Analysis of Community Energy Supply Business Models from Actor and Market Perspective

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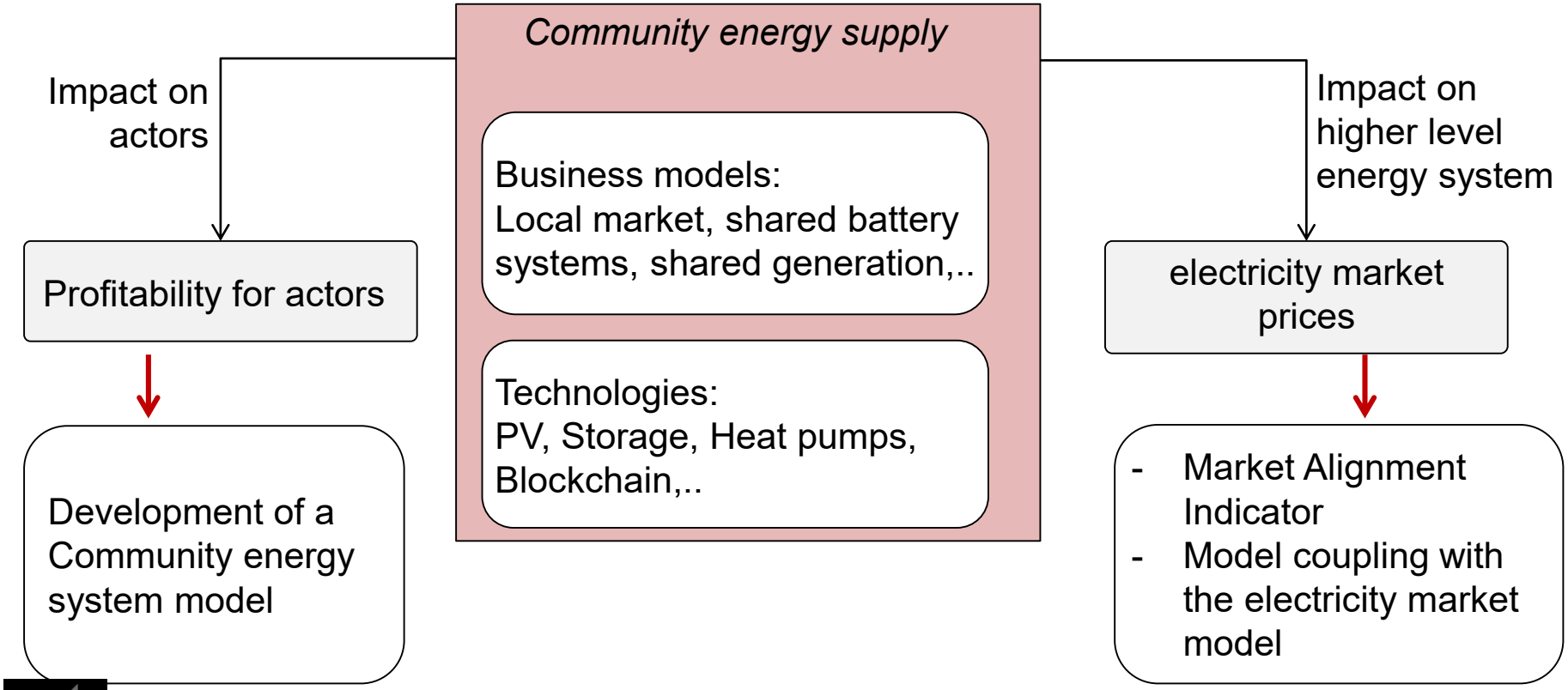
Community Energy Supply

Community energy systems are part of a bigger energy system.

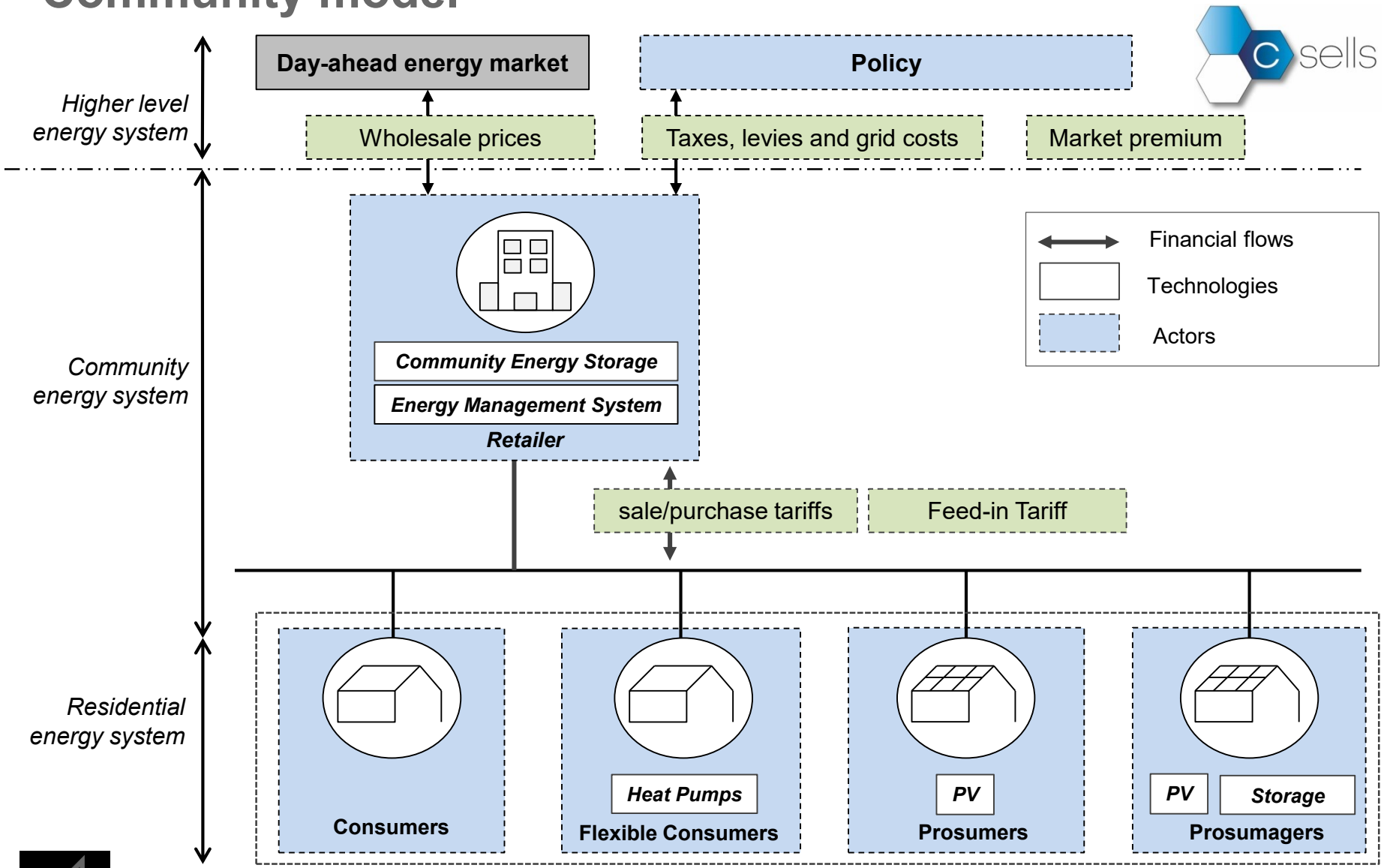


Community Energy Supply

Community energy systems are part of a bigger energy system.

Definition: Integration of a *community energy storage system (CES*) and *local real-time tariffs* in the electricity supply business models for the aggregation of electricity generation and consumption on the community level.

Community model



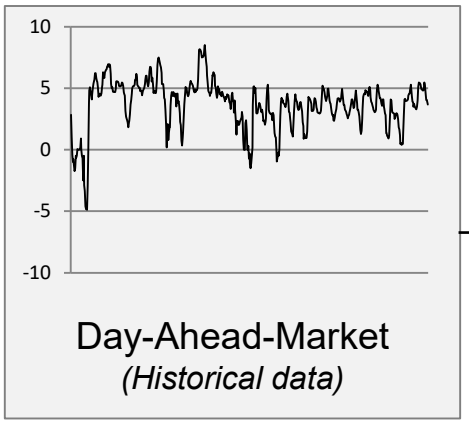
Scenarios and assumptions

	Business model elements		
Scenario	**CES**	**Tariff**	**Strategy**
REF	✗	BAU	Competition
BAU	✓		
Global RTP	✓	Global RTP	
Local RTP Competitive	✓	Local RTP	
Local RTP Autarky	✓		Autarky

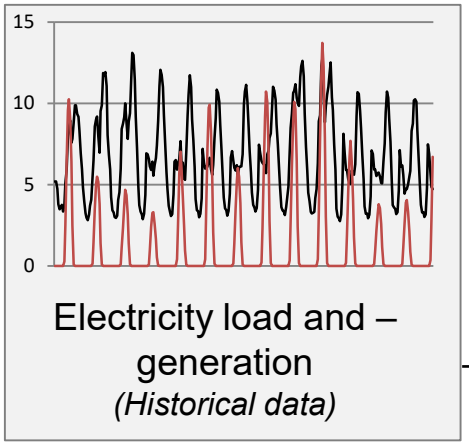
Model assumptions:

- Two-way communication infrastructure between retailer and households
- The local RTP tariffs do not cause higher costs for households
- Retailer and households with „24h perfect foresight“
- Private grid: Tax and levy redemption inside the community
- Haven‘t considered the CES investment costs
- Community-Setup: 10 Consumers, 10 Prosumers, 10 Flexible Consumers, 10 Prosumagers

Simulation logic



Day-Ahead-Market
(Historical data)



Electricity load and – generation
(Historical data)

Local RTP

Stackelberg Game

Forecast of market prices

Retailer optimizes her utility function

Stackelberg Leader

Prediction of 24h electricity load and feed-in schedule

GA

Prediction of 24h real-time prices

Forecast of electricity load and generation

Households optimize their utility function

Stackelberg Followers

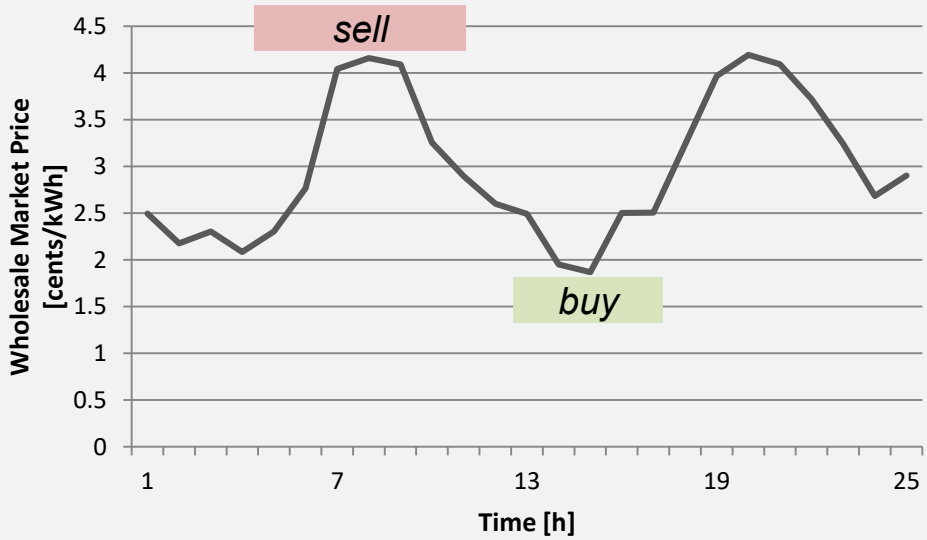
Market Alignment Indicator (MAI)

Definition

- Deployment of flexibility options is not necessarily aligned with the signals of electricity market

Assumption

A flexibility option would behave aligned with the market signals if:



- We define MAI:

$$\text{MAI} = \frac{\text{Welfare}_{\text{Szenario i}}}{\text{Welfare}_{\text{Benchmark-Scenario}}}$$

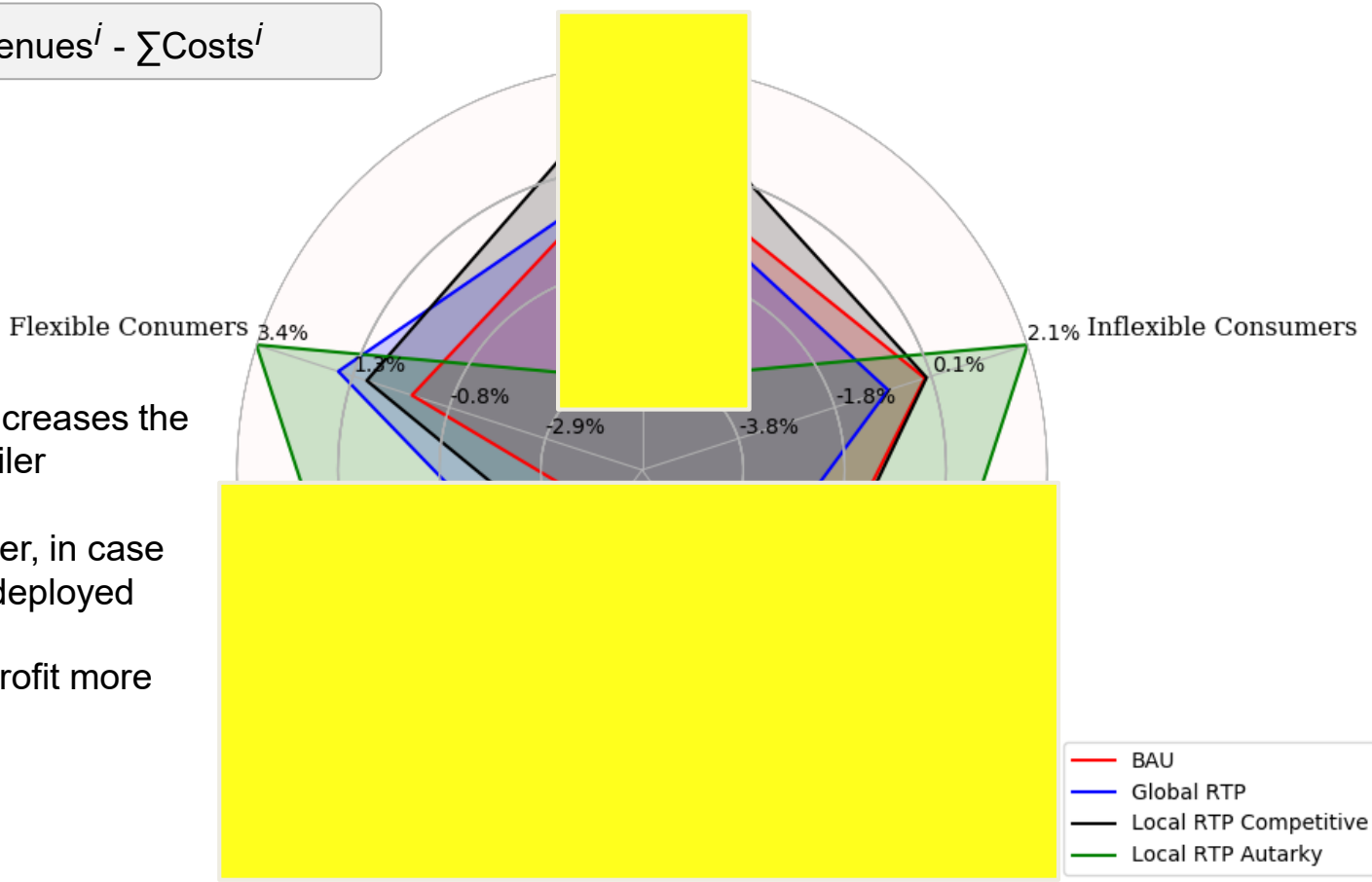
$$Welfare_{Szenario\ i}(t) = (E_{Retailer \rightarrow Market}(t) - E_{Market \rightarrow Retailer}(t)) * \text{P}_{\text{Market}}(t)$$

- Benchmark-Scenario: The retailer controls over all the flexibility options in the community

Results

Utility of the actors relative to REF Scenario

Utility of Actor ^{i} = $\sum$Revenues^{i} - $\sum$Costs^{i}



- Deployment of CES increases the operative profit of retailer
- Highest profit for retailer, in case the local RTP tariff is deployed
- Flexible households profit more from real-time pricing

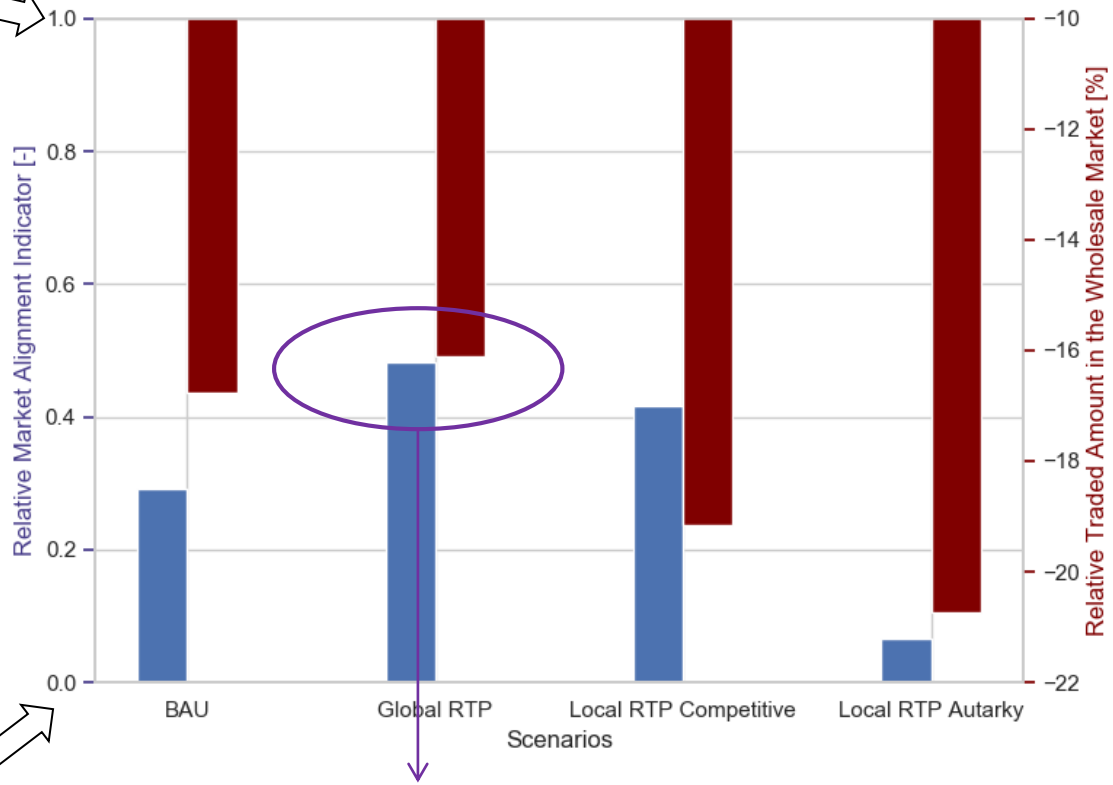
Results

Market Alignment Indicator (MAI)

- Deployment of CES leads to higher MAI value as well as more local consumption of electricity
- Low MAI in case of retailer business model is autarky orienteered.
- Local consumption of electricity can be adjusted in alignment of electricity market signals.

MAI and *reduced exchange with the wholesale market relative to* REF Scenario

Welfare Benchmark Scenario

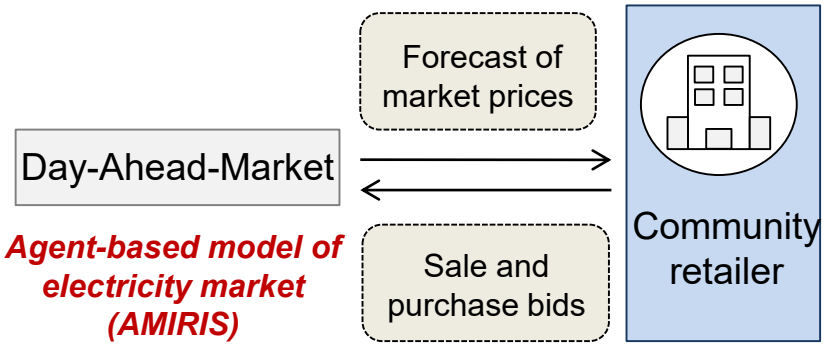


Welfare REF Scenario

May lead to the so-called „avalanche effect“

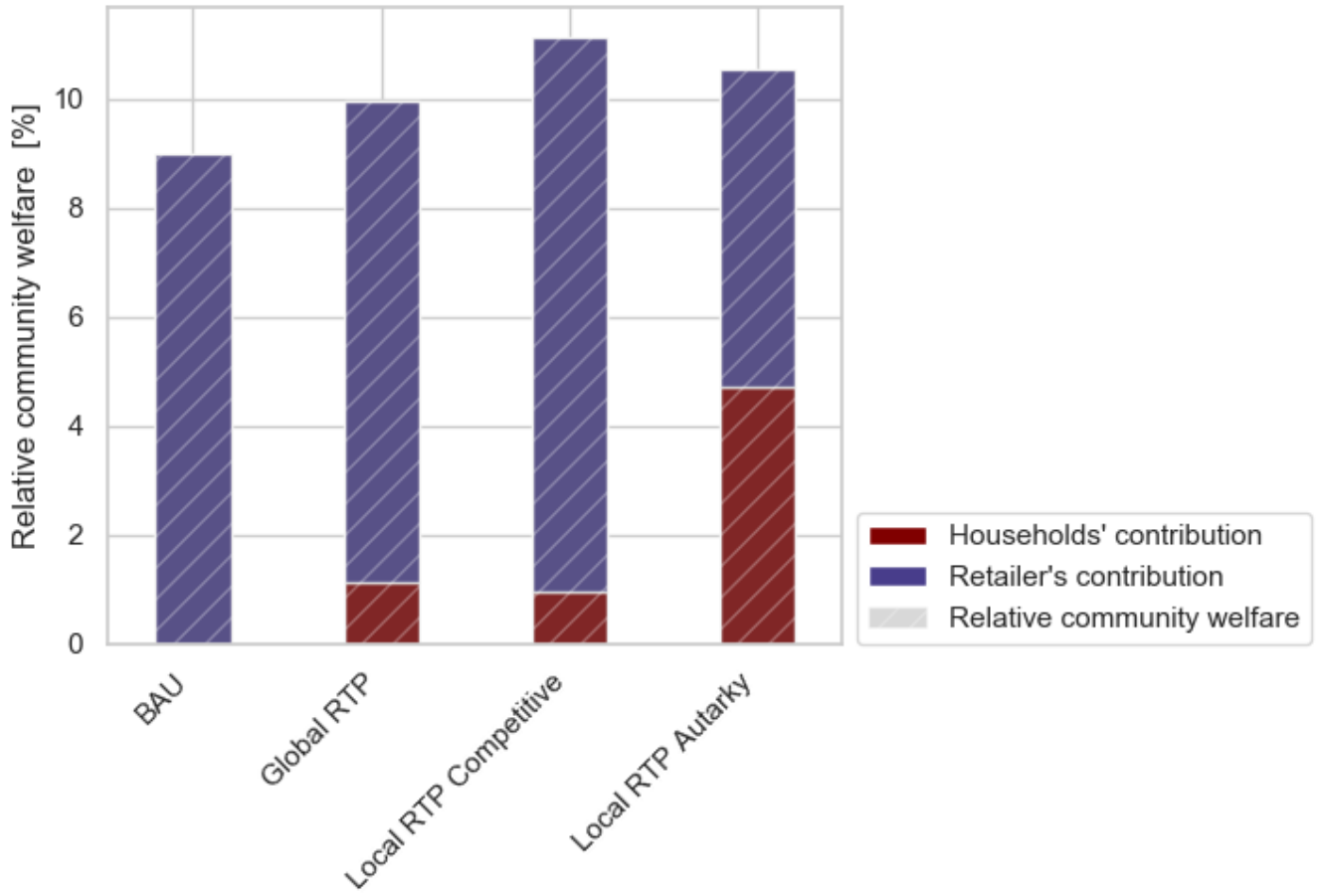
Next steps

- ***Coupling*** the community model with electricity market model „AMIRIS“
- Analysis of ***system indicators*** such as: CO2 emissions, System costs..
- Consideration of ***investment costs*** in the simulation
- Analysis of CES deployment ***political framework***



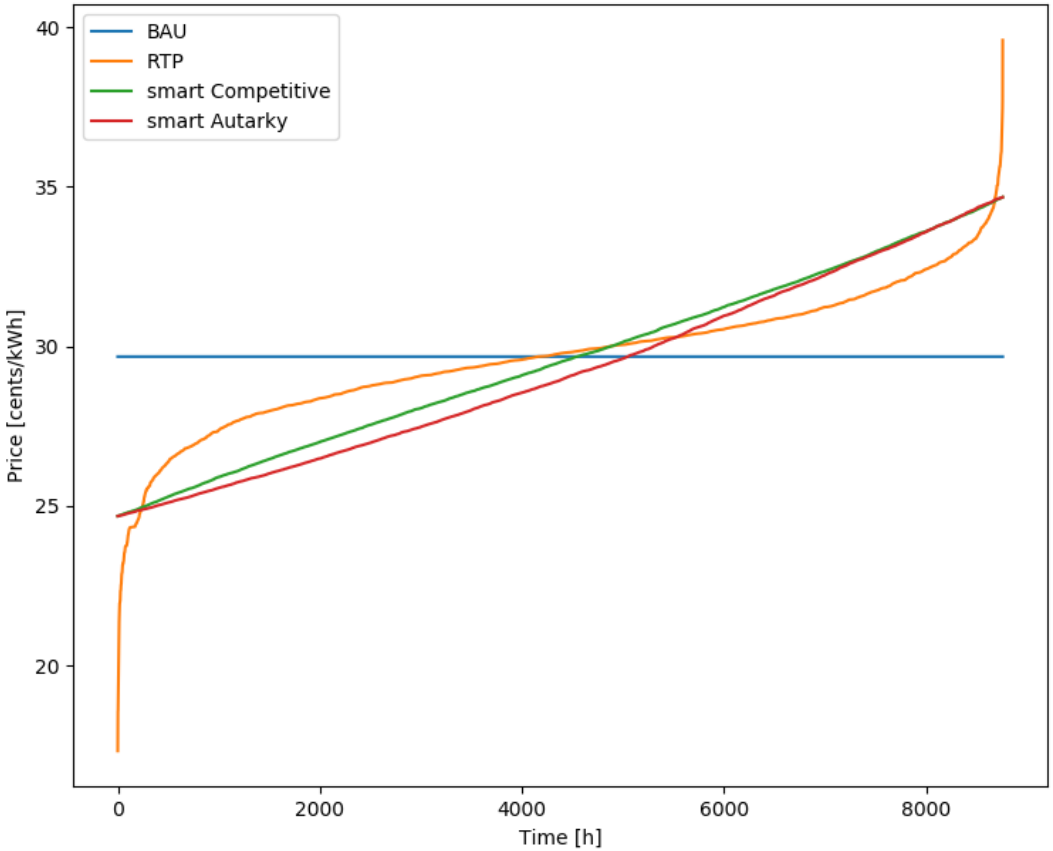
Thanks for your attention!

Back-up
Community welfare



Backup

Retailer Verkaufspreise



Back-up

Implemented political framework