How to model and regulate the deployment of residential PV battery systems? – Integrating prosumer behavior into AMIRIS

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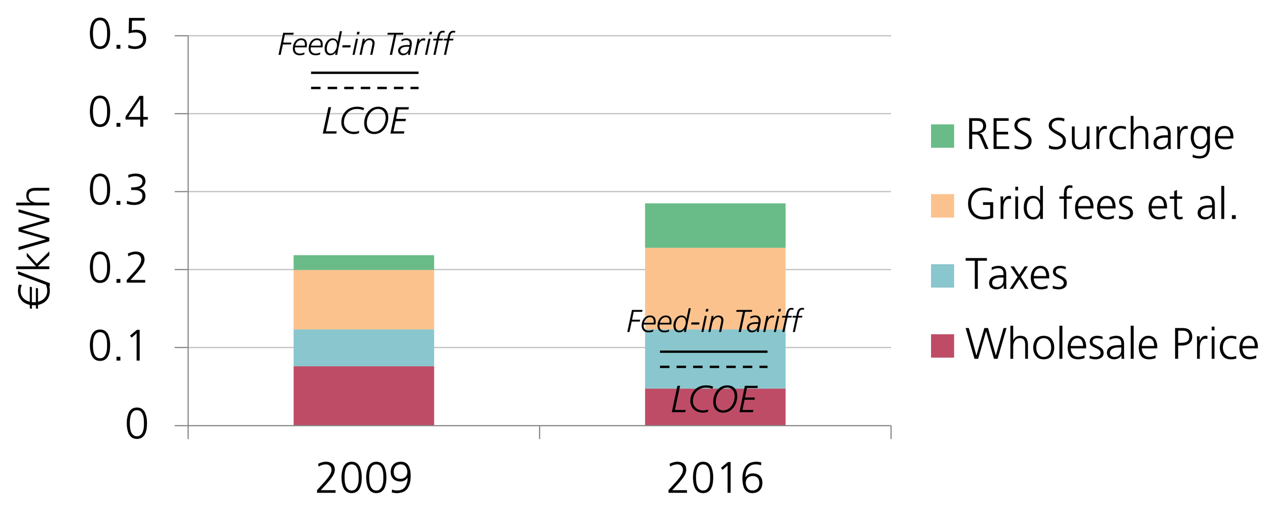
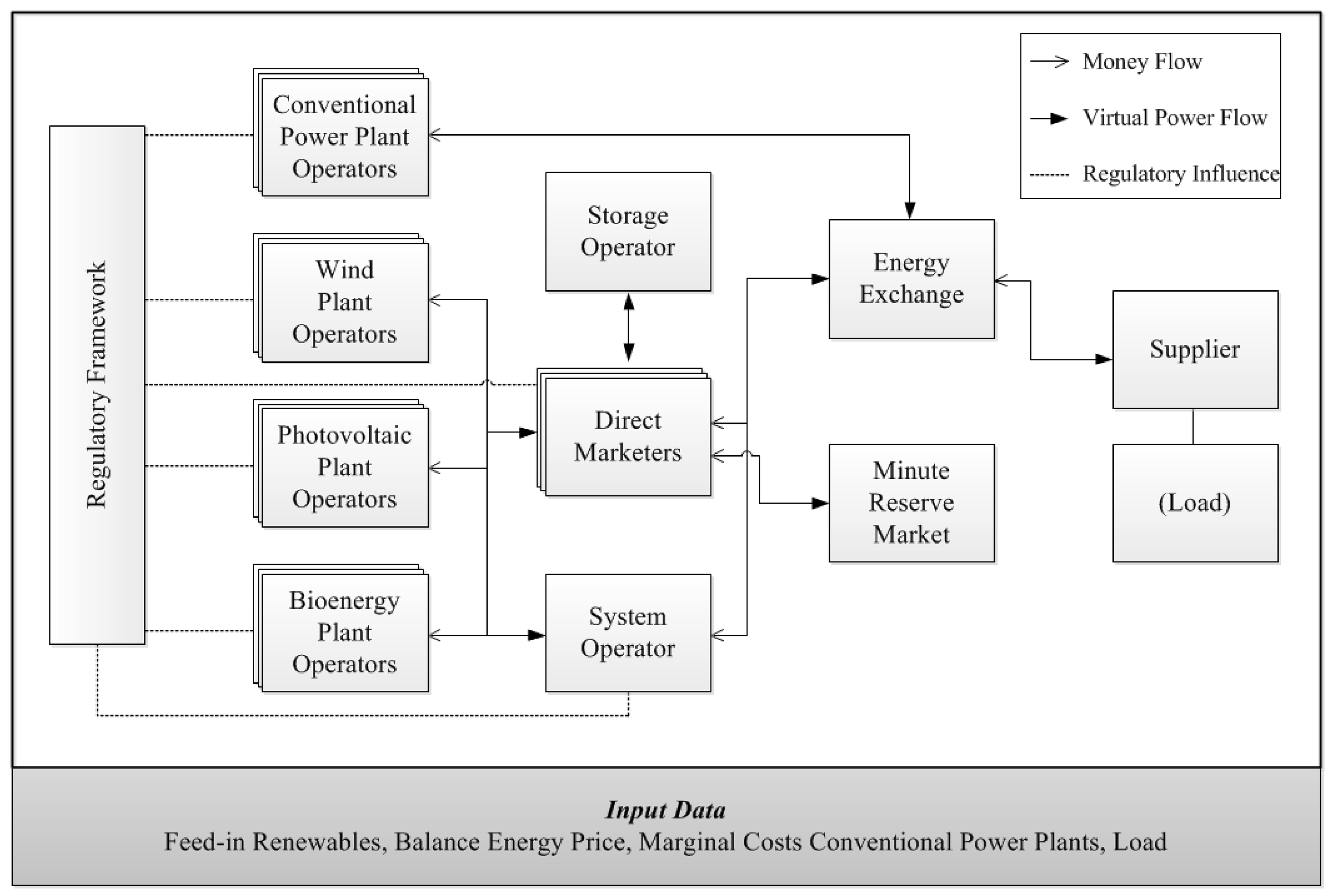
Motivation



Retail prices, levelized cost of solar electricity (LCOE) and feed-in tariff for residential consumers in Germany (stylized) [1]

- The fall of PV and battery prices made local self-generation and consumption financially attractive for households
- Prosumers save grid fees, consumers need to compensate
- Self-consumption and feed-in is not in line with optimal system operation ; no scarcity signals are transmitted
- How can system-friendly behavior be incentivized?

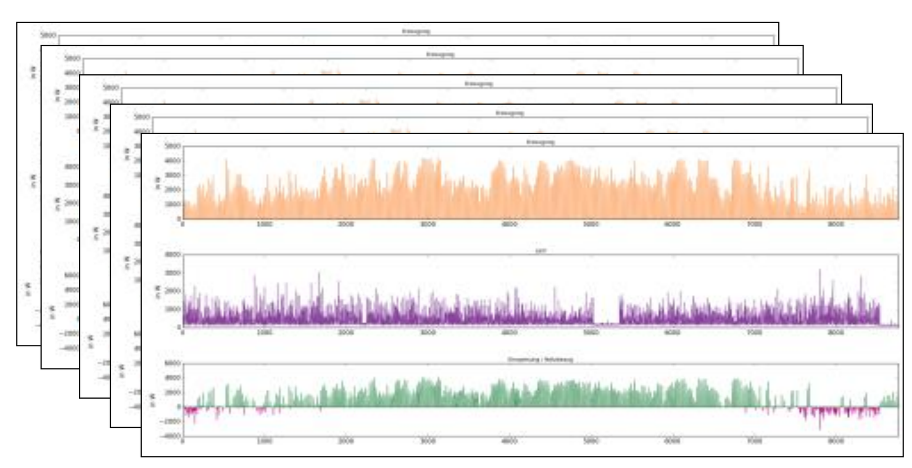
Objectives



The AMIRIS model(stylized) [2]

- Integrating self-consumption and prosumer behavior into an agent-based model of the German electricity system (AMIRIS)
- Assessing the prospective uptake of PV batteries in an overall system context
- Studying different rate designs (capacity based tariffs, real-time pricing, time-variable feed-in remuneration) to regulate deployment

Approach & Methods

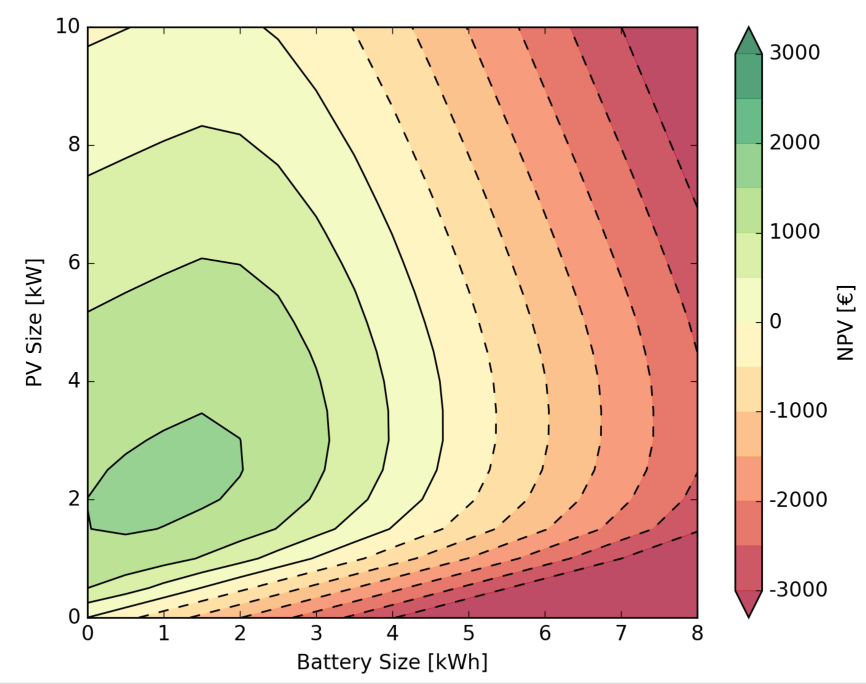


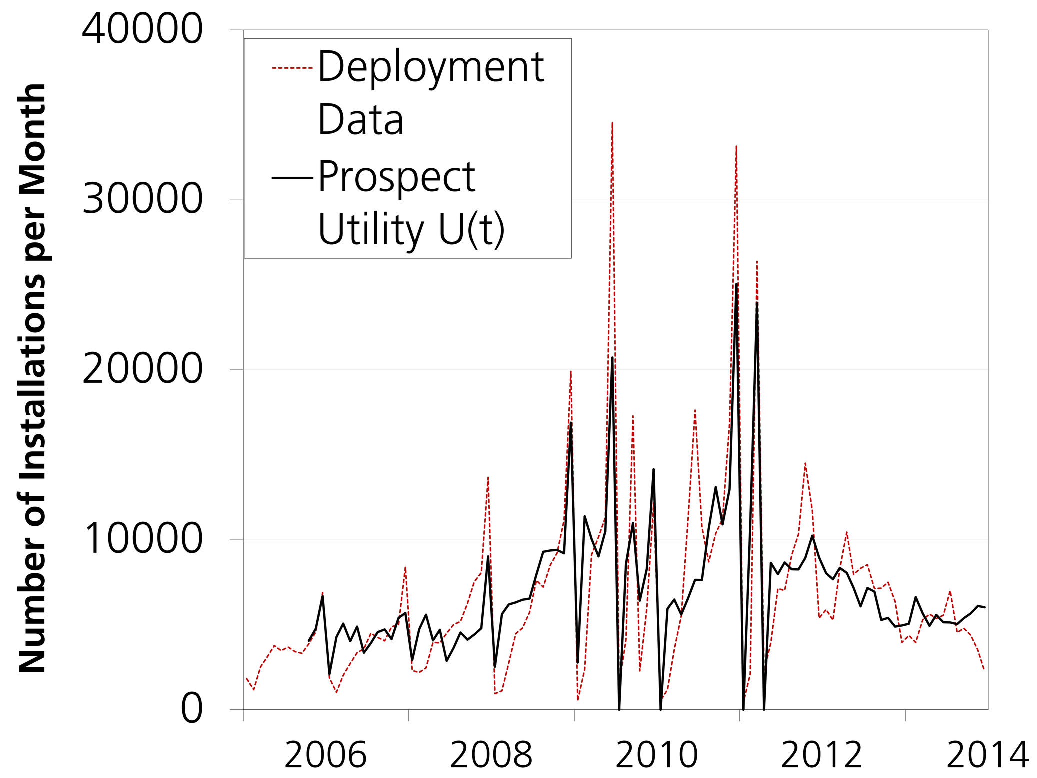
Technical modelling:

- Compute "egoistic" storage dispatch, deriving grid load and feed-in profiles for many PV battery systems configurations
- Input: high-resolution household load (HTW Berlin) and PV generation profiles (DLR REMix-EnDat)

Economic Assessment:

- Compute net present value (NPV) matrices
- Input: remunerations, electricity rate strucuture…
- PV and battery cost scenarios





Uptake modelling:

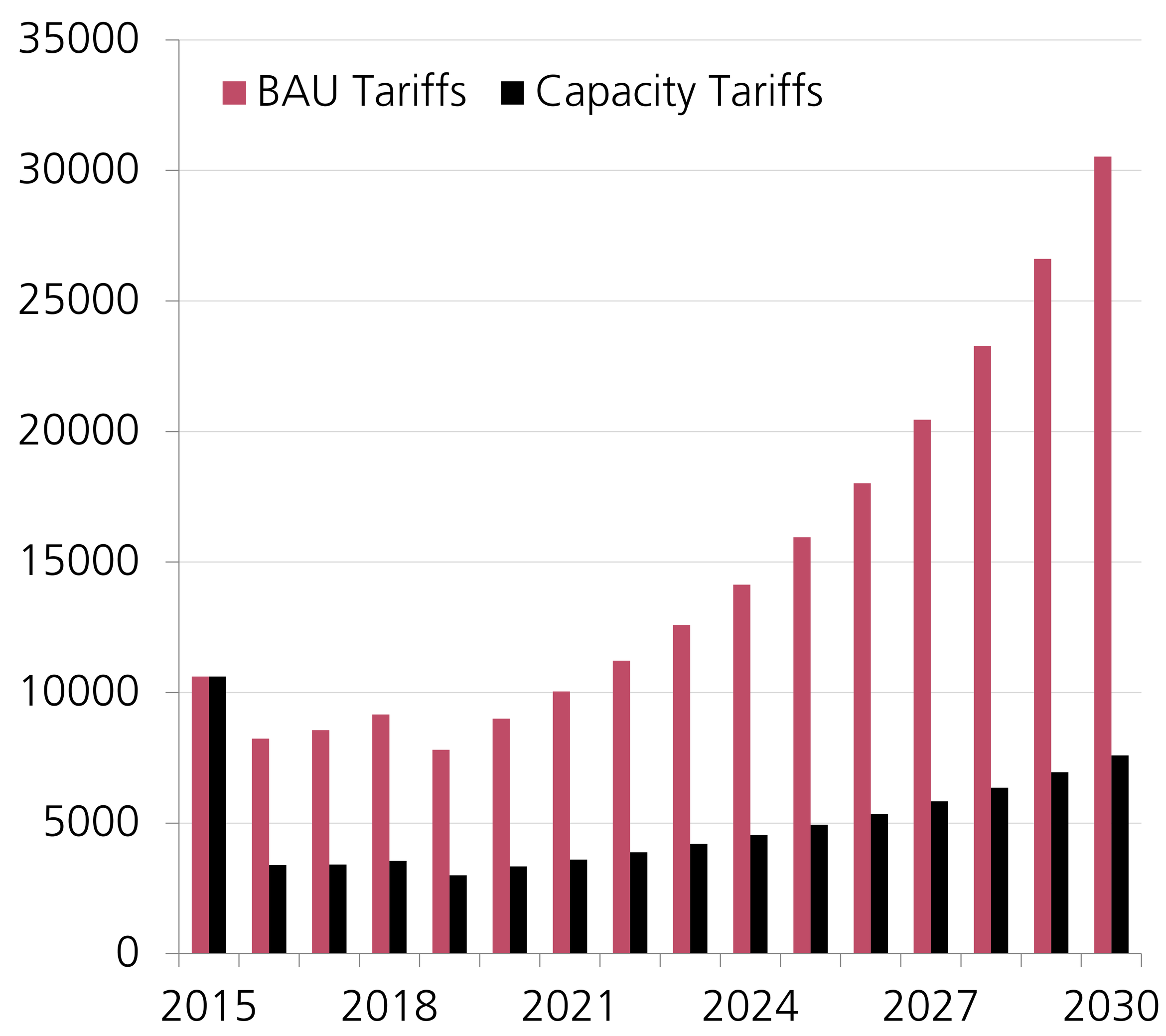
- Compare utility measure derived from Prospect model [3] based on [4] with historic uptake data

Results

Market Model Integration:

- Increasing shares of self-consumption can have a parasitic, prisoner-dilemma like effect on the overall system.
- However, levy and network charges structure have a major influence on system-friendliness.
- Prospective profitability of PV battery systems is taken to endogenously simulate storage dispatch and deployment under different regulatory scenarios.
- PV battery deployment dynamics can be reproduced taking the anticipation of absolute profitability, and its *change*.
- We find that capacity based tariffs reduce the prospective uptake considerably.

Uptake model (# systems / year)



Summary & Outlook

The assessment of PV battery system deployment and dispatch requires an actor-based perspective in a system context. Next, system effects on the demand side will be studied in the framework of an agent-based electricity market model [2], with an internal representation of market prices (hourly basis, dynamically calculated in dependence of the generation mix).

References

[1] W.-P. Schill et al. *Economics of Energy & Environmental Policy*, vol. 6, (2017).

[2] M. Deissenroth et al., *Complexity,* vol. 2017, (2017).

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[4] A. Tversky & D. Kahneman, *Journal of Risk and Uncertainty*, vol. 5, no. 4, pp. 297–323, (1992).

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