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The 1<sup>st</sup> IAEE Online Conference takes place on 7th – 9th June 2021

**IAEE Award Ceremony** 



This digital conference is exceptional in many ways:

 It offers to bring together energy economists, policymakers and business leaders from around the world in real time for 3 consecutive days. This event will allow a non-stop exchange from San Francisco to Tokyo.

2. It will feature mid-day keynote addresses to bring together a global audience in a common time zone.

3. It will address the ideal climate and energy policy regime that should simultaneously respond to potentially conflicting objectives, especially in the era of COVID: ensuring energy security, promoting universal access to affordable energy services, and fostering greener and more sustainable energy systems while taking into account geopolitical and economic dimensions.

In this context, IAEE's international online conference aims to bridge the latest scientific advances in energy economics and its relevance to practical experiences in the energy sector. It will also host 180 parallel sessions and numerous poster sessions. The digital edition reaches out to a wider global audience, regardless of time zone, and provides a unique online platform for academics, policymakers, and business leaders from around the world to present and discuss the latest economic research on pressing energy issues in an open, non-partisan setting.

#### News



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## On the Potential of Rooftop-PV as a Household Appliance with negative Electricity Demand – Evidence from Austria

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1<sup>st</sup> IAEE Online Conference: Energy, Covid, and Climate Change 7<sup>th</sup> – 9<sup>th</sup> June 2021





PV Deployment – Two "Colliding" Philosophies / Paradigms

PV Systems – Household Appliances with negative Electricity Demand & Distribution Grid Operators' Revenue Challenge

PV-Sharing/Trading Concepts – Multi-Apartment Buildings & Energy Communities at different Geographical Borders

Residential Building Integrated PV Energy Community Potential in Austria

**Concluding Remarks** 



### Energy Planners ("Centralists!")

versus

### Status Quo:

- PPAs (Power Purchase Agreements) work out, but...
- Economic cannibalism of utility-scale PV in energyonly markets! *See e.g. Californian "Duck Curve"*



### Future:

- PPAs (Power Purchase Agreements)
- Cross-sectoral demand bidding based on consumers' opportunity cost? See e.g. Härtel/Korpås: Demystifying market clearing and price setting effects in low-carbon energy systems, https://doi.org/10.1016/j.eneco.2020.105051
- Trading of other than current (firm) products, like flexibilities, power gradients, etc.?

### Energy Democrats ("Dreamers?")

### Status Quo:

- Building attached/integrated PV is "THE" key technology enabling energy democracy (onsite generation, energy communities, local markets)
- Physics of energy management is looked at more closely again (individual supply/demand matching)
- At present mainly legal & regulatory barriers as well as techno-economic challenges for distribution grid operators



![](_page_4_Picture_0.jpeg)

![](_page_4_Picture_2.jpeg)

Purchasing less electricity from the grid...

...the brave ones!

![](_page_4_Figure_5.jpeg)

...the "nest defilers/selfish" (quitting alleged solidarity)?

![](_page_4_Picture_7.jpeg)

Solar PV tax (above 25,000 kWh) in Austria for contributing to the implementation of the EU Energy Efficiency Directive? There is something wrong, but maybe I do not understand the energy transition at all...;-)

![](_page_5_Picture_0.jpeg)

![](_page_5_Picture_2.jpeg)

### Incentive to increase fixed grid tariff component (right figure) to compensate for (parts of) revenue losses...

![](_page_5_Figure_4.jpeg)

## Regulatory Theory – High Fixed Grid Tariff Component Justified?

![](_page_6_Picture_1.jpeg)

### Definition of a Natural Monopoly (Grid):

- Subadditivity of Cost (necessary condition)
- Economies of Scale (sufficient condition); capital intensive grids lead to declining average cost
- Sunk cost (additional attribute)

![](_page_6_Figure_6.jpeg)

# PV Self-consumption & Energy Communities lead to more elastic electricity demand:

Less grid electricity delivered -> increase of fixed grid tariff component (over time not only once) -> negative feedback loop for PV self-consumption -> seeking for more diversified & aggregated loads in bigger energy communities -> Peer-to-Peer trading

![](_page_6_Figure_9.jpeg)

![](_page_7_Picture_0.jpeg)

![](_page_7_Picture_2.jpeg)

![](_page_7_Figure_3.jpeg)

Source: EEG PV Parity Model Mithras (2012)

![](_page_8_Picture_0.jpeg)

![](_page_8_Picture_2.jpeg)

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

![](_page_8_Figure_4.jpeg)

![](_page_9_Picture_0.jpeg)

![](_page_9_Picture_2.jpeg)

### BAPV / BIPV Sharing Models in Multi-Apartment Buildings

![](_page_9_Figure_4.jpeg)

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<sub>2</sub> 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

## PV-Sharing Concepts in Multi-Apartment Buildings (3/4)

![](_page_10_Picture_1.jpeg)

![](_page_10_Figure_2.jpeg)

WIEN

![](_page_10_Figure_3.jpeg)

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

![](_page_11_Picture_0.jpeg)

![](_page_11_Picture_2.jpeg)

### Profitability of PV Sharing & Deep Building Renovation for varying CO<sub>2</sub>-Prices

![](_page_11_Figure_4.jpeg)

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.

![](_page_12_Picture_0.jpeg)

![](_page_12_Picture_2.jpeg)

PV Sharing & Peer-to-Peer Trading in Energy Communities at different Geographical Borders

![](_page_12_Figure_4.jpeg)

<u>Advantage of energy community compared to microgrid:</u> neither physical connectivity nor mandatory participation is expected; however, an energy community can also perfectly coincide with a microgrid

## Different Categories of Residential PV Energy Communities (2/4)

![](_page_13_Picture_1.jpeg)

### Representative Residential PV Energy Communities for typical Austrian Settlement Patterns\*

![](_page_13_Figure_3.jpeg)

(Austrian overall 2030 PV Target)

## Cost-Optimal PV Capacities for varying PV Sharing Allocation (3/4)

![](_page_14_Picture_1.jpeg)

### <u>10 Multi-apartment buildings</u> in <u>city</u> EC

![](_page_14_Figure_3.jpeg)

### <u>10 Single-family buildings in rural</u> EC

![](_page_14_Figure_5.jpeg)

(i) Buildings in EC with feasible PV rooftops - individual PV self-consumption

(ii) Buildings in EC with feasible PV rooftops – optimal PV sharing among those with PV

(iii) All buildings in EC (also those without PV) – optimal PV sharing among all buildings in EC

![](_page_15_Picture_0.jpeg)

![](_page_15_Picture_2.jpeg)

Cost-Optimal Rooftop PV System Sizes (Capacities) for ...

... individual ECs per Settlement Pattern

...Austria (upscaled on Country-level)

![](_page_15_Figure_6.jpeg)

![](_page_16_Picture_0.jpeg)

![](_page_16_Picture_2.jpeg)

- PV systems are household appliances with negative electricity demand
- Even more, PV can be the high-end technology in deep renovation of buildings
- "Energy democracy" will take-off, supported by technology innovation & digitalization
- "Electricity autarky" is NOT the goal, but exploitation of synergies via energy communities
- Legislative/regulatory barriers prevent rapid PV implementation in buildings
- Amendments in distribution grid regulation / tariff setting are urgently needed:
  - Grid infrastructure capacities must be able to cope with the most challenging supply/ demand patterns during the year
  - Thus, much greater weighting of the fixed grid tariff component to ensure stable revenue streams for the distribution grid operator
  - Adding new dynamic grid tariff component sending correct price signals about current grid state
- Lower variable grid tariff component has negative impact on profitability of PV self-consumption:

- Incentives for formation of suitable energy communities

- An increasing CO<sub>2</sub> price is reflected in an increasing variable electricity tariff component again...