16th IAEE European Conference
Ljubljana
25–28 August 2019

Energy Challenges for the Next Decade

#IAEE19LJ

School of Economics and Business, University of Ljubljana, Slovenia

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Energy markets are becoming increasingly complex. Over the past decades, we have witnessed tremendous changes in the industry's fundamentals induced by policy and technological advancement, which required redesigning of markets. Climate policies aimed at decarbonisation extensively contributed to the changed energy mix. Recent shifts in geopolitical relations with the EU partners additionally add to the industry's complexity and uncertainty. The EU energy policy in the next decade continues to be directed towards achieving competitive, secure and sustainable energy system, which calls for huge investments in infrastructure and low-carbon technology with increased involvement of private capital.

The central topic of this conference will be to assess the impacts and identify the main challenges of these events for all energy segments: oil, natural gas and power markets through the entire value chain in order to design a sustainable policy for the following decade. The main question to be addressed is: Have we learned from the experience how to design effective policies for the next decade together with all stakeholders – consumers, companies and governments? We invite you to be a part of this debate by attending this conference and exploring the vibrant city of Ljubljana, the capital of Slovenia and the seat of the EU Agency for the Cooperation of Energy Regulators (ACER).

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

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16th IAEE European Conference: Energy Challenges for the Next Decade
Ljubljana, 25-28 August 2019

Outline

1. Emerging „Energy Democracy“
2. Rooftop-PV Competitiveness in Single Family Houses
3. PV-Sharing Concepts in Multi-Apartment Buildings
4. PV-Sharing Concepts on Local Energy Community Level
5. Concluding Remarks - Implications for the Electricity System

1. Emerging „Energy Democracy“

Emerging Bottom-Up Developments:

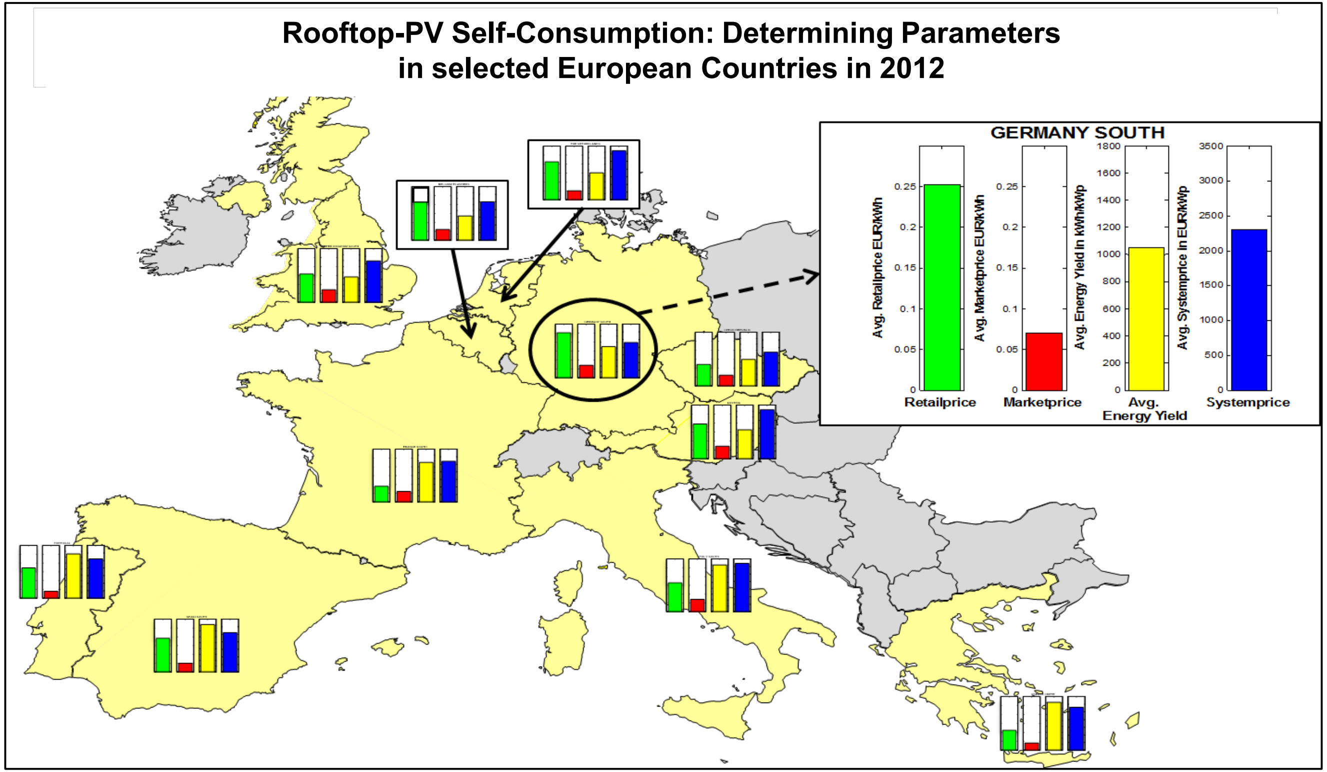
-> Small-scale “plug&play” technologies available (PV, batteries, e-vehicles, ICT)
-> Local self-consumption increasingly visible (-> residual loads)
-> EC policy support: local/citizens’/renewable energy communities
-> Modelling/quantification of local/regional effects in premature stage

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, …

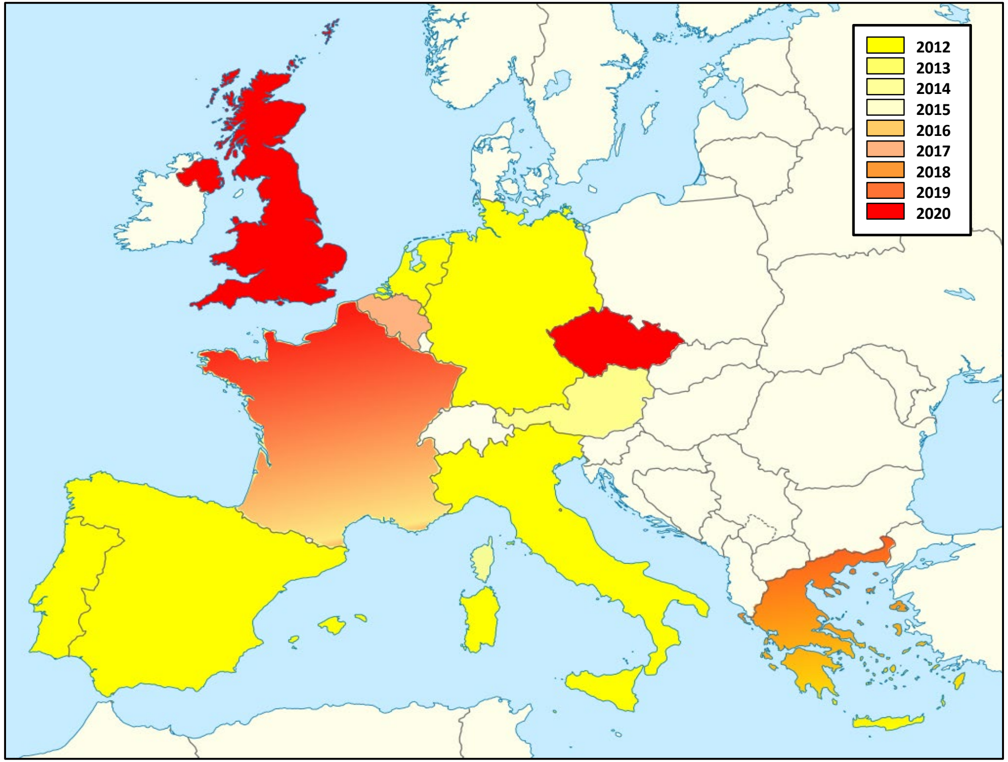
At present, 2 philosophies / paradigms are colliding (also in academia):
-> Energy Planners („Good old world!“) versus
-> Energy Democrats („Dreamers?“)

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



Source: EEG PV Parity Model Mithras (2012)

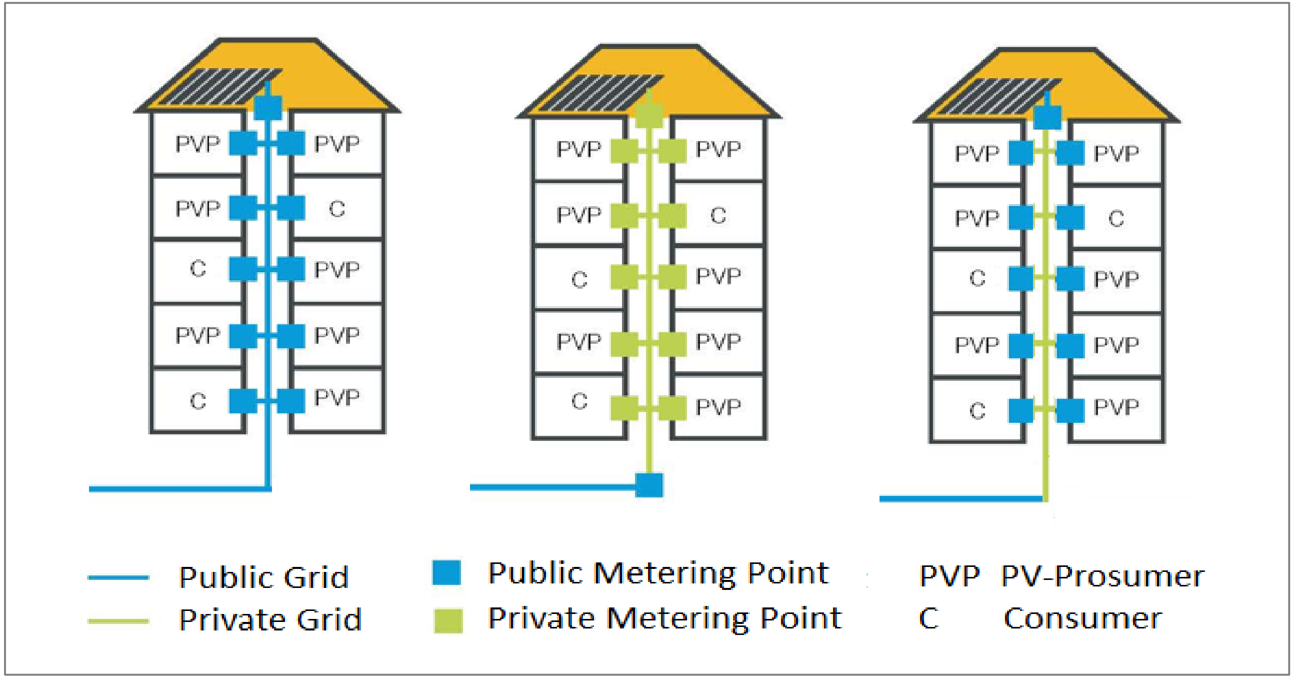
Trade-Off Year of Competitiveness of PV-Self Consumption



Source: EEG PV Parity Model Mithras (2012)

3. PV-Sharing Concepts in Multi-Apartment Buildings (1/5)

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

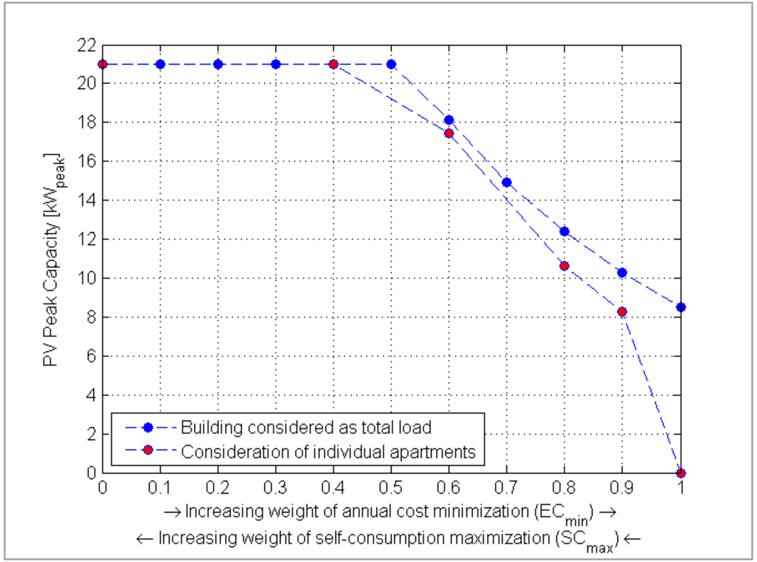


Source: H2020 EU-Project PVP4Grid, www.pvp4grid.eu

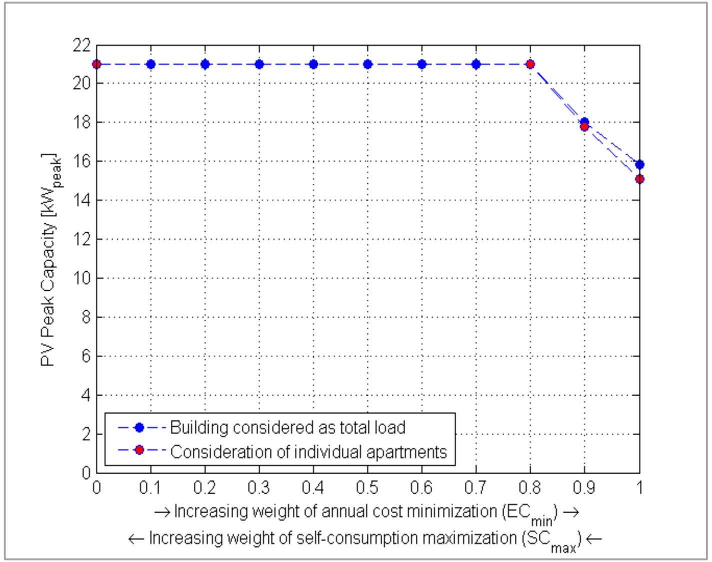
Example: Comparison Austria - Germany

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

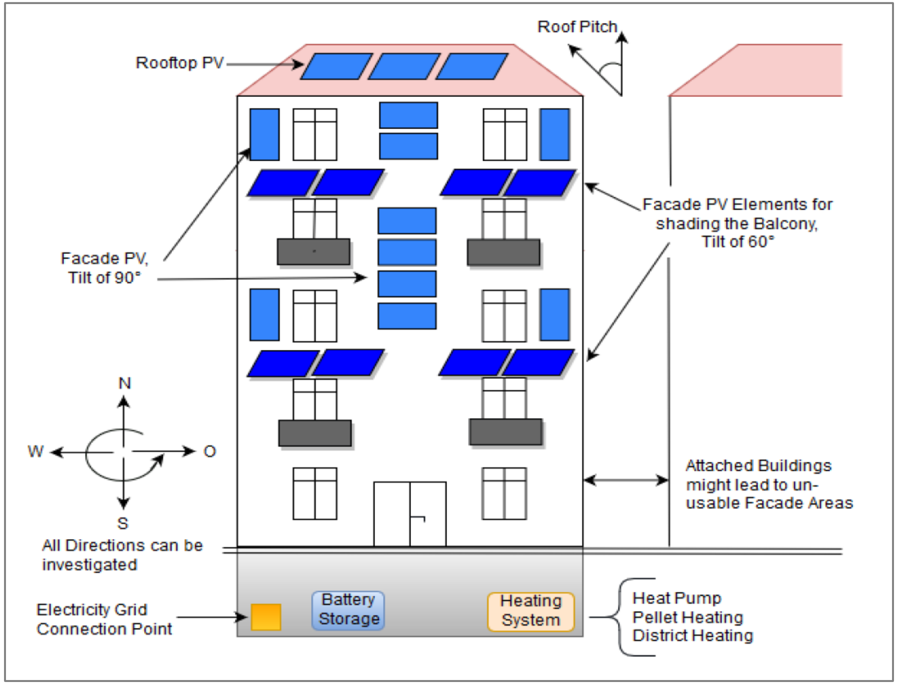


German Retail Electricity Price 2017



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

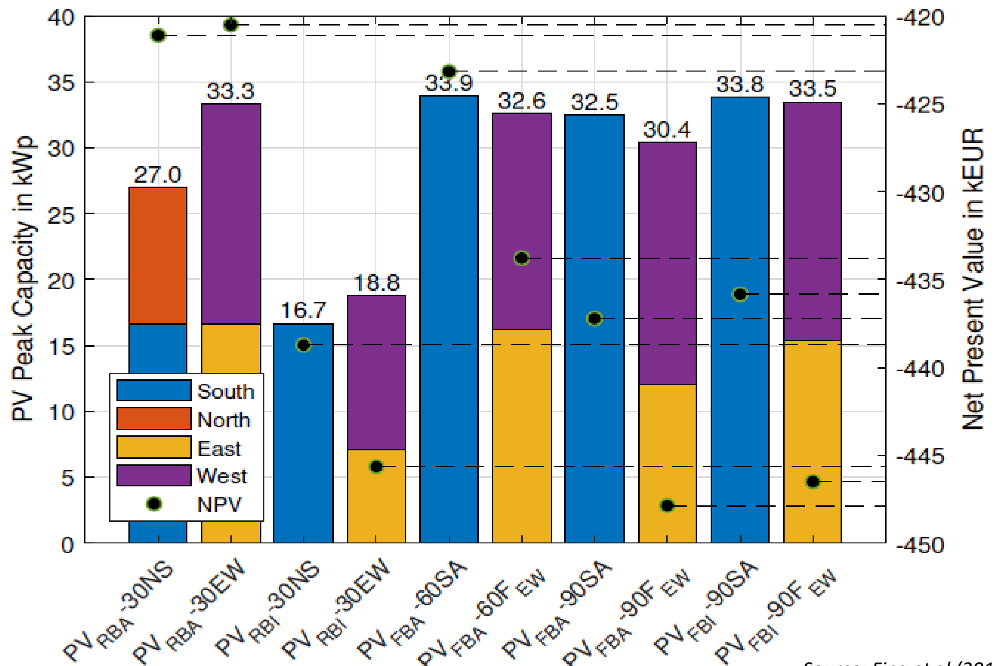


Optimization Model (determining optimal Technology Capacities, Net Present Value):

- 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

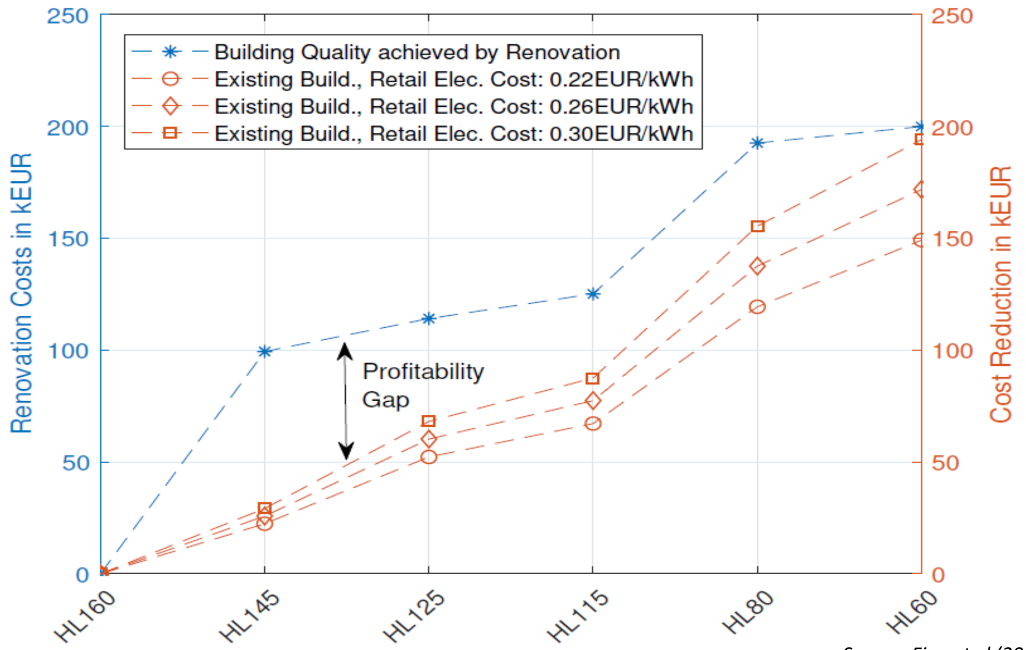


Source: Fina et al (2019)

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

3. PV-Sharing Concepts in Multi-Apartment Buildings (5/5)

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

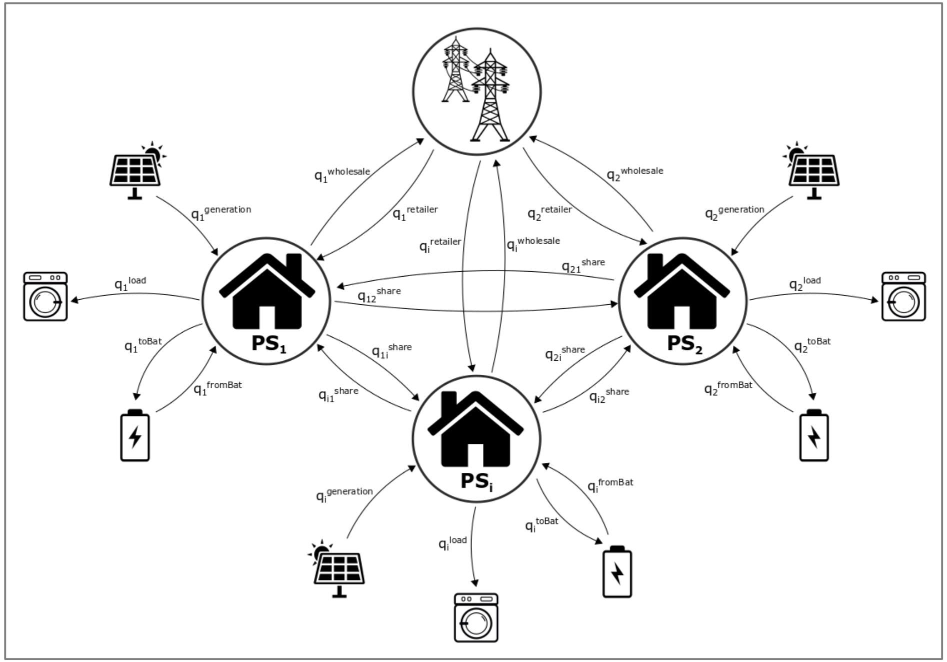


Source: Fina et al (2019)

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.

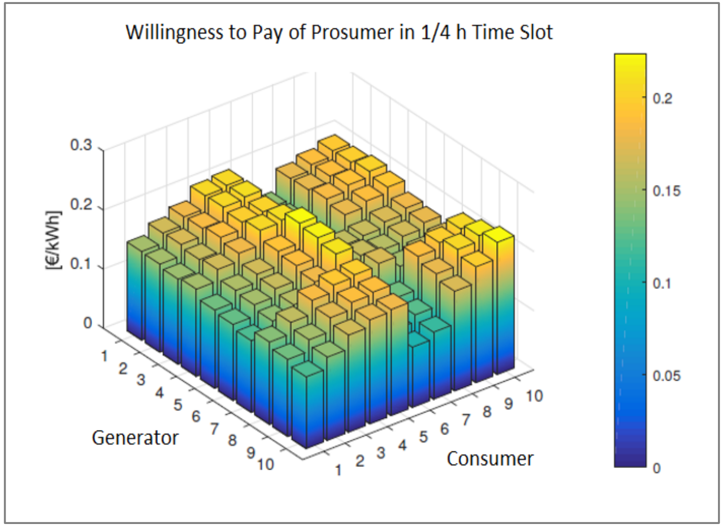
4. PV-Sharing Concepts on Local Energy Community Level (1/5)

Peer-to-Peer Trading in Local Energy Community



Willingness-To-Pay (WTP) of Prosumers

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

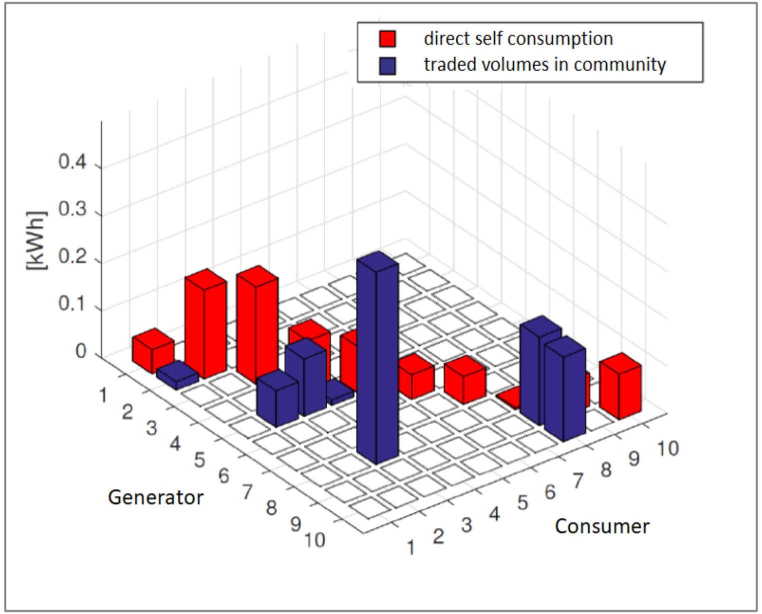


23.01.2018, 11:15-11:30 Uhr
(Marginal Power Plant - CCGT: 490 kgCO2/MWh Marginal Emissions)

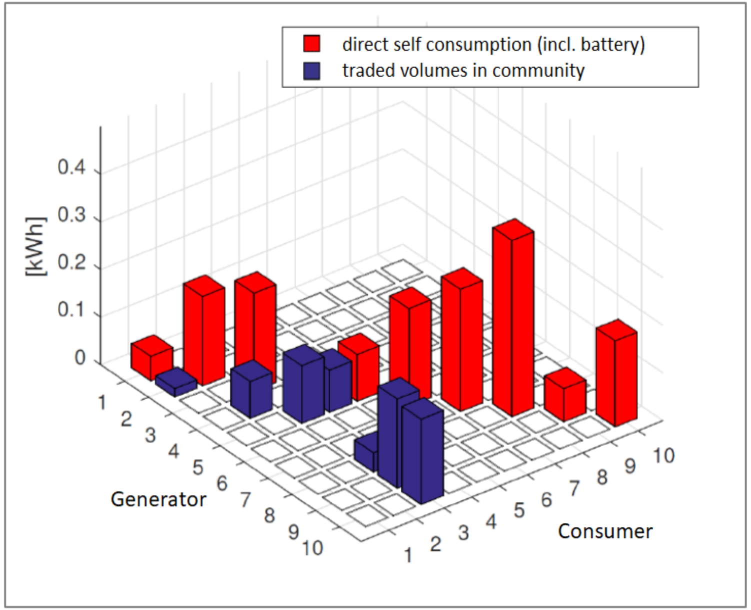
Source: Lukas Wachter (2018): Peer-to-Peer Stromhandel in einem Verteilnetz mit lokaler Photovoltaik Stromerzeugung unter Berücksichtigung verschiedener Zahlungsbereitschaften, Master Thesis, EEG/TU-Wien.

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

…without Battery Storage

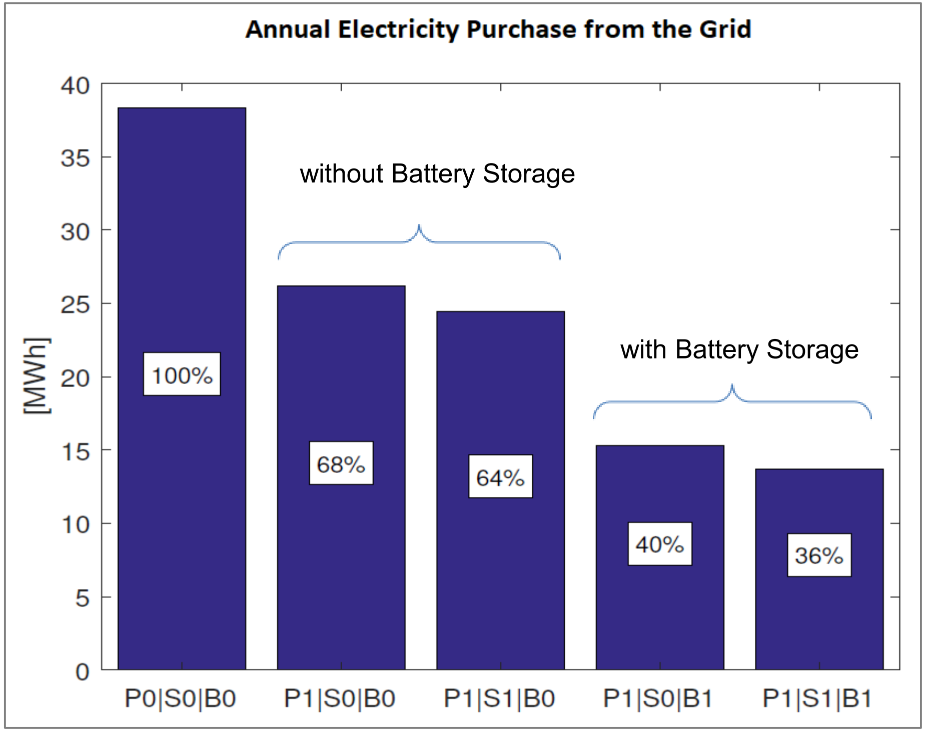


…with Battery Storage



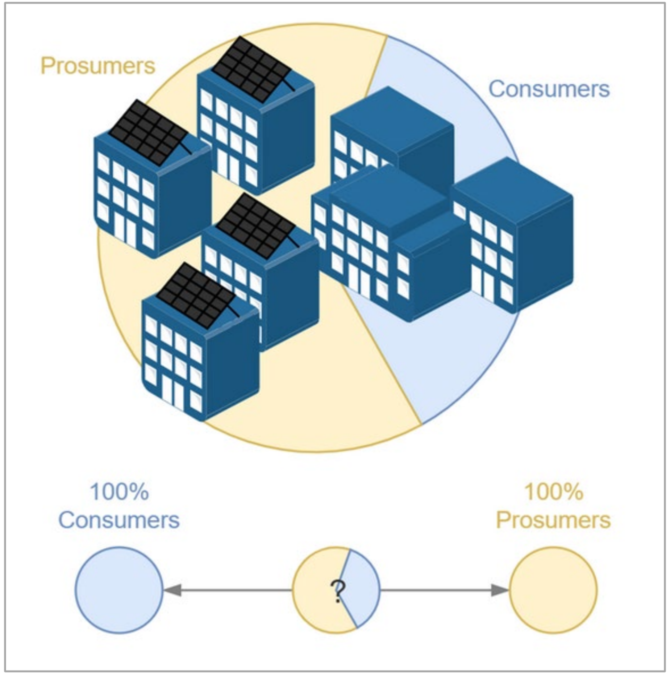
Source: Wachter (2018)

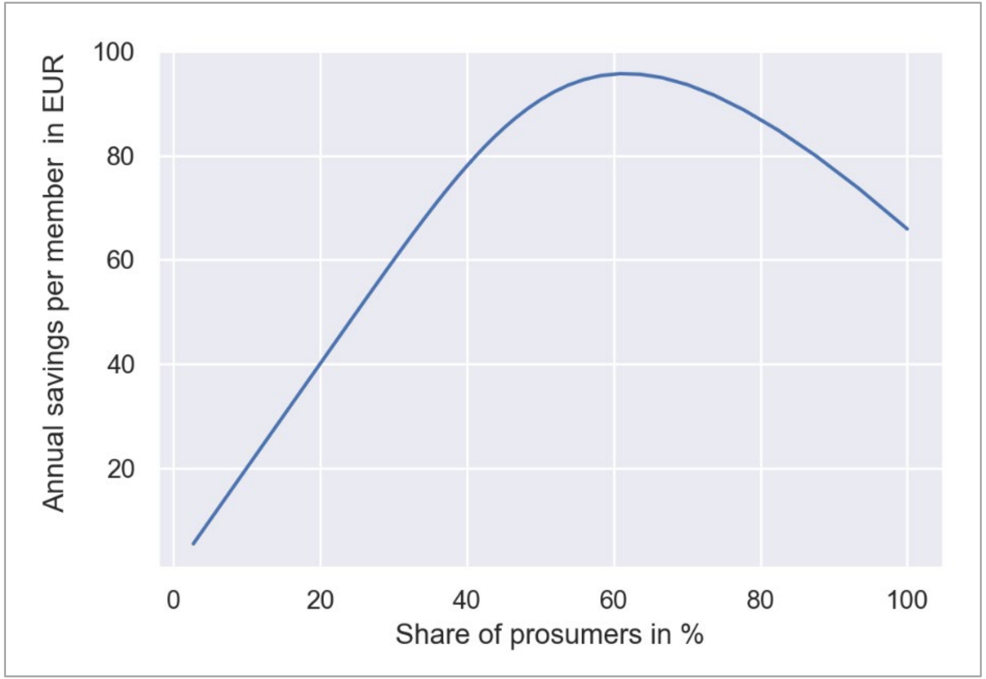
Lessons Learned in Local Energy Community



Source: Wachter (2018)

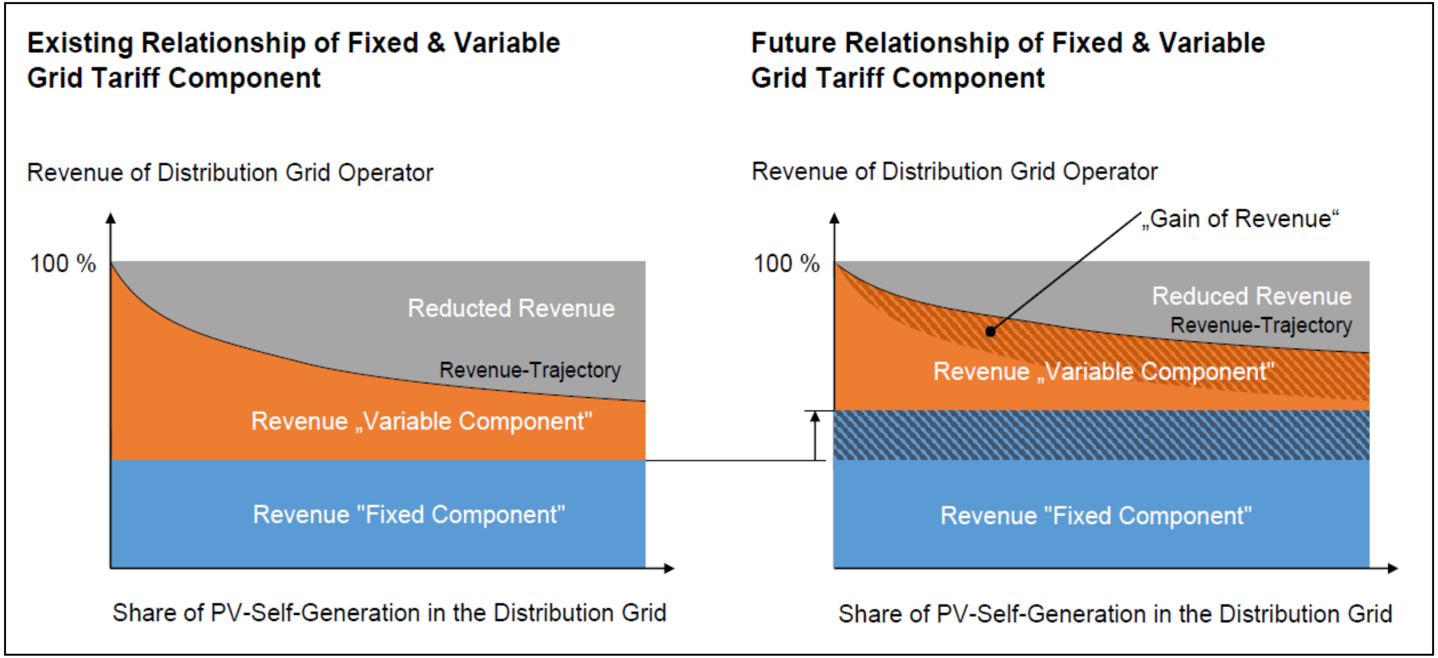
Optimal Composition of a Local Energy Community (Example)





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. Botterud 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.