DIW BERLIN

Prosumage of solar electricity: tariff design, prices, and capacity investment

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Bundesministerium für Bildung und Forschung

Agenda

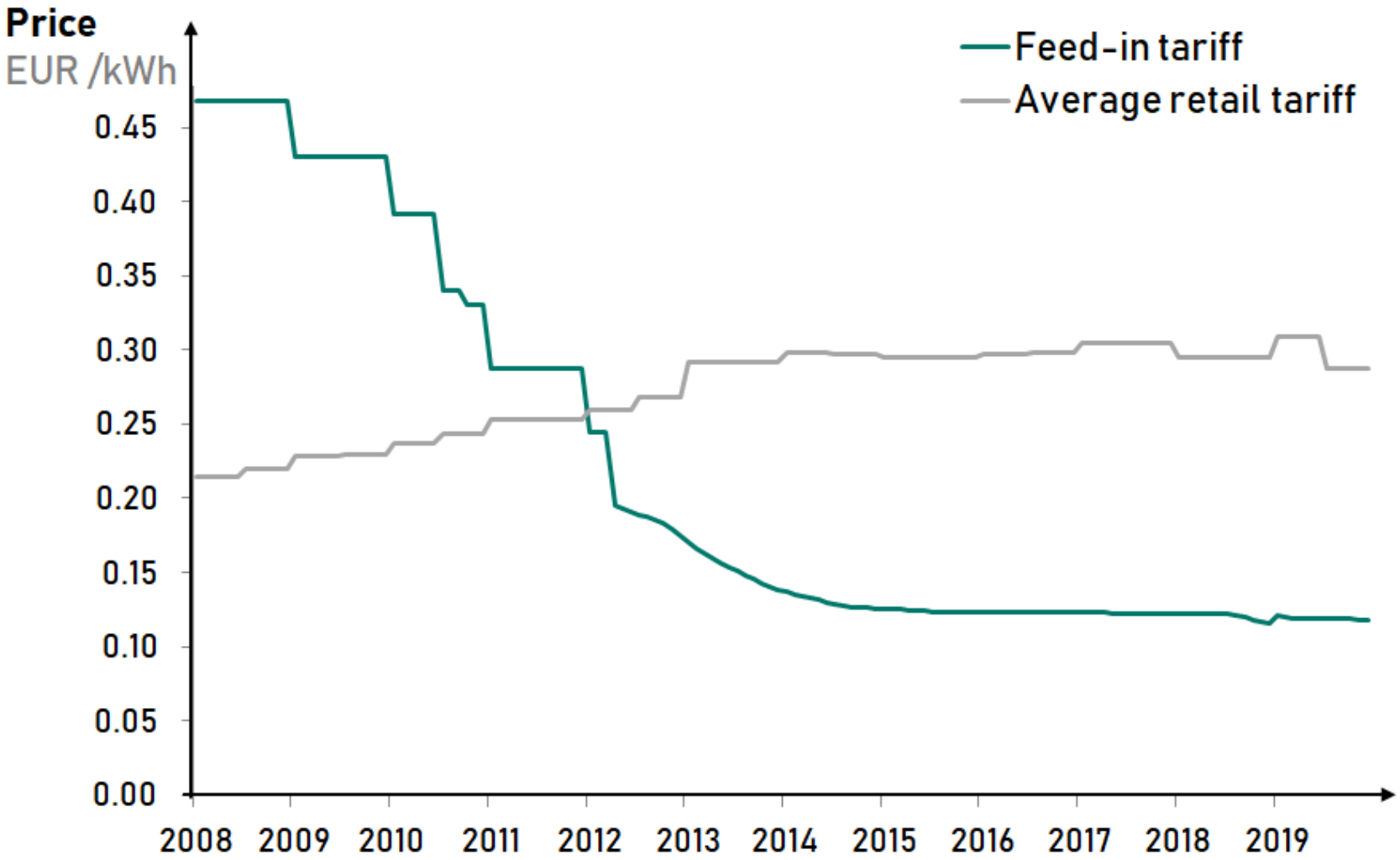
1 Concept & background

2 Modelling

3 Results

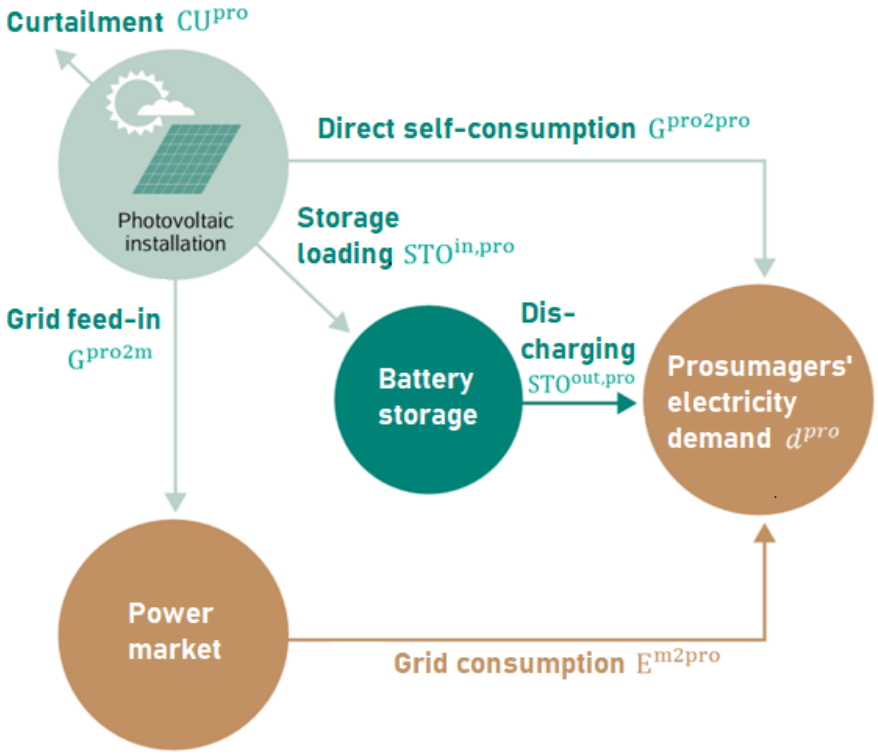
4 Conclusion

Rising Incentives for self-consumption of solar power in Germany



Sources: Own illustration based on BNetzA (2019) & Destatis (2019).

Research questions



Source: Schill et al. (2017), own illustration.

- How do retail and feed-in tariffs affect households' decisions to engage in prosumage?
- What are the impacts on the power sector?
- How can we investigate both in a numerical model?

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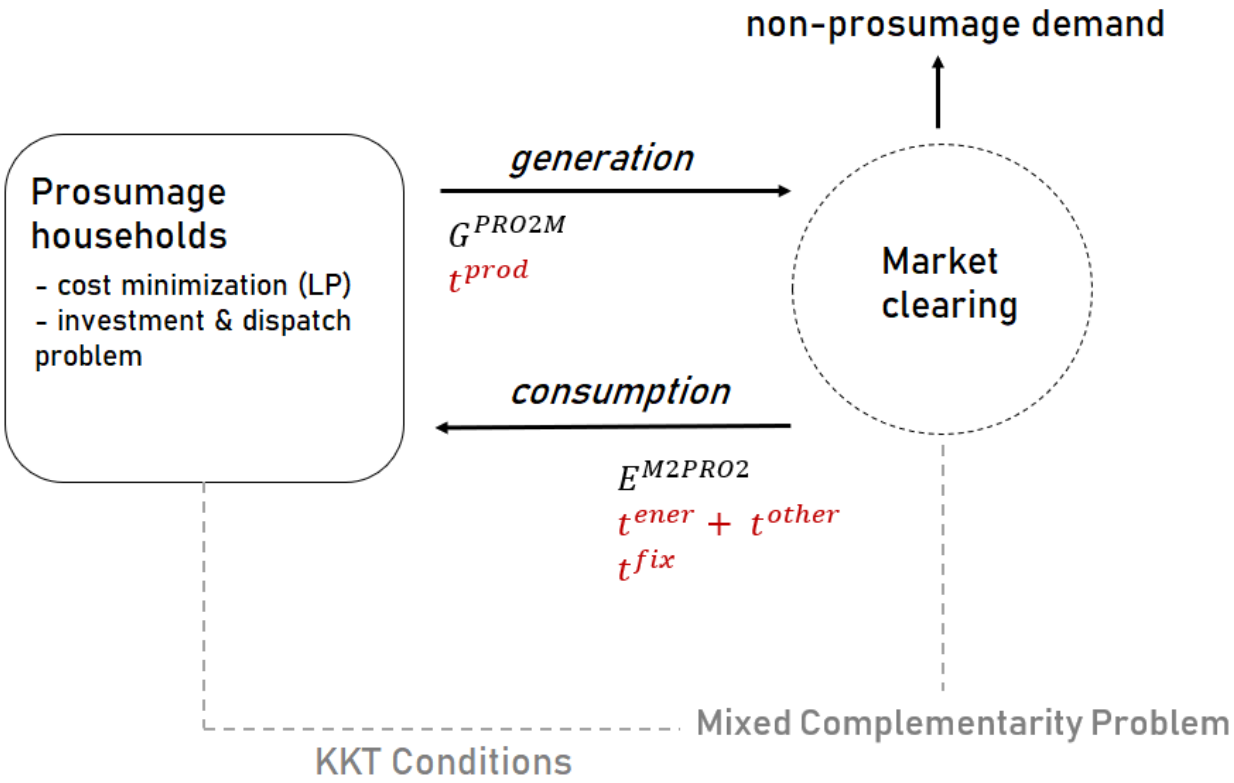
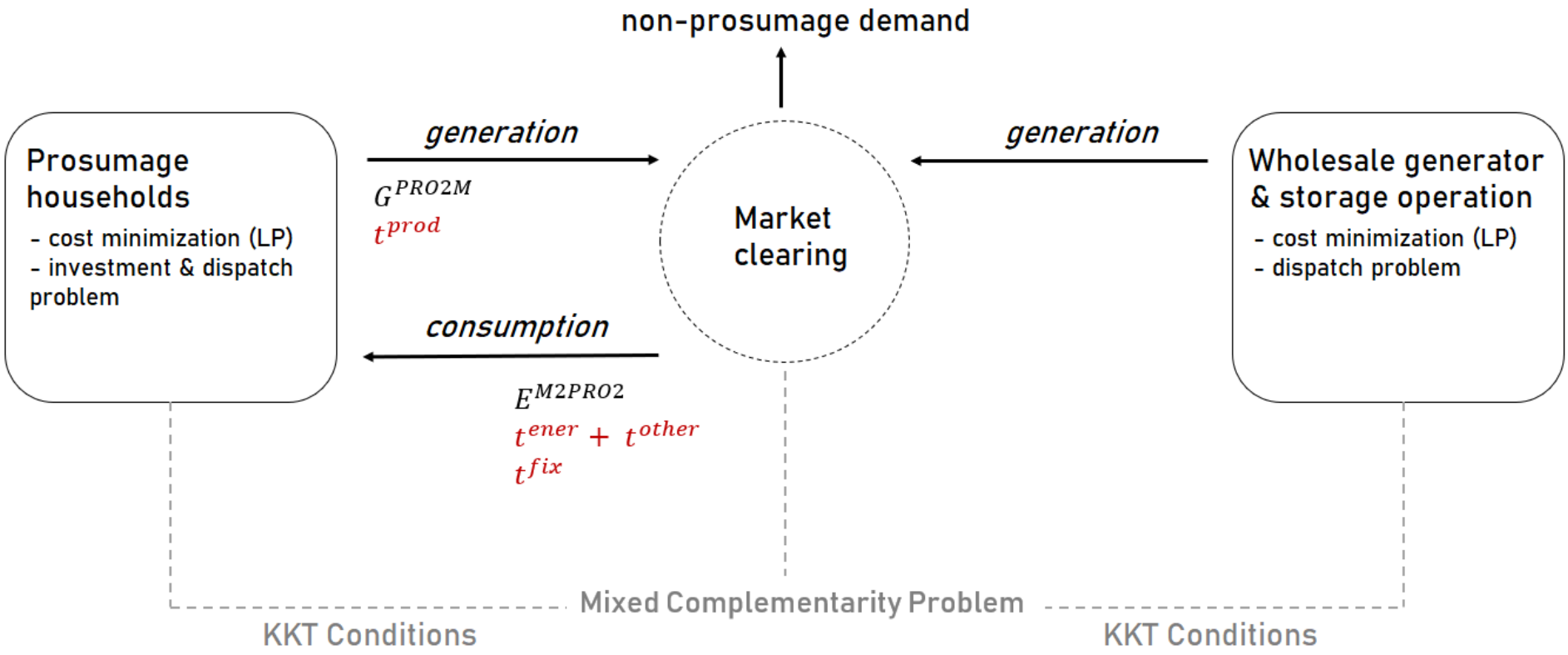
Modelling framework: Mixed complementarity problem



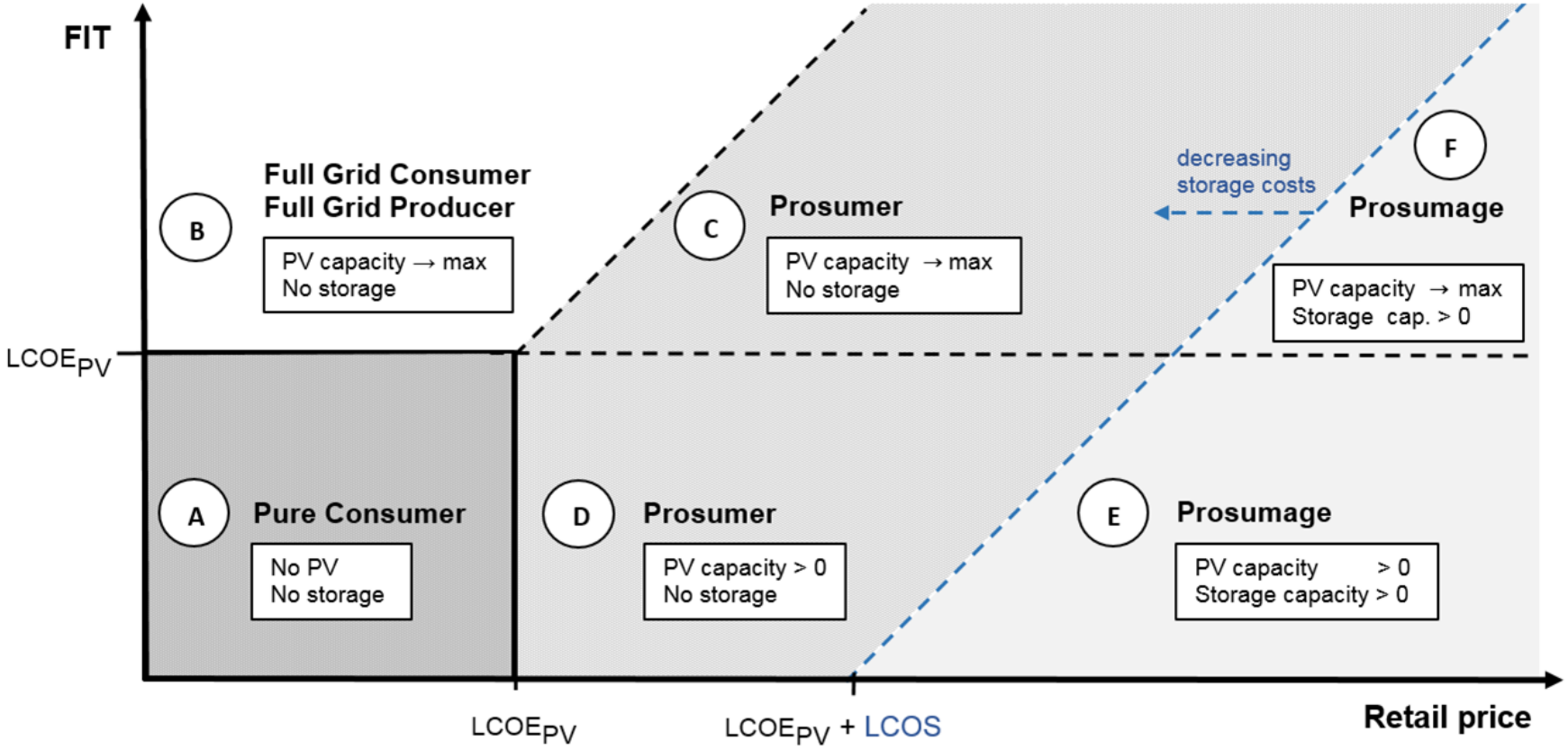
- Household agent represents one million households
- Decides on PV and battery capacities and their hourly use
- Tariffs varied in scenarios, calibrated to a baseline run

Modelling framework: Mixed complementarity problem



- Benevolent system operator dispatches non-prosumage capacities
- Capacities in line with German Network Development Plan 2019 B

Tariff scenarios cover various incentive schemes for households



Source: Own illustration adapted from Ossenbrink (2017).

Tariff scenarios

- Baseline scenario reflects German 2019 situation
- Scenarios vary tariff component but maintain billing amount for reference household
- Panel I: Varying FIT, volumetric retail tariff (status quo)
- Panel II: Restructuring of retail tariffs with larger fixed part
- Panel III: Introducing real-time pricing to tap flexibility potential

Scenario	**Energy** EUR/kWh t_h^{ener}	**Other** EUR/kWh t^{other}	**FIT** EUR/kWh t_h^{prod}	**Fixed** EUR/year t^{fix}
Baseline	0.05	0.25	0.08	-
Panel I	0.05	0.25	0 - 0.08	-
Panel II	0.05	0.1-0.2	0 or 0.08	250-750
Panel III	RTP	0.25	RTP	-

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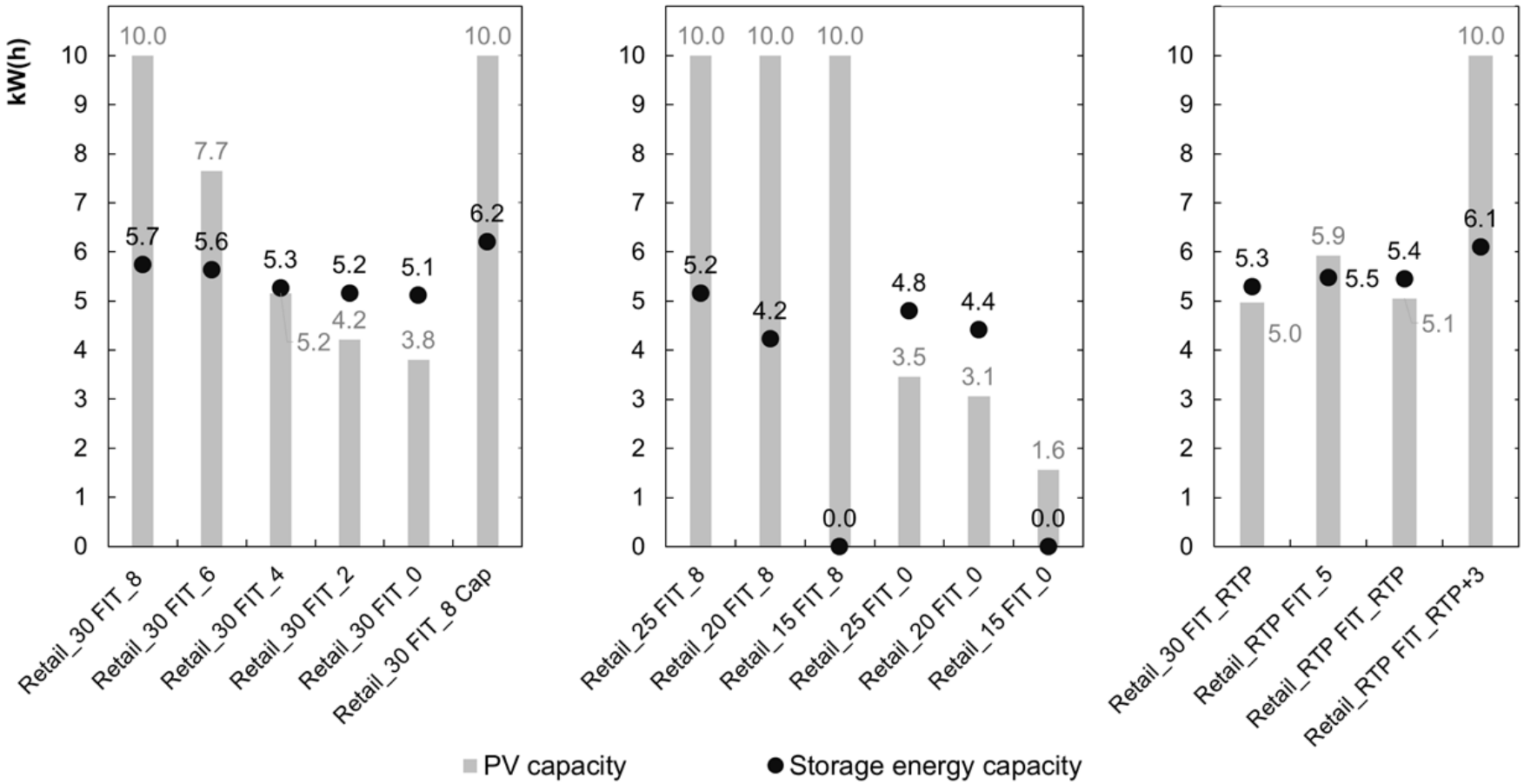
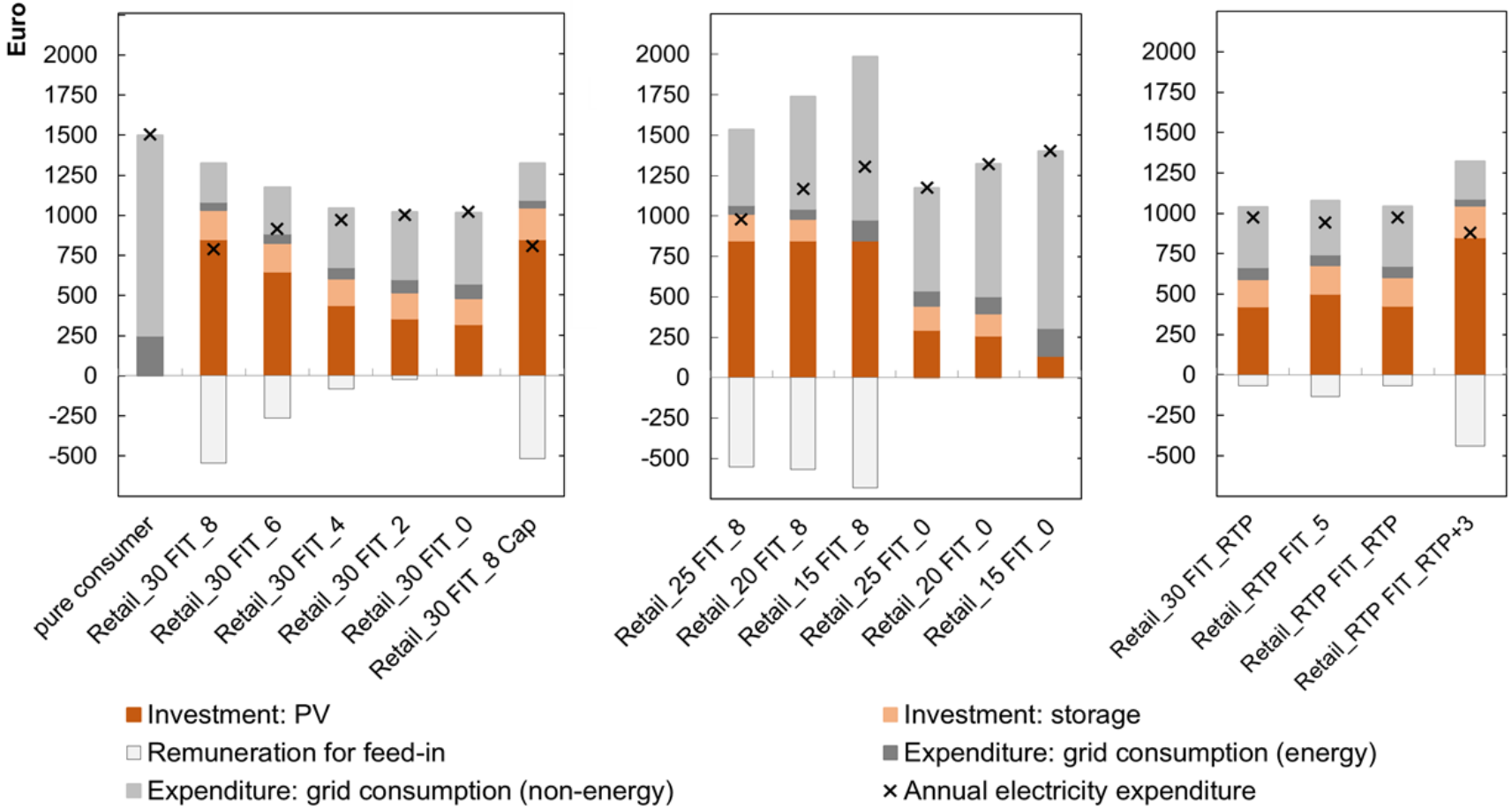
Results: Investment decision



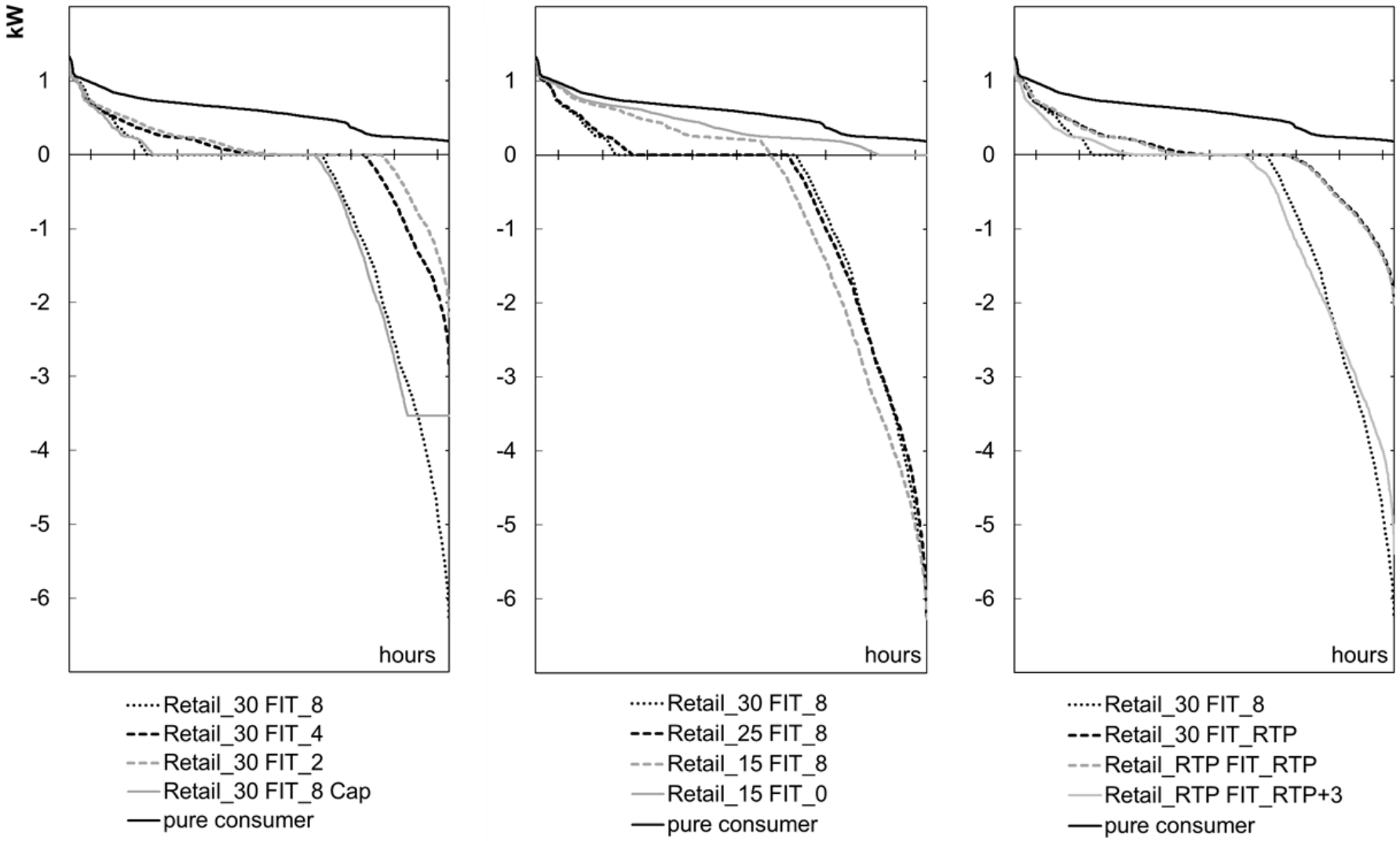
- PV capacities ceteris paribus higher with higher FIT
- Smaller PV capacity, aimed at optimizing self-consumption, if FIT is below LCOE
- Small impact of FIT on storage capacity
- Difference between retail tariff and FIT governs storage investment

Results: household electricity bill



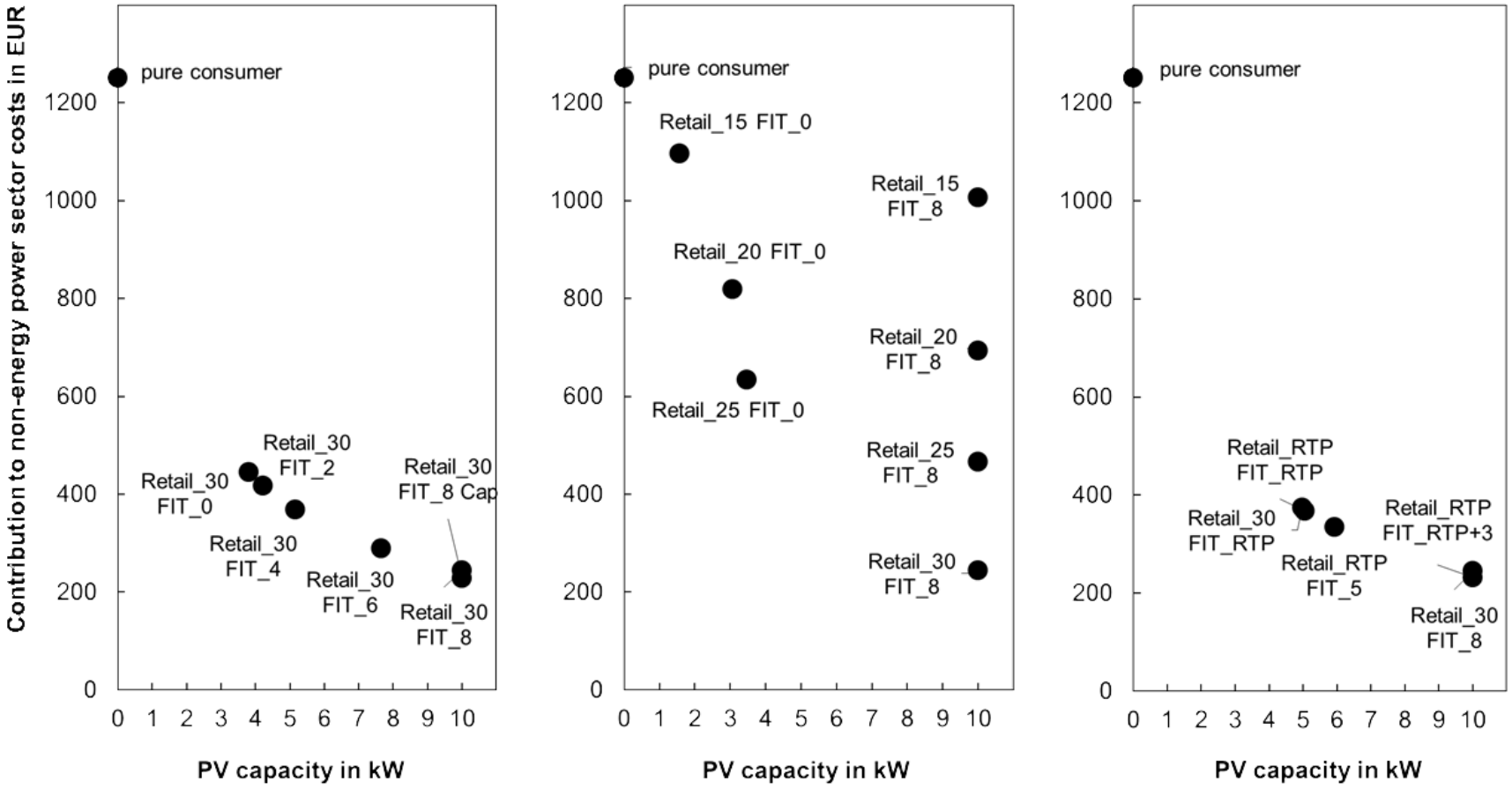
- Higher FIT induces shift from costs for grid consumption toward investment costs
- Higher fixed parts in retail tariffs decrease saving potential of prosumage
- Feed-in cap has minor impact on profits

Results: Peak demand and feed-in



- None of investigated tariff scheme reduces peak grid demand
- Feed-in cap and real-time pricing help to lower peak feed-in

Results: PV expansion versus system fixed costs recovery



- Trade-off between PV expansion and recovery of non-energy system costs
- Combination of high FIT and dominant fixed part in retail tariffs performs best in this regard

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Conclusion

Incentives created through setting tariff for power consumption (retail) & feed-in are fundamentally different

- FIT strongly impacts optimal PV capacity, but less so batteries
- High volumetric retail tariff drives profitability of batteries

Effect of prosumage on system depends on incentives created through tariff design

- No tariff design options clearly dominates
- Sufficiently high FIT and fixed parts in retail tariffs can address both challenges of renewables expansion and system fixed cost recovery
- Feed-in caps can lower feed-in peaks in the grid without causing major disadvantages for prosumagers

Mixed complementarity problem can be used to study effects of prosumage under varying tariff scenarios

- Easy reformulation of existing linear problems
- Ability to simulate real-time pricing options

Thank you for your attention

Open access paper in Energy Policy 152 (2021):
https://doi.org/10.1016/j.enpol.2021.112168

Model version available: https://doi.org/10.5281/zenodo.3345784

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