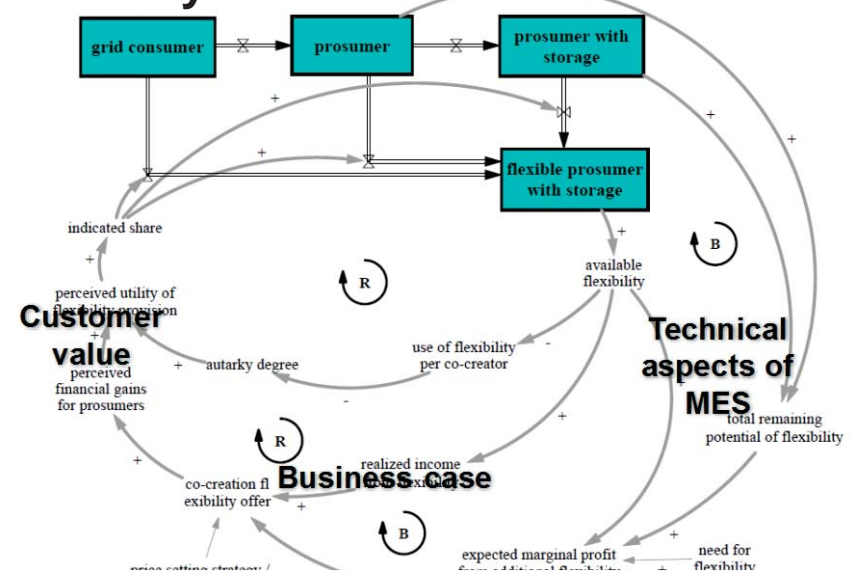
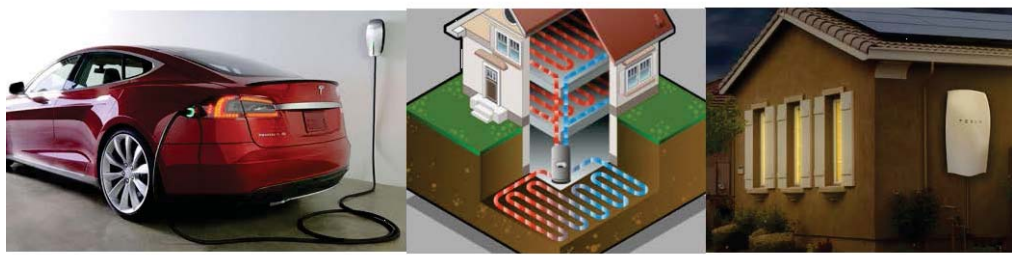
Investigating prosumers' willingness to provide flexibility in three technology areas

Long-term value creation with flexibility business models

1) Electric Vehicles

2) Heat Pumps

3) PV + Battery

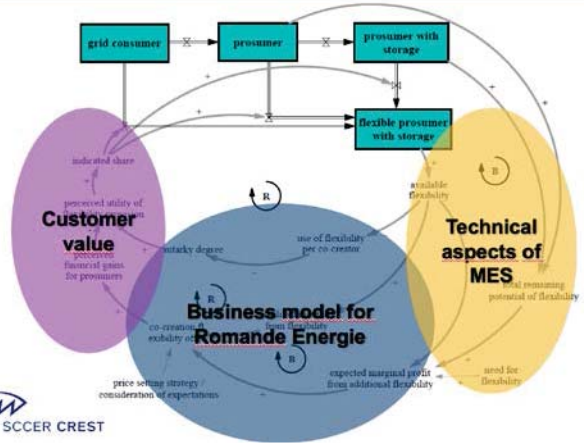


Research avenues: Flexibility business models for electric utilities – SCCER joint activities

Romande Energie demonstrator



JA Romande Energie
Main components of the model



Arbon Energie demonstrator

Arbon Energie
Quartierbatterie - Lokalisierung Solaranlagen



→ Wo ist der optimale Standort für eine Quartierbatterie?

Arbon Energie: Hybrid-Geschäftsmodelle für eine simulationsbasierte Analyse

| | Geschäftsmodell | Tarif | Dienstleistung | Technologien |
|---|--|------------|--|---|
| A | Eigenverbrauch & Quartierbatterie | RTP | Zentralspeicherung • Pay per use • Subscription | PV Boiler Wärmepumpen Batterien ICT-Steuerung |
| B | Quartierstrom und -batterie (peer-to-peer) | | Zentralspeicherung • Pay per use • Subscription Peer-to-peer Infrastruktur • License • Subscription Messung und Abrechnung | PV Boiler Wärmepumpen ICT-Steuerung |
| C | Mieterstrom zum Flatrate-Tarif | Flat | Messung und Abrechnung | PV Micro-KWK |
| D | Aggregator mit dynamischen Tarifen | RTP CPP | | Wärmepumpen ICT-Steuerung Micro-KWK |

→ Simulationsmodell:
Kunden-Dynamik, Verbreitungsdynamik, Wirtschaftlichkeit

Thank you for your attention!

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SCCER CREST

References

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Ulli-Beer, S., Kubli, M., Zapata, J., Wurzinger, M., Musiolik, J. & Furrer, B. (2017, forthcoming). Participative modelling of decentralisation dynamics in energy systems: Why and how should we look beyond the case specific modelling challenge?

Kubli, M., & Ulli-Beer, S. (2016). Decentralisation dynamics in energy systems: A generic simulation of network effects. *Energy Research & Social Science*, 13, 71-83. doi:<http://dx.doi.org/10.1016/j.erss.2015.12.015>