Competitiveness of different renewable energy community concepts in a smart energy future

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Outline

1. Emerging „Energy Democracy“

Emerging Bottom-Up Developments:

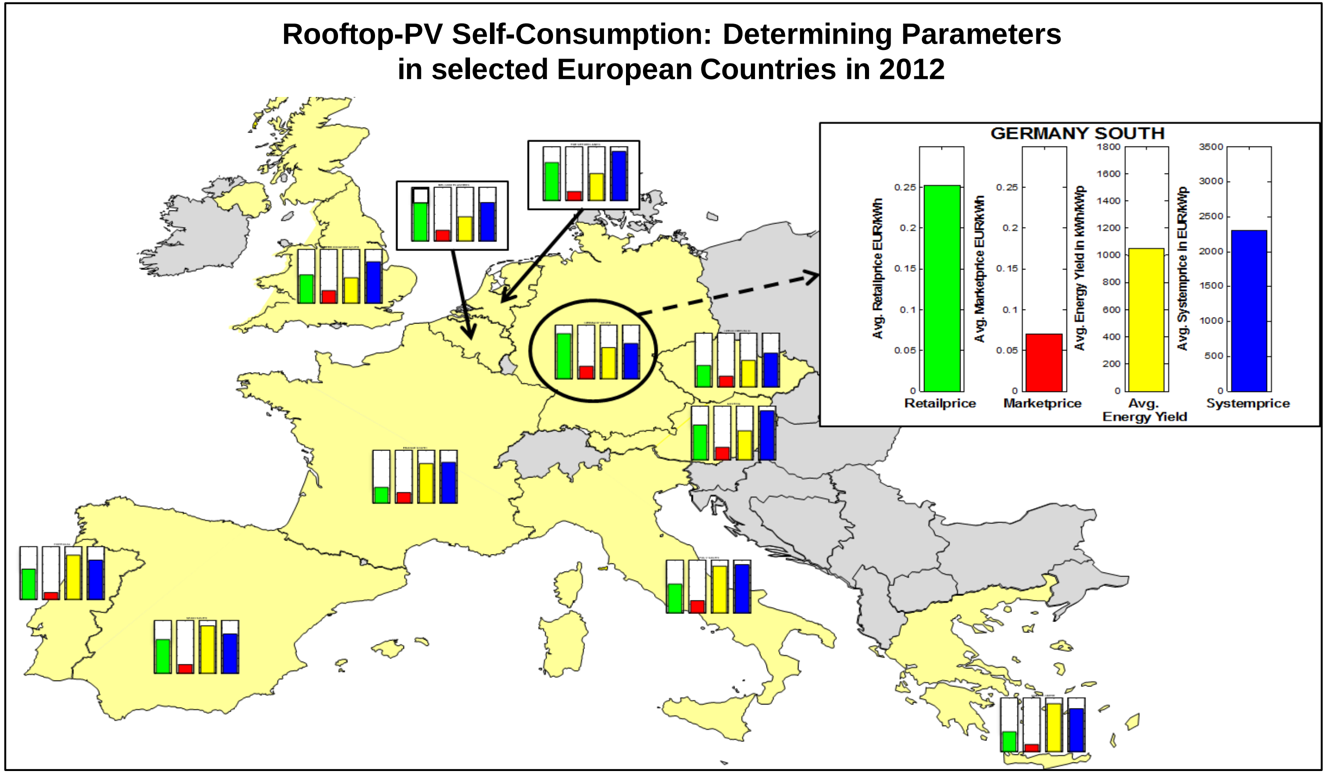
-> Small-scale “plug&play” technologies available (PV, batteries, e-vehicles, ICT)
-> Local self-consumption increasingly visible (-> residual loads)
-> EC policy support: local/citizens’/renewable energy communities
-> Modelling/quantification of local/regional effects in premature stage

Established Top-Down Market Design is Challenged:

-> Improving the frames of the existing energy market set-up
-> This is how majority of our models work (we feel comfortable)
-> Demand is an exogenous constraint we give little attention
(we model at least different elasticities / flexibilities)
-> Arguments: economies-of-scale, cost-efficiency, …

At present, 2 philosophies / paradigms are colliding (also in academia):
-> Energy Planners („Good old world!“) versus
-> Energy Democrats („Dreamers?“)

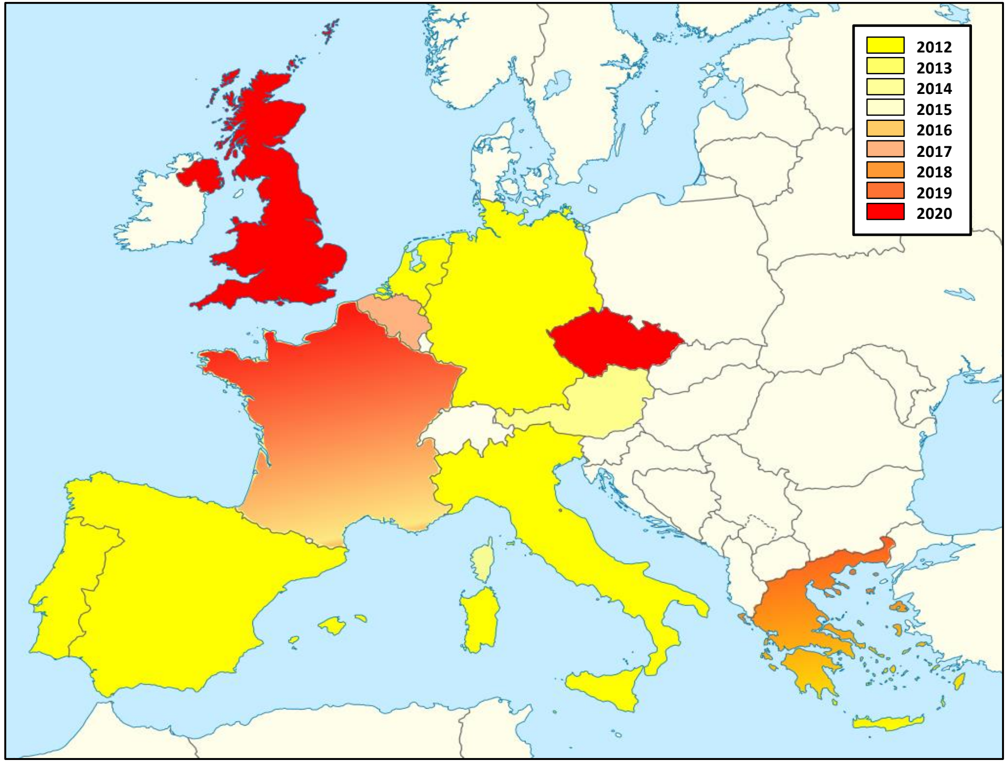
2. Rooftop-PV Competitiveness in Single-Family Houses (1/2)



Source: EEG PV Parity Model Mithras (2012)

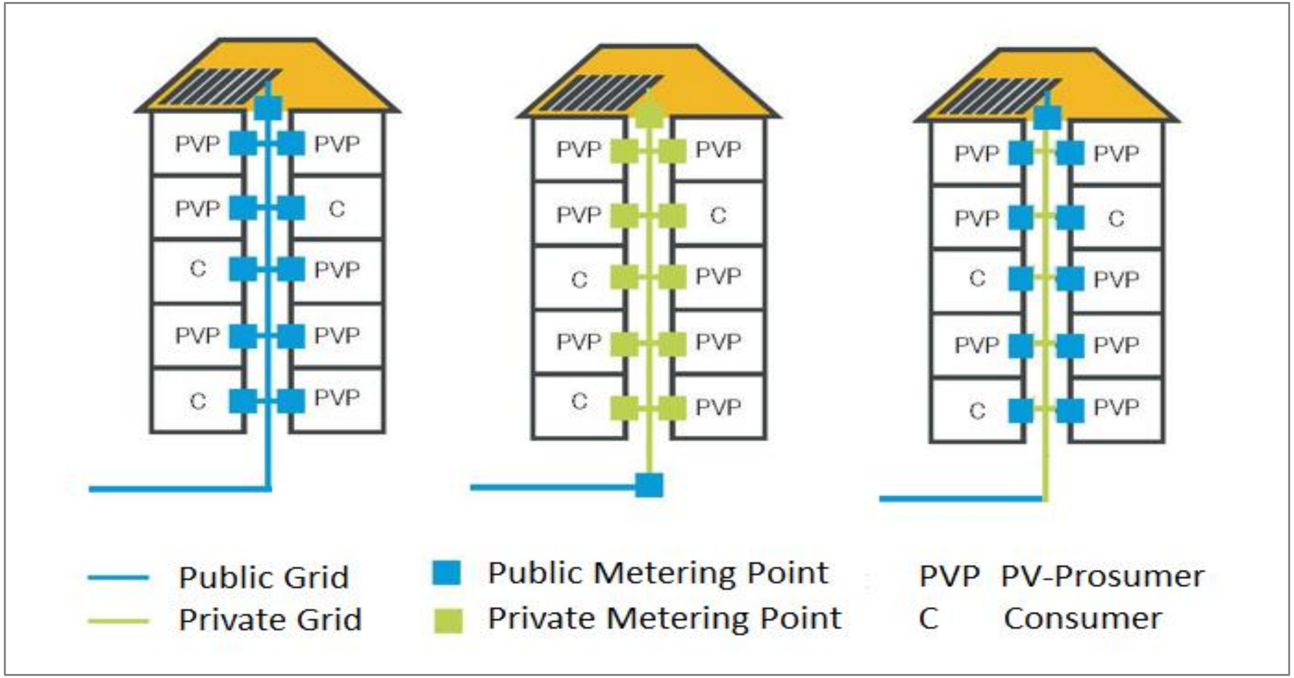
2. Rooftop-PV Competitiveness in Single-Family Houses (2/2)

Trade-Off Year of Competitiveness of PV-Self Consumption



Source: EEG PV Parity Model Mithras (2012)

Possible Boundaries (simplified) between Public and Private Grid as well as Metering Points (w/o common areas like undergeround carpark)

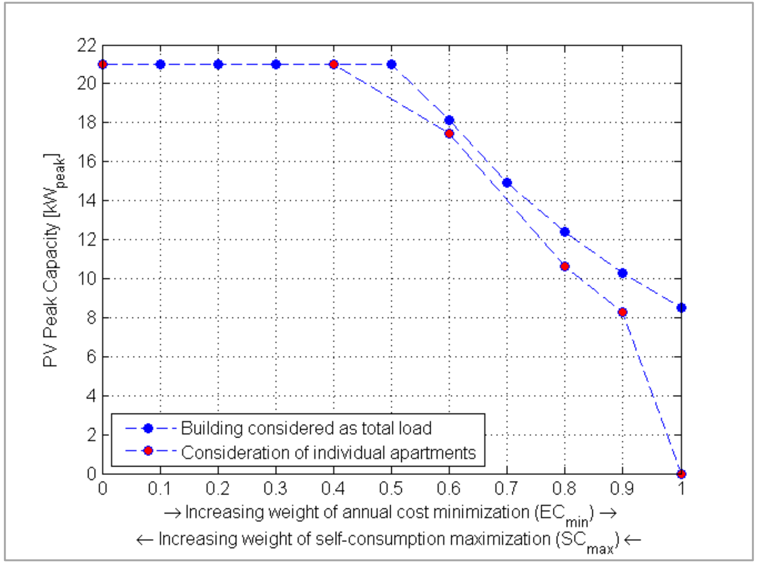


Source: H2020 EU-Project PVP4Grid, www.pvp4grid.eu

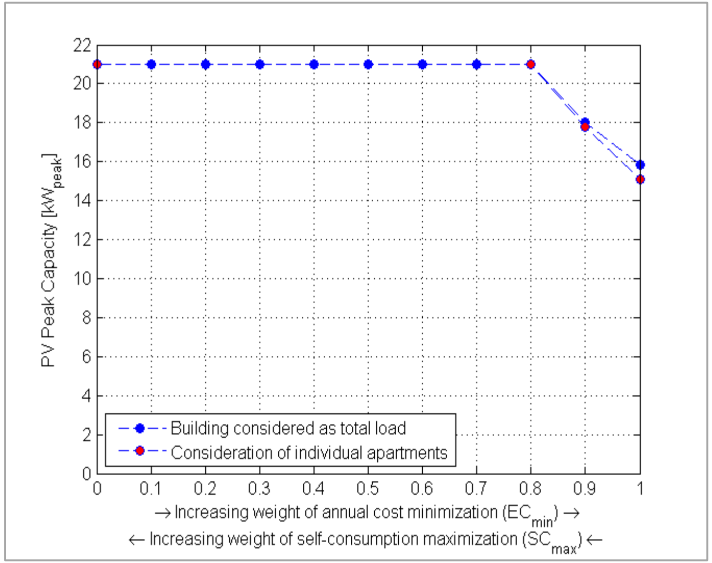
Example: Comparison Austria - Germany

Multi-apartment building with 10 different units
Static versus dynamic PV/load allocation/matching
Multi-objectives: min(total cost) versus max(self-consumption)
Optimization output: optimal installed PV capacity

Austrian Retail Electricity Price 2017

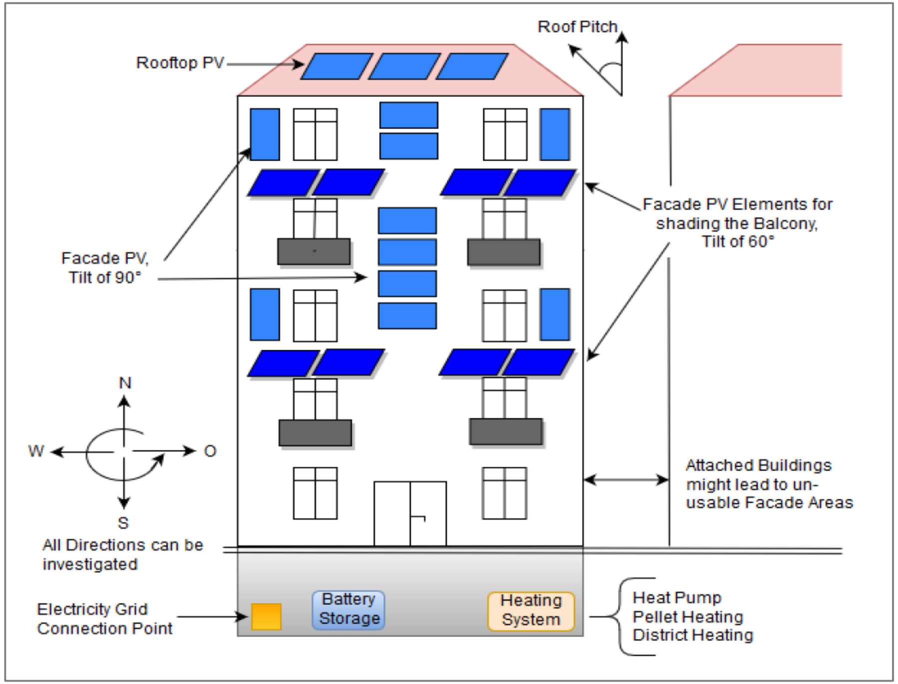


German Retail Electricity Price 2017



Source: Fina et al (2018), Economic Assessment and Business Models of Rooftop Photovoltaic Systems in Multiapartment Buildings: Case Studies for Austria and Germany", Journal of Renewable Energy, 2018, https://doi.org/10.1155/2018/9759680

BAPV / BIPV Sharing Models in Multi-Apartment Buildings

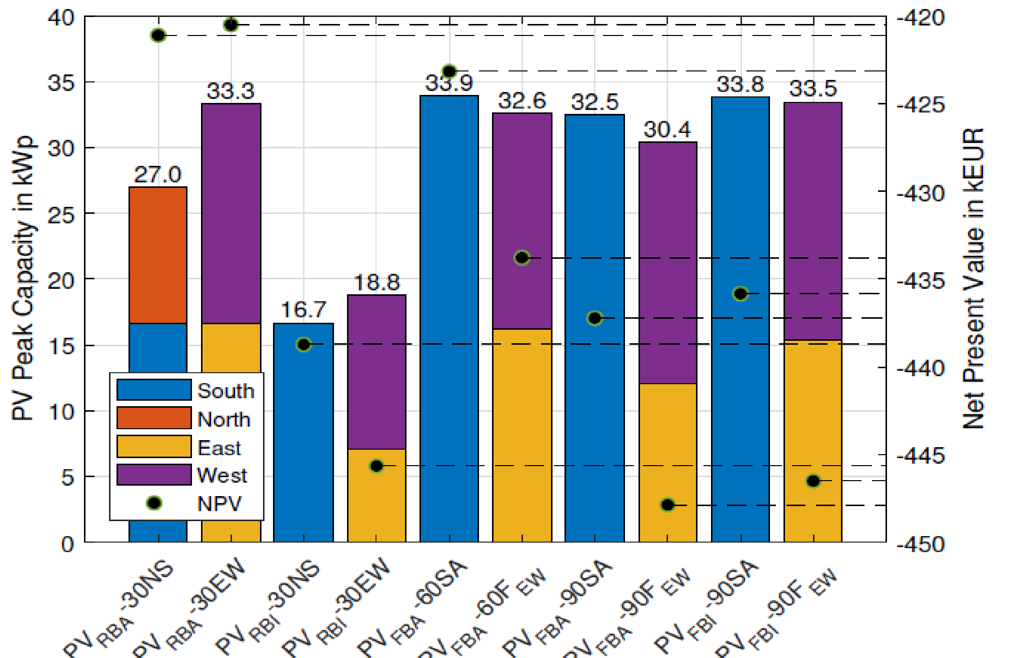


<u>Optimization Model (determining optimal Technology Capacities, Net Present Value):</u>

- BAPV & BIPV
- Static/dynamic PV/Load Allocation
- Voluntary Participation
- Operational Model
- Incl. Investments (Retrofitting, Heating System Changes, etc.)
- System Boundary: Multi-apartment Building
- Sensitivity Analyses: PV Integration Concept, Heating System, Roof Piches, Tenant Portfolio, Building Quality, Retail Electricity and CO_2 Prices,…

Source: Fina et al (2019), Profitability of Active Retrofitting of Multi-Apartment Buildings: Building-Attached/Integrated Photovoltaics with Special Consideration of Different Heating Systems. Energy&Buildings 190 (2019) 86-102. https://doi.org/10.1016/j.enbuild.2019.02.034

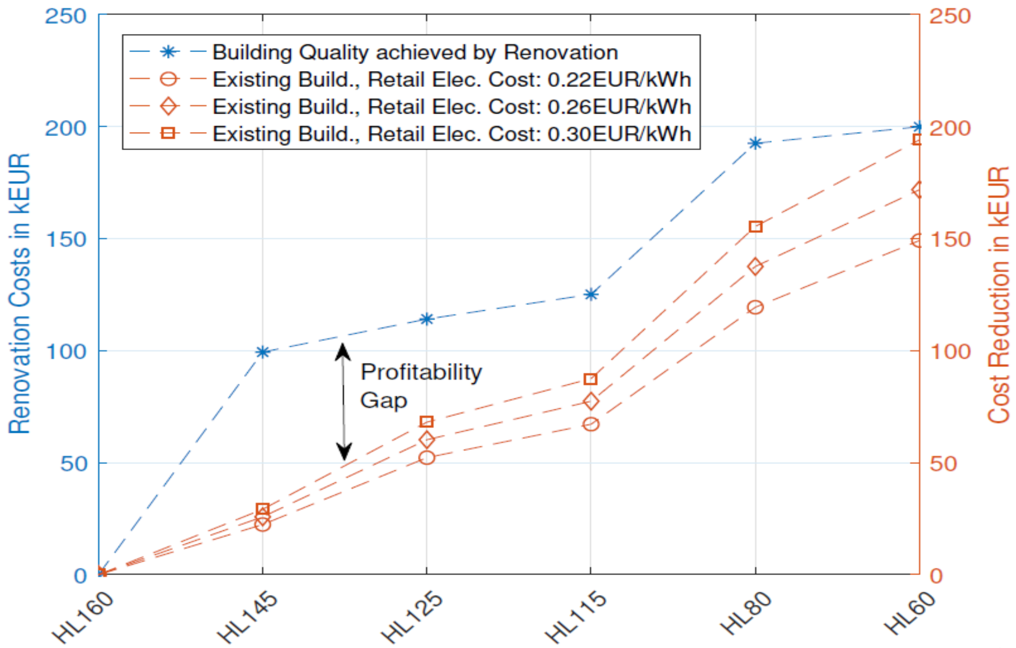
Optimal PV System Size & Profitability of different Building Configurations



Source: Fina et al (2019)

Impact of building configutation and PV implementation concept on optimal PV system size and Net Present Value (NPV). Heat load: 145 kWh/m2/yr; Heating system: monovalent heat pump

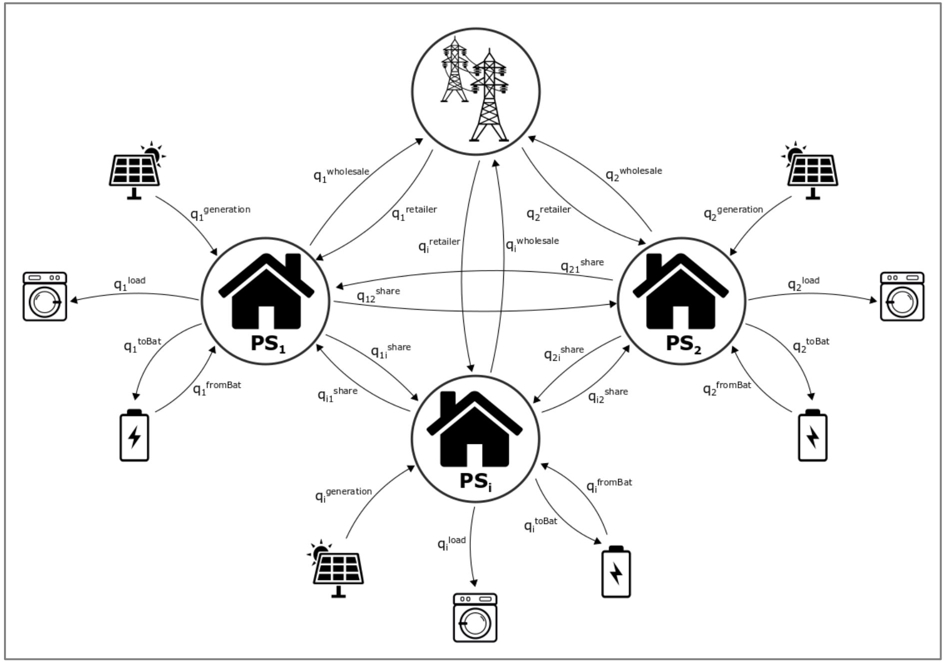
Profitability of PV Sharing & Building Renovation for varying CO_2-Prices



Source: Fina et al (2019)

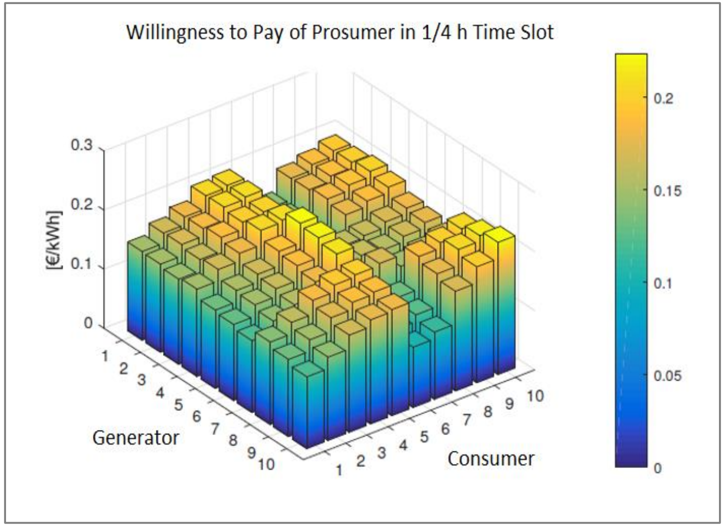
Changes of profitability gap between renovation costs and cost reductions with increasing CO2 prices/ retail prices (80 €/tCO2, 160 €/tCO2). Heating system: monovalent heat pump.

Peer-to-Peer Trading in Local Energy Community



Willingness-To-Pay (WTP) of Prosumers

<u>WTP of Prosumers depends on:</u> (i) Marginal CO2-Emissions
(ii) Spatial Distance

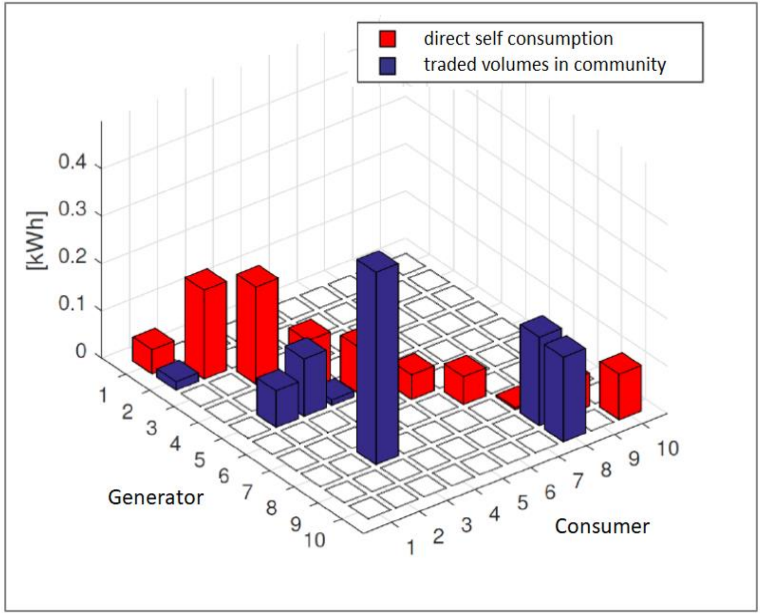


23.01.2018, 11:15-11:30 Uhr
(Marginal Power Plant - CCGT: 490 kgCO2/MWh Marginal Emissions)

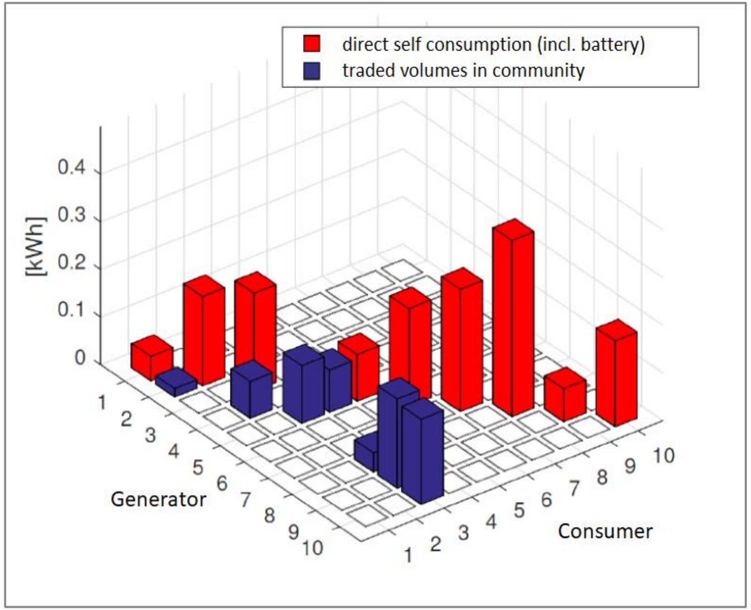
Source: Lukas Wachter (2018): Peer-to-Peer Stromhandel in einem Verteilnetz mit lokaler Photovoltaik Stromerzeugung unter Berücksichtigung verschiedener Zahlungsbereitschaften, Master Thesis, EEG/TU-Wien.

Energy Trades (1/4 h) in Local Energy Community

…without Battery Storage

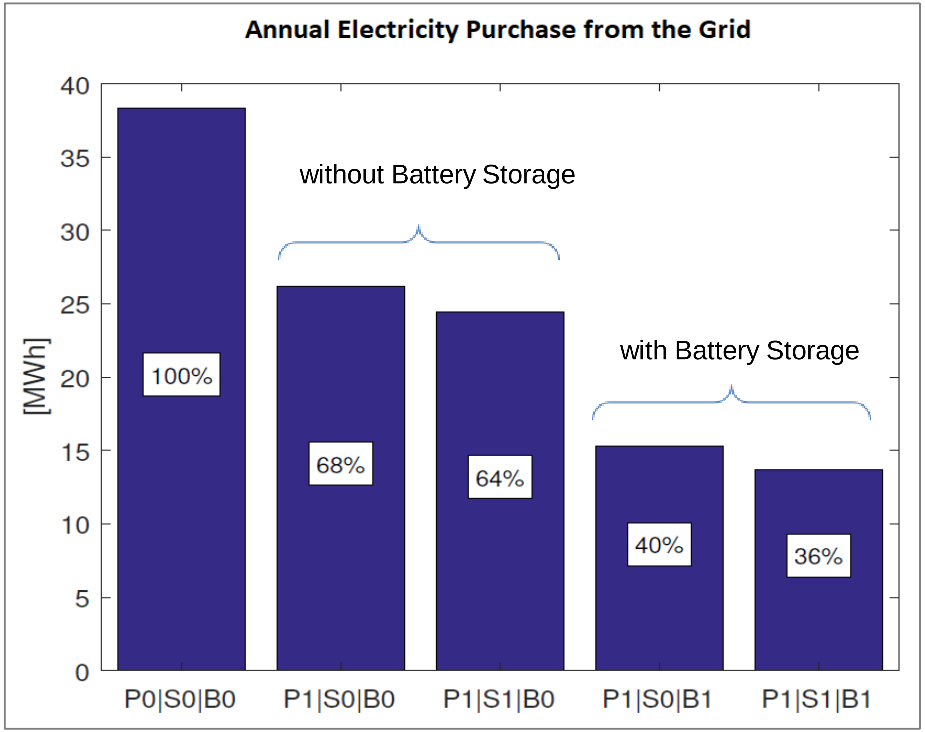


…with Battery Storage



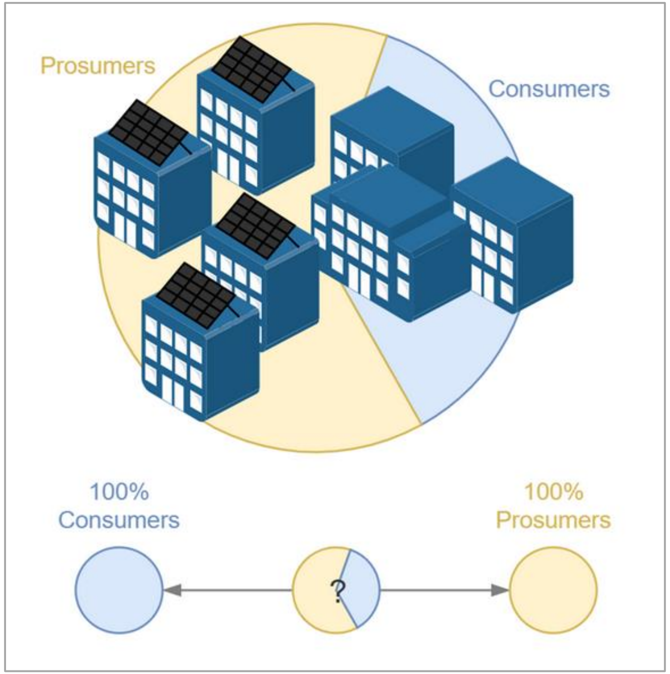
Source: Wachter (2018)

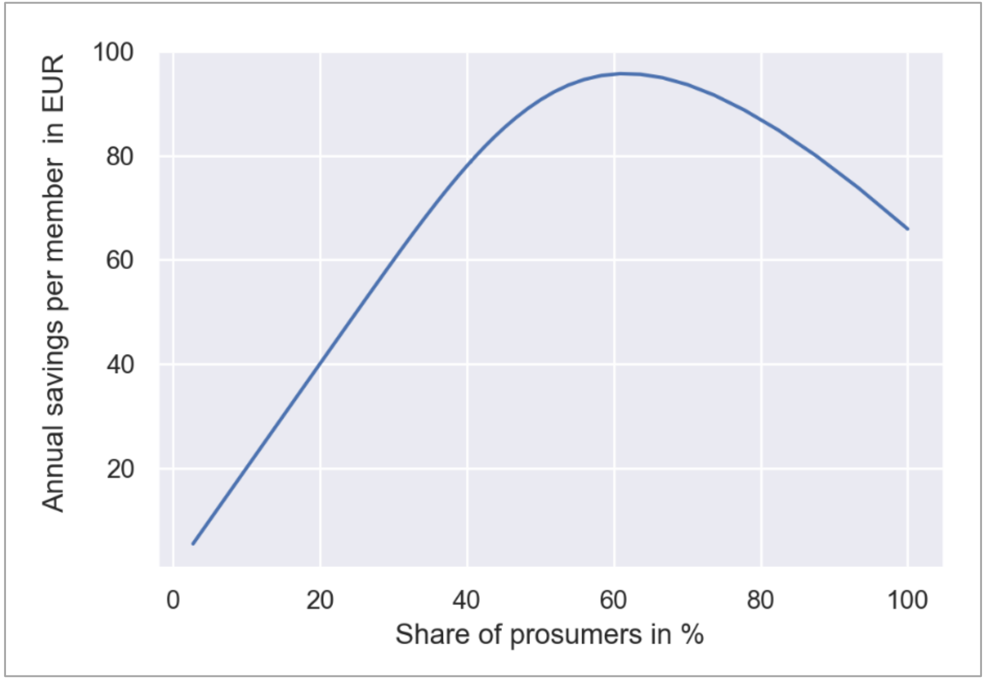
Lessons Learned in Local Energy Community



Source: Wachter (2018)

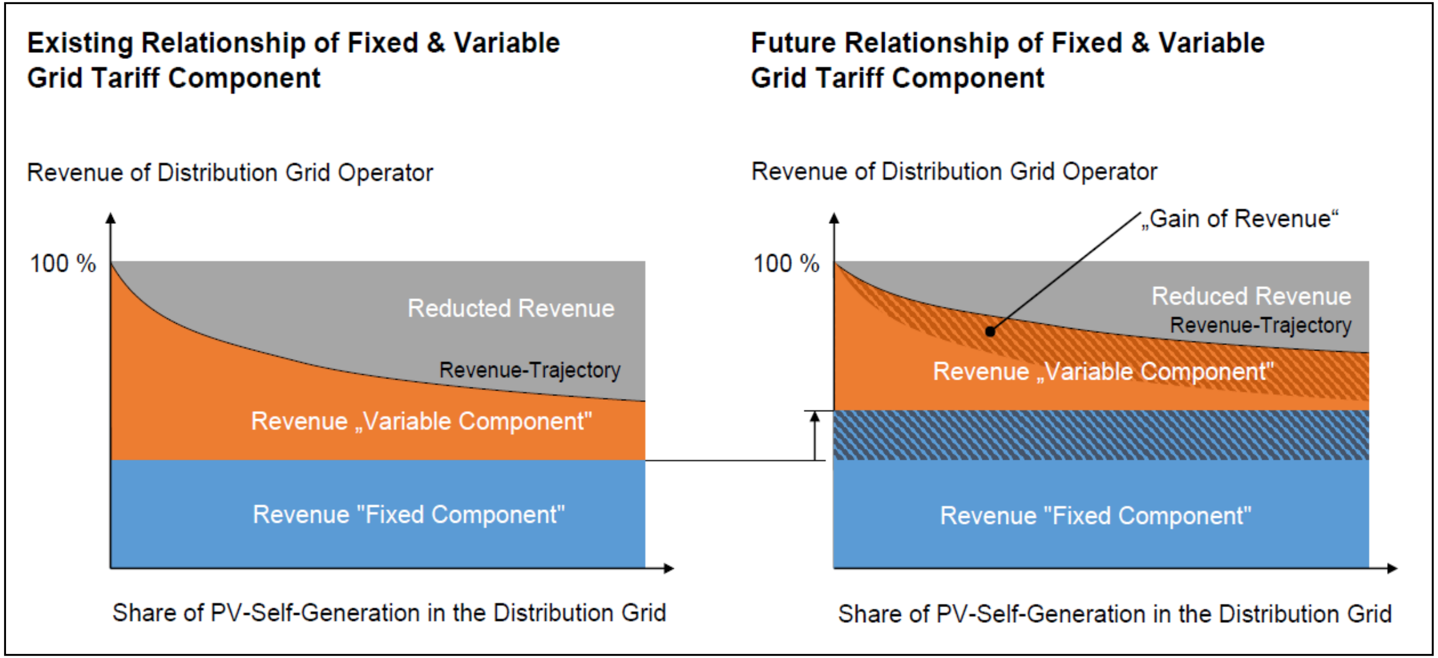
Optimal Composition of a Local Energy Community (Example)





Source: H2020 EU-Project PVP4Grid, www.pvp4grid.eu

Distribution Grid Operator's Revenue Challenge



5. Concluding Remarks - Implications for the Electricity System (1/1)

- Robust business models on local energy community-level will emerge if „old-fashioned“ policy making, legislation and regulations do not prevent cooperation and innovation.
- Energy community concepts will benefit from digitalization and increasingly become self-sufficient (not to be mixed up with autarkic).
- Grid tariff design is expected to head increasingly towards fixed charges in a renewable world.
- This directly impacts profitability of local PV self-generation & PV sharing concepts in the short-term.
- In the longer term, further PV system cost decrease will relieve this negative effect again.
- Then „energy democracy“ is expected to take-off…
- …unimpressed by arguments of „energy planers“ in terms of cost efficiency, economies of scale, utilization rates, etc.
- However, resource adequacy questions safeguarding robust and smooth electricity market operation will become even more essential than today! See e.g. Botterund A., H. Auer: Resource Adequacy with Increasing Shares of Wind and Solar Power: A Comparison of European and U.S. Electricity Market Designs, *Economics of Energy and Environmental Policy*, forthcoming.