

Systemfreundlichkeit von PV-Batteriesystemen – Der Einfluss von zeitvariablen und kapazitätsbasierten Tarifen

Martin Klein, Ahmad Ziade, Marc Deissenroth
Deutsches Zentrum für Luft- und Raumfahrt
Institut für Technische Thermodynamik
Abteilung Systemanalyse und Technikbewertung

Strommarkttreffen

Batterien: Kostenentwicklung, Technologien, Anwendungen
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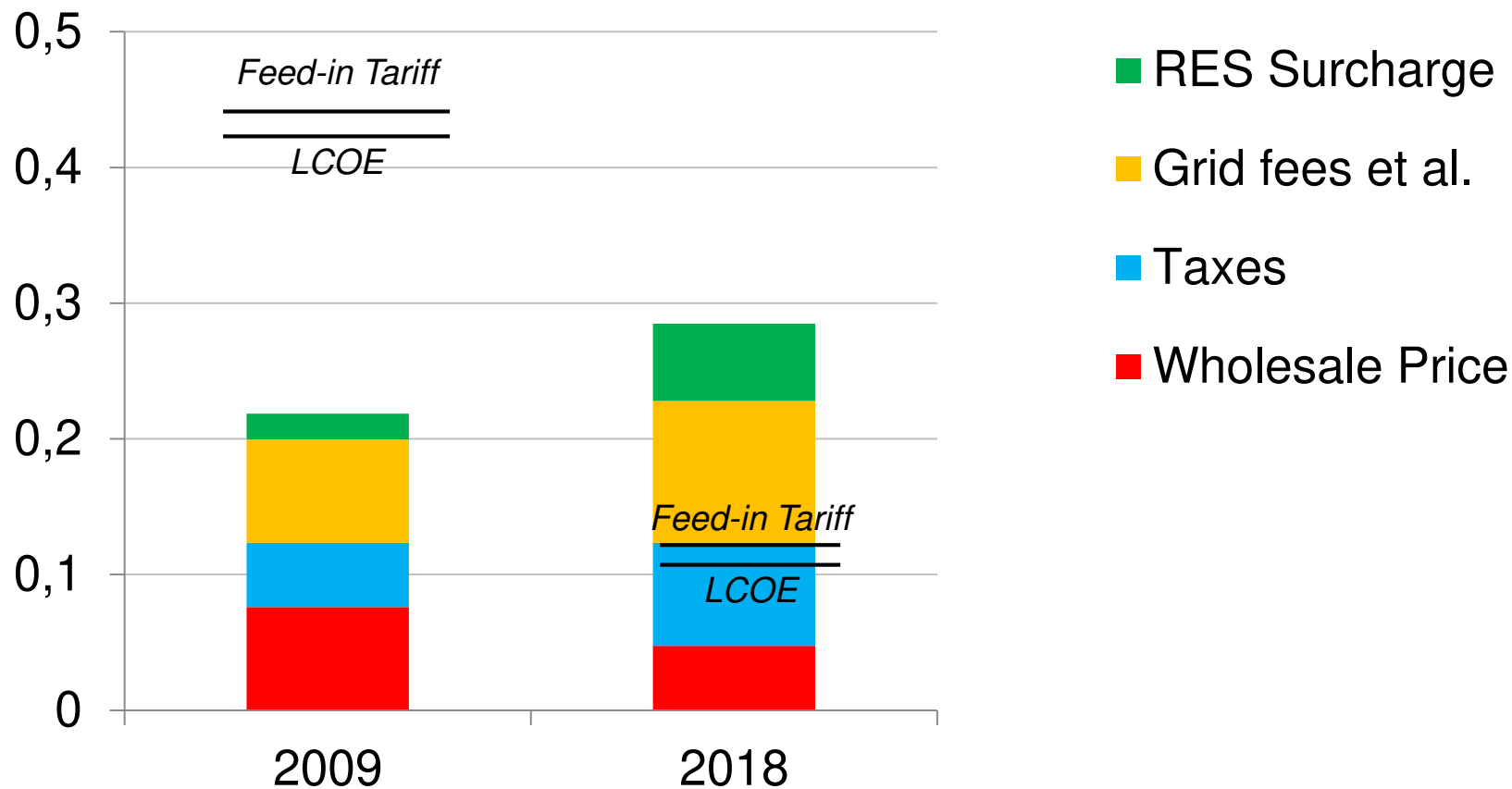


Knowledge for Tomorrow



Retail Electricity prices and levies – the incentive to self-consume

Example from Germany

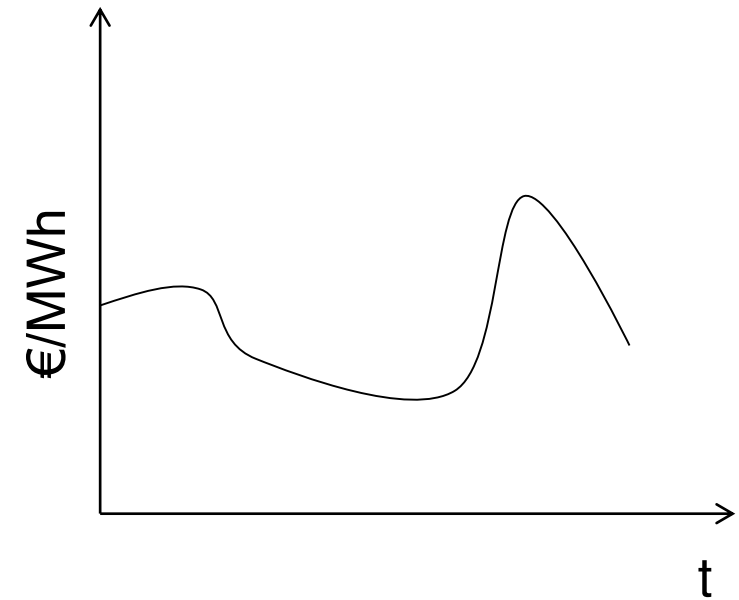
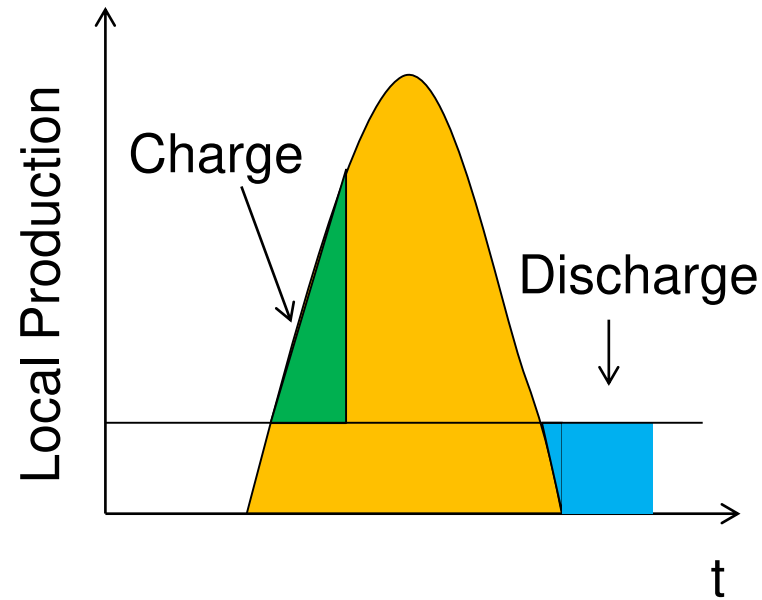
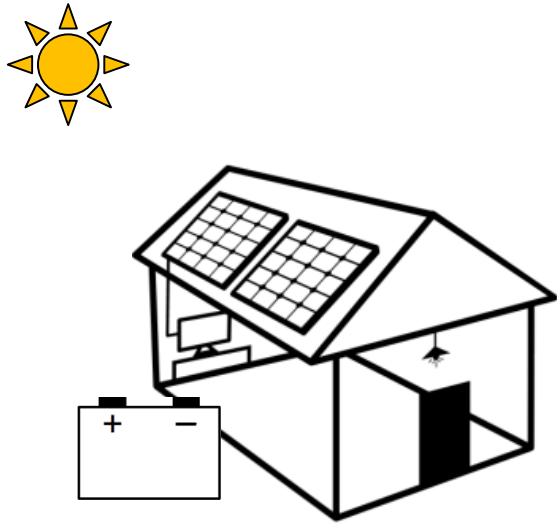


Source: Schill et al. - Prosumage of solar electricity: pros, cons, and the system perspective, *EEEP*, 2017, 6



Case 1 – Market signals propagate correctly to Prosumers

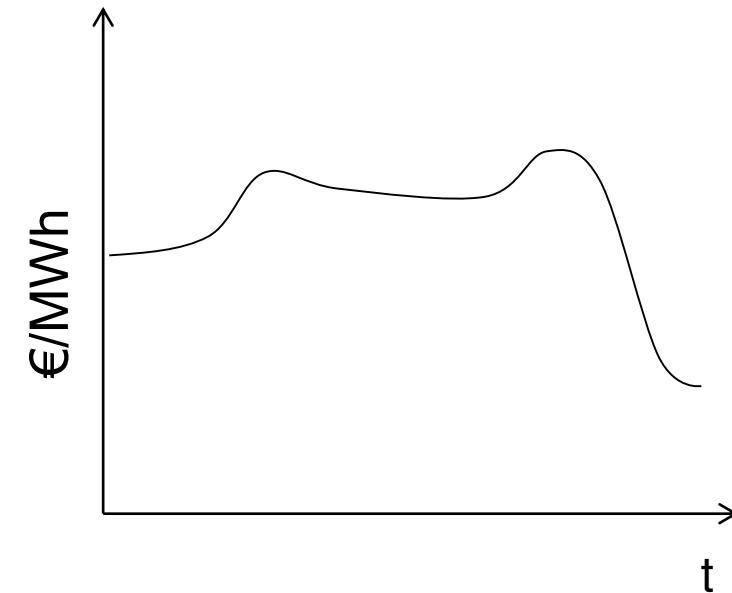
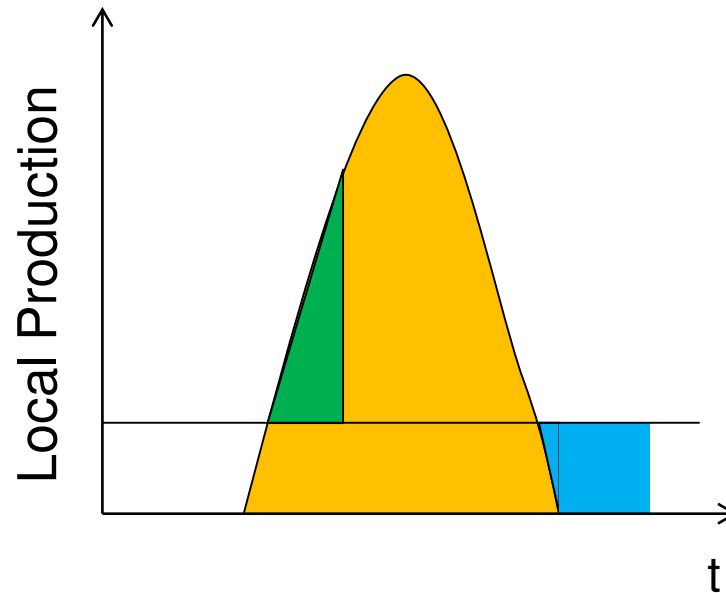
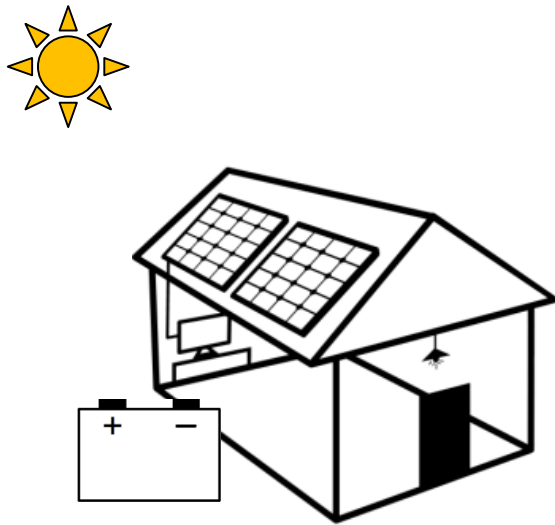
Sunny Day in the entire market zone



Schematic depiction



Case 2 – Market signals do not propagate correctly to Prosumers Sunny day at our PV site, overcast in market zone



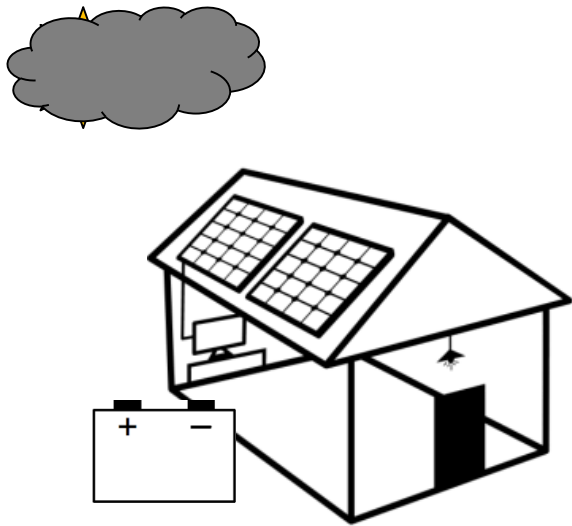
Schematic depiction

State of charge **inconsistent** with market signals:
Charging at high prices (scarcity),
Discharge at low prices (surpluses)

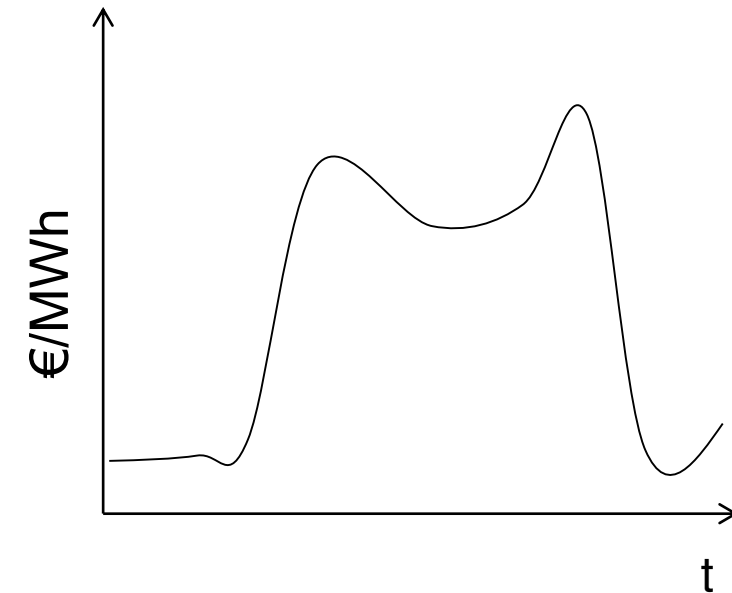
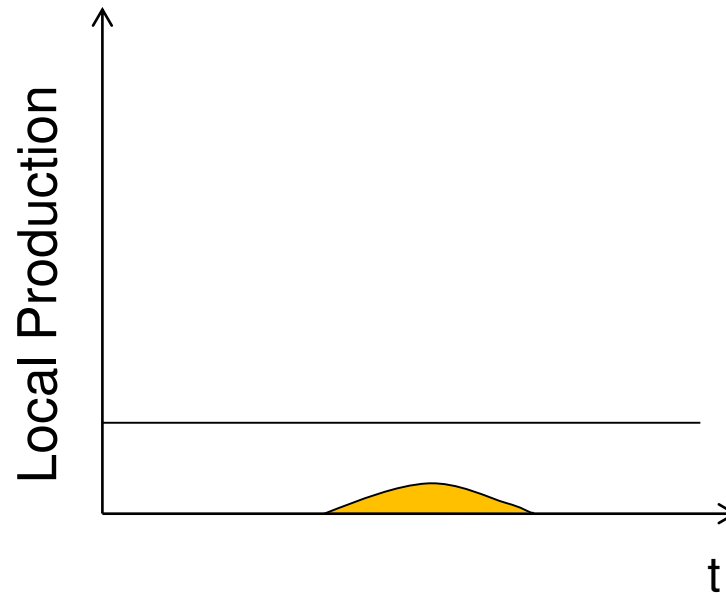


Case 3 – Market signals do not propagate correctly to Prosumers

Windy night, overcast winter day



Schematic depiction



State of charge **inconsistent** with market signals:
Storage is not used, even if there is a price/scarcity delta



System-friendliness indicator (SFI)

- The system-friendliness indicator measures how close the household battery dispatch is that to the ‘ideal’ case. It considers the short-term welfare (W) of the battery of the self-consumption system:

$$W_{\text{Battery}} = W_{\text{PV-Battery System}} - W_{\text{PV-System}}$$

- The **SFI** is obtained by comparing it to an arbitrage battery of the same size:

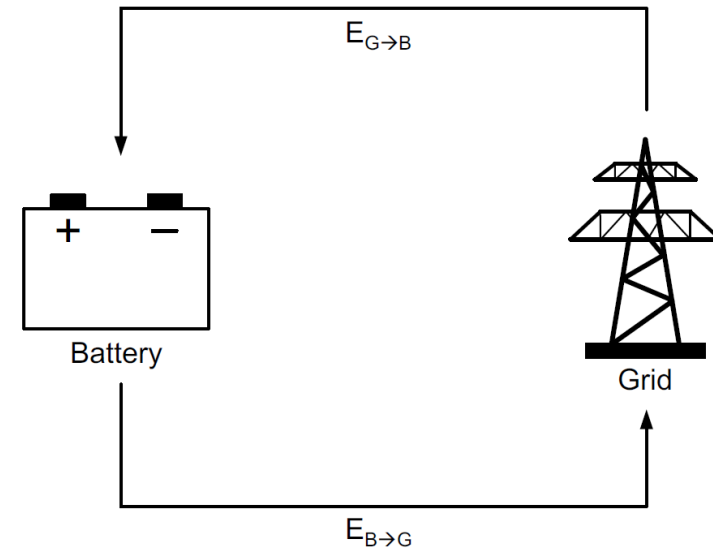
$$\text{SFI} = \frac{W_{\text{Battery}}}{W_{\text{Arbitrage}}}$$

- Internal validation: When households were exposed to wholesale market prices for generation and consumption, the SFI is 1



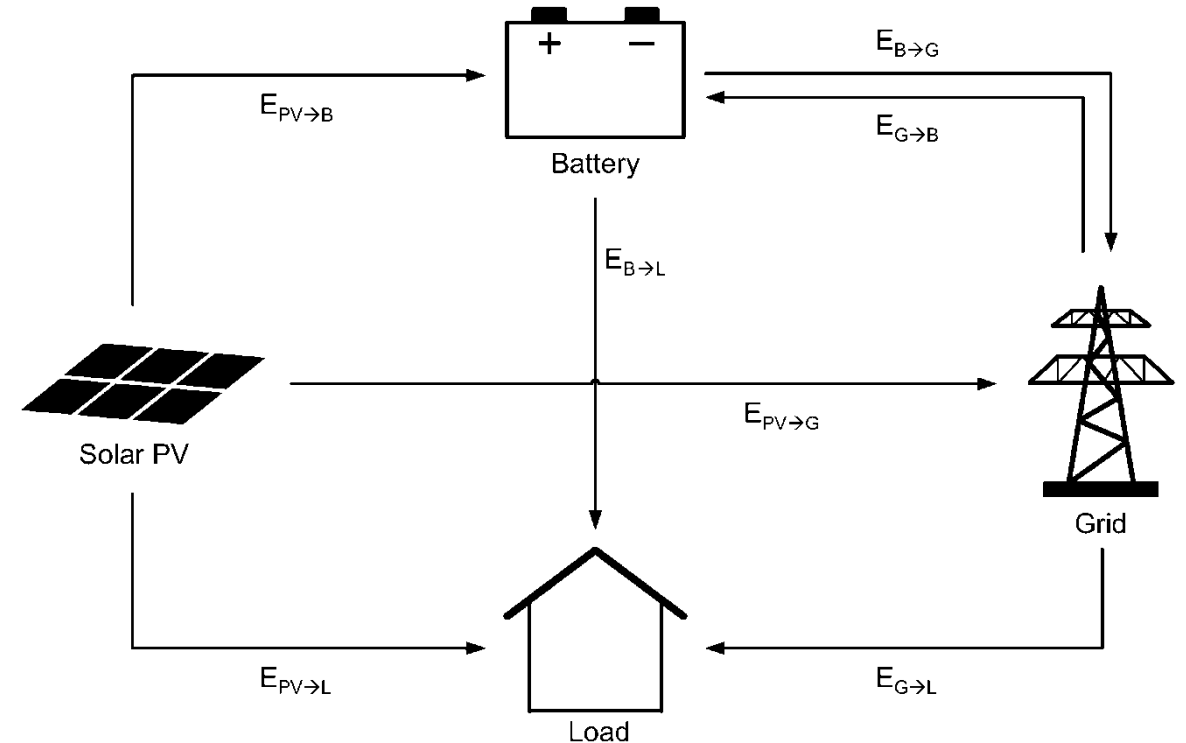
Arbitrage Case

- Ideal case is complete responsiveness to price signals. This means a storage that operates on arbitrage
- Storage maximizing revenue exposed to wholesale market prices



Time Varying Cases

- Consumer feeds energy to the grid for a fixed or a variable feed-in tariff (FIT)
- Buys electricity for a variable or fixed retail price
- Battery can feed into the grid for wholesale market prices
- Model will be made open source (BSD license), release note on <https://forum.openmod-initiative.org/>



Evaluated policy scenarios – Policy design elements

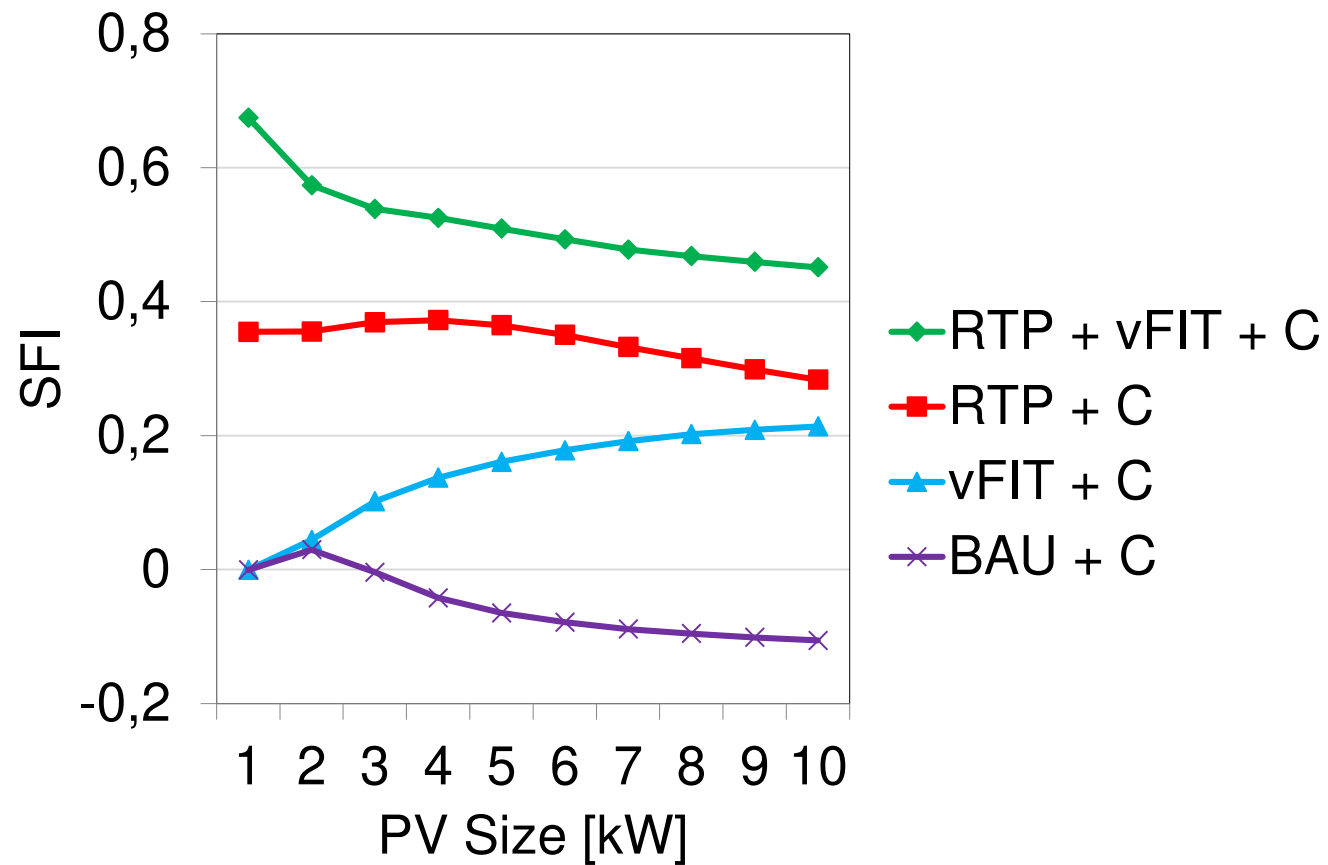
Case	Real-Time Pricing	Variable Feed-in tariff	Capacity-based
BAU	No	No	No
C	No	No	Yes
RTP	Yes	No	No
RTP + C	Yes	No	Yes
vFIT	No	Yes	No
vFIT + C	No	Yes	Yes
RTP + vFIT	Yes	Yes	No
RTP + vFIT + C	Yes	Yes	Yes

- Evaluated across 74 households and 100 PV and storage combinations
- All policies neutral to the regular consumers (same payments per year) by design



Results: System-friendliness indicator (SFI)

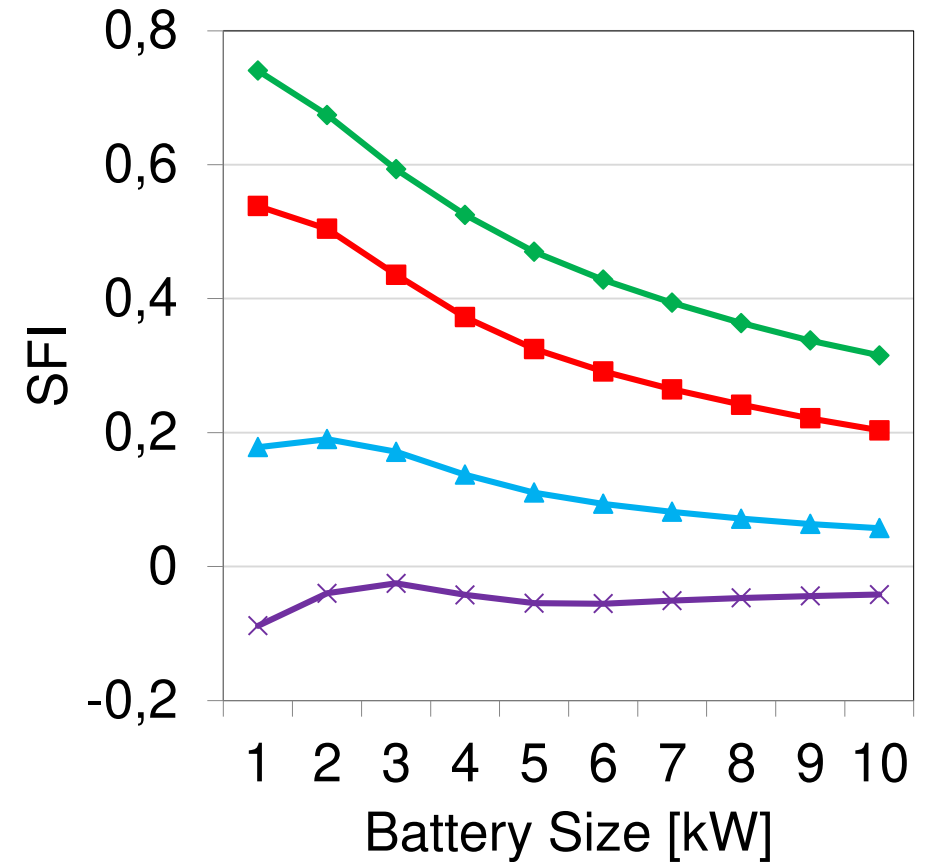
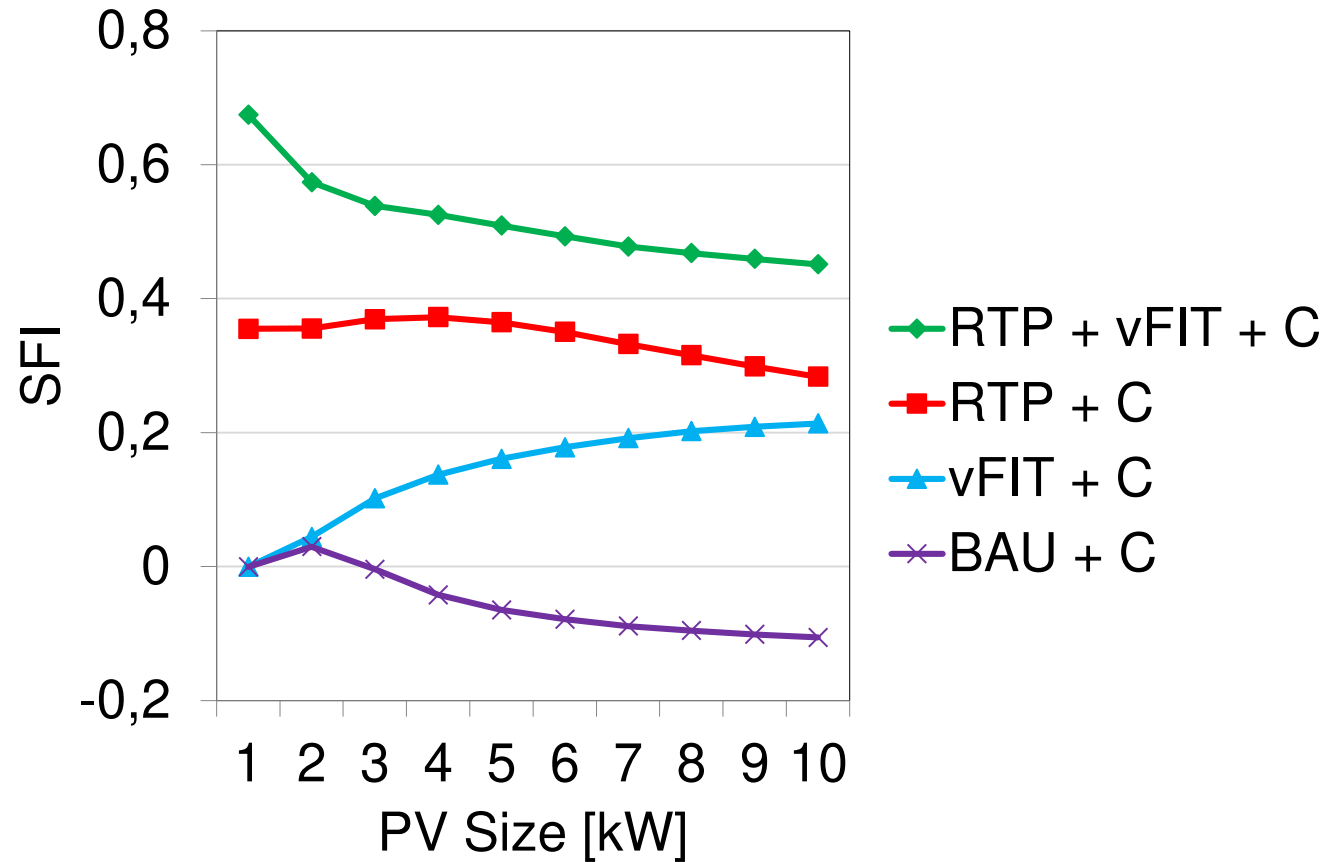
Example case: 4 kWh battery, capacity network charges



Results: System-friendliness indicator (SFI)

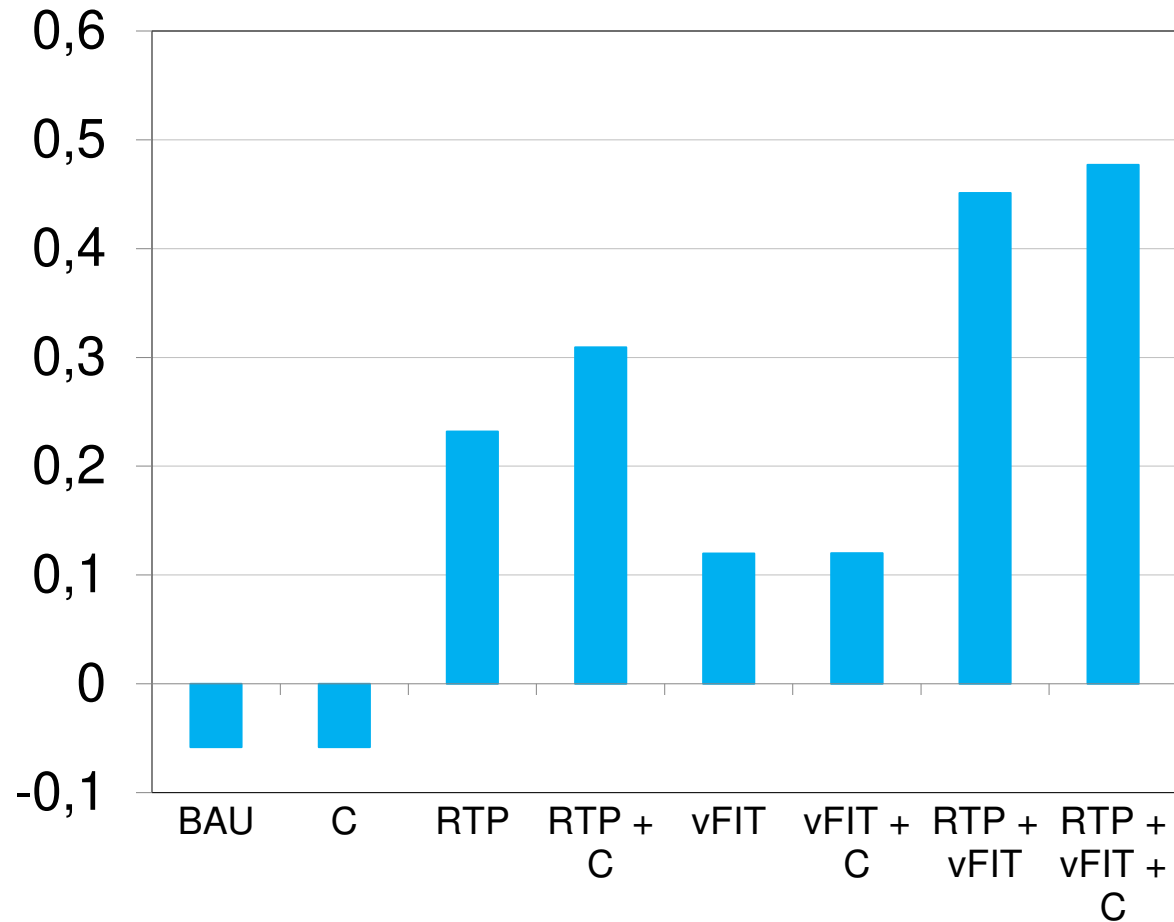
Example case: 4 kWh battery, capacity network charges

4 kW PV system



Results: System-friendliness indicator (SFI)

Mean values for all investigated cases



- Operation of self-consumption batteries in business-as-usual case slightly system-unfriendly
- Real-time prices can better the SFI considerably
- Variable feed-in tariff less successful
- Best result obtained for combination of all policy design elements
- SFI not close to 1 because of other extras like taxes



Discussion and Conclusion

- SFI: Novel method to assess the system-friendliness of prosumer storages proposed irrespective of battery size
- Time-varying feed-in tariff, real-time prices and capacity tariffs are investigated
- Scarcity signals transmitted to prosumers can improve their system-friendliness
- Both dynamic prices for generation and consumption can better the *SFI*
- *SFI* is best if two-way price signal (for generation and consumption) is transmitted
- Flat capacity tariffs also have a significant impact on the system-friendliness and improve the attribution of network charges; adverse for the business case of self-consumption



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Contact: m.klein@dlr.de



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