Assessment of regional peer-to-peer electricity trading

18th IAEE European Energy Conference

INES Institute of Sustainable Energy Systems

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Outline

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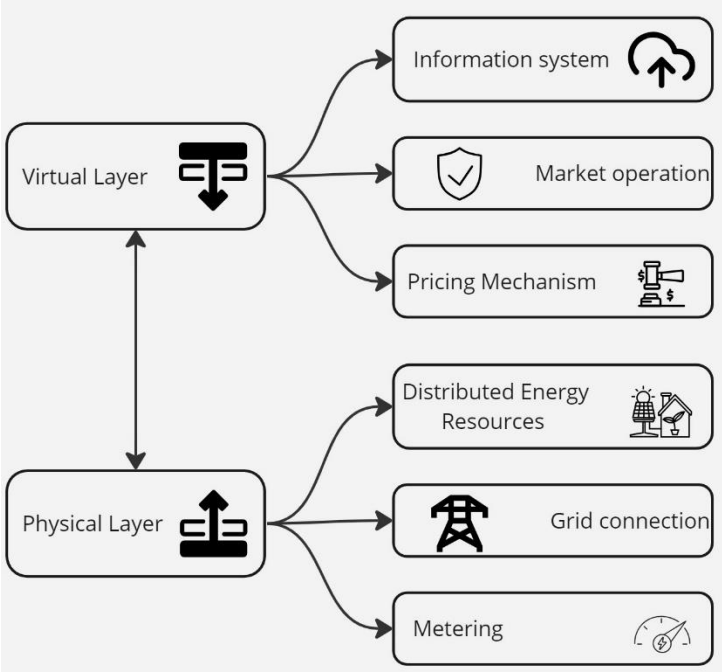
- Overview
- Purpose of research
- Methodology
- Results
- Outline

Overview
What is actually peer-to-peer electricity trading (P2P-ET)?

Direct way of electricity trading between consumers and prosumers, without classic intermediaries

- Integration of
  - Physical Layer
  - Virtual Layer

- Potential benefits
  - Electricity bill cost savings
  - Grid flexibility
  - Active participation

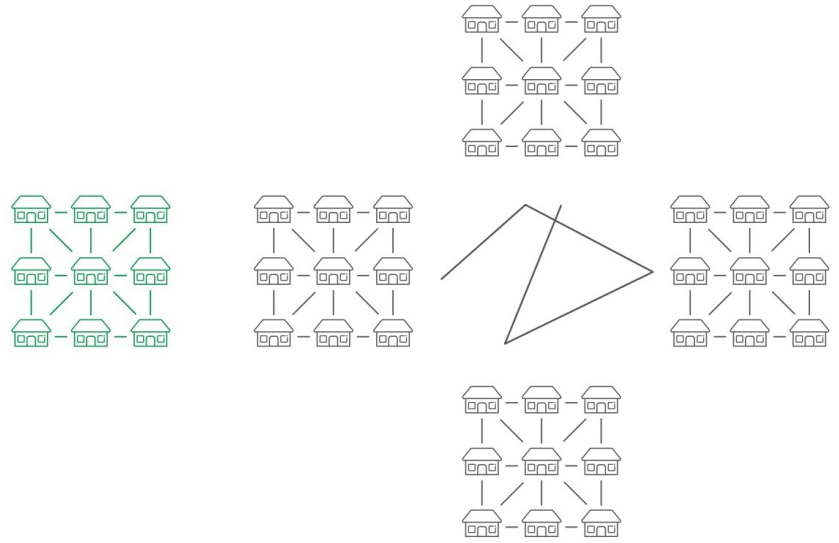


Overview
What is actually peer-to-peer electricity trading (P2P-ET)?

Direct way of electricity trading between consumers and prosumers, without classic intermediaries

- Classifications
  - Local P2P
  - Regional P2P

- Market types
  - Centralized
  - Distributed
  - Decentralized



Source: IRENA, Peer-to-Peer Electricity Trading. Adapted from Park and Young, 2017

Overview
Climate neutrality in Baden Wurttemberg (BW)

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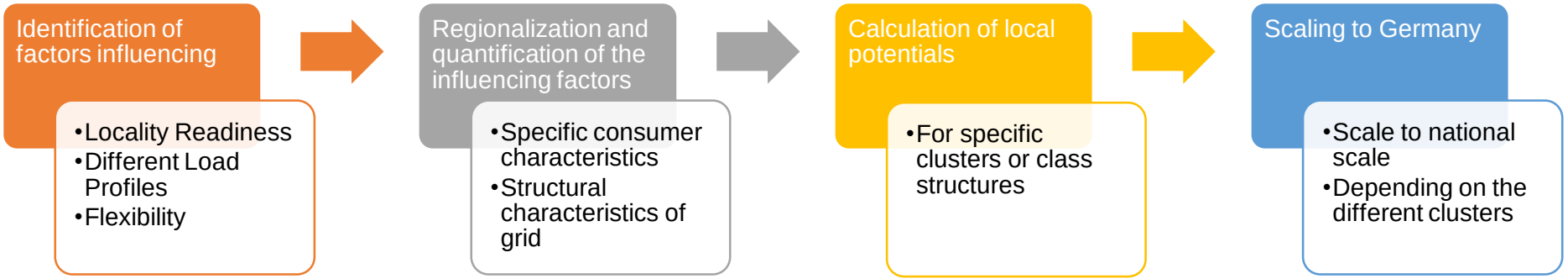
New climate objective: BW climate-neutral until 2040

- Milestones to achieve climate goals in 2040
  - 7 x wind capacity
  - 6 x solar capacity
  - 2 x solid biomass capacity
  - 400 x geothermal capacity

	2019	2030	2040
Electricity Generation (TWh)	57	81	92
Renewable Electricity Generation (TWh)	18	50	77
GHG Emissions (Mtonnes)	72	30	0
Electricity Import (TWh)	15	23	15

Source: own representation, adapted from: “Baden Württemberg Klimaneutral 2040 Erfoerderlicher EE-Ausbau für Klimaneutralität 2040”

Purpose of research
Assessment of regional P2P



Source: Own representation, adapted from: “EWI Kurzstudie, Ökonomische Bewertung des Nutzens lokaler Koordinationsmechanismen in der Stromversorgung”

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Purpose of research
P2P-Scalability factors

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Technological

- Battery Storage Systems (BSS)
- Electric vehicles (EV)
- Heat pumps
- Smart Meters (SMGW)
- Energy Management Systems (EMS)
- Sector-coupling between Residential, Tertiary and Industry sectors
- Demand Side Management (DSM)

Social Aspects

- Local / regional consciousness
- Early adopters as Target group for P2P
  - 36 – 60 age range
  - High Energy-knowledge
  - Prosumers

Legal / Political

- Adjusted grid usage fees
- Successful Smart-Meter-Rollout
- Incentive mechanisms for investing in renewable and flexibility technologies
- Framework for secure data transmission

Market-based

- Lower P2P-Electricity price as Wholesale price
- Dynamic electricity price mechanisms
- Local P2P concepts instead of supraregional P2P concepts
- P2P market operated by professional players
- P2P market platform with smart contracts

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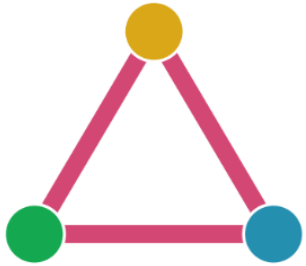
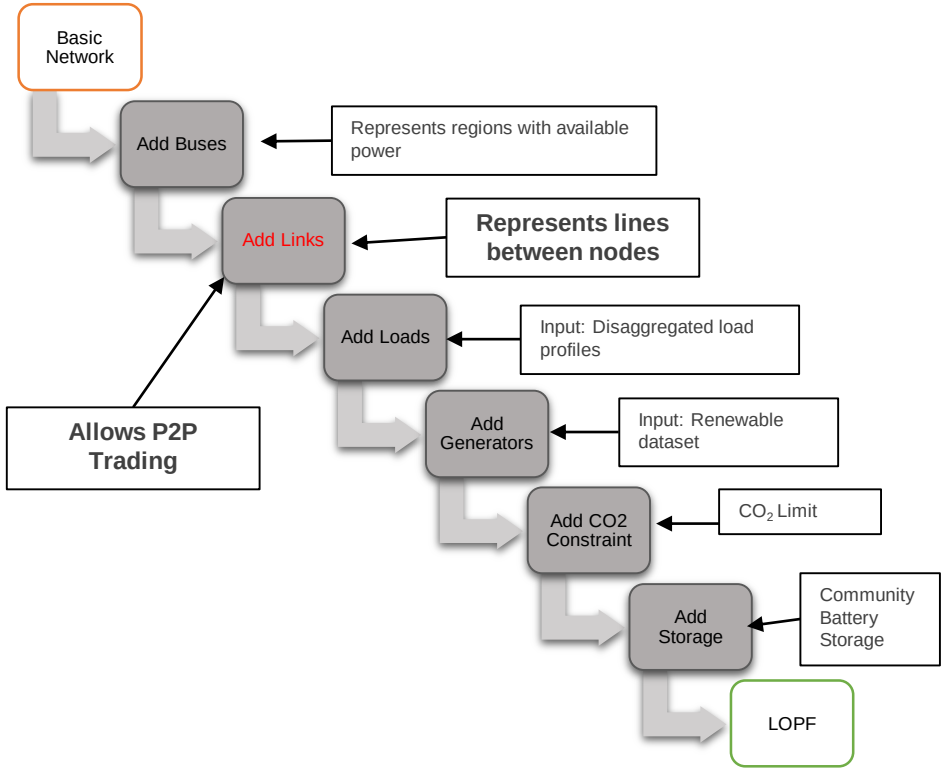
Methodology
PyPSA network multi optimization

Representation of Residential Sector using:

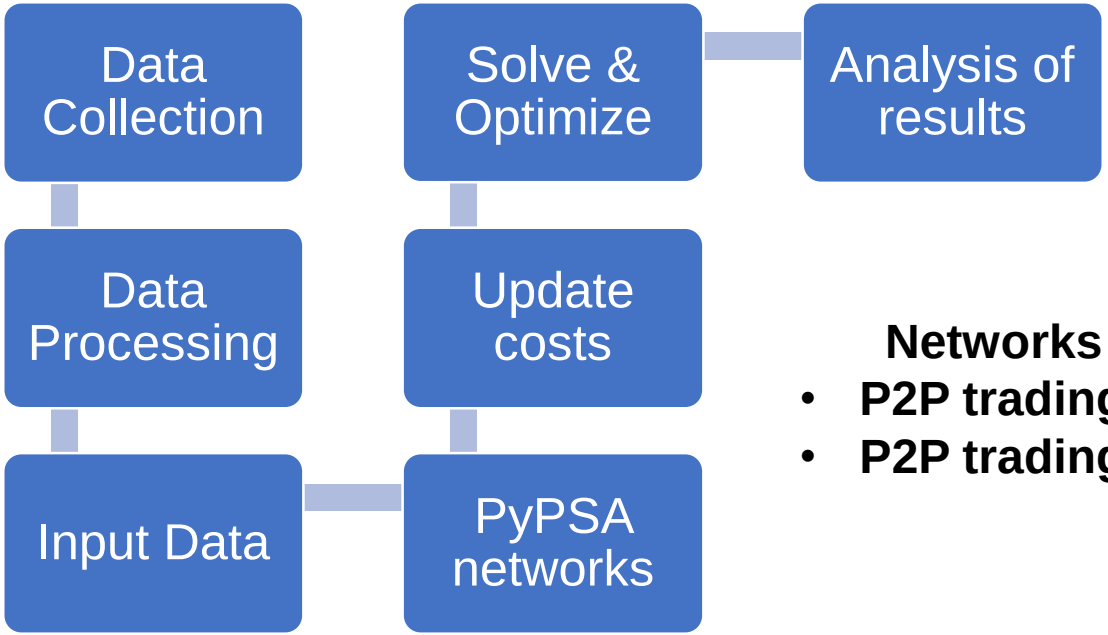
PyPSA: Python for Power Systems Analysis



T. Brown, J. Hörsch, D. Schlachtberger, PyPSA: Python for Power System Analysis, 2018, Journal of Open Research Software, 6(1).



Methodology
Data preparation

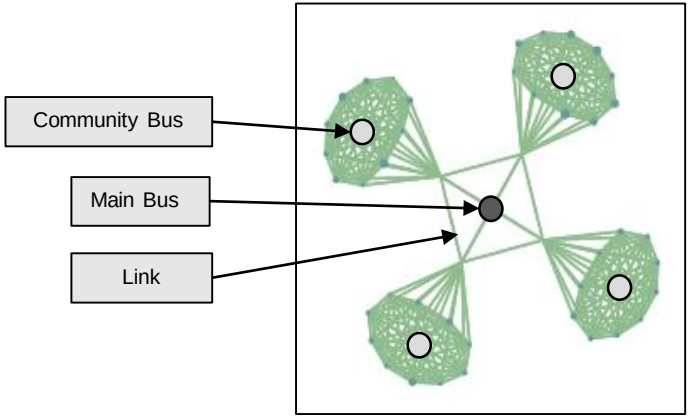


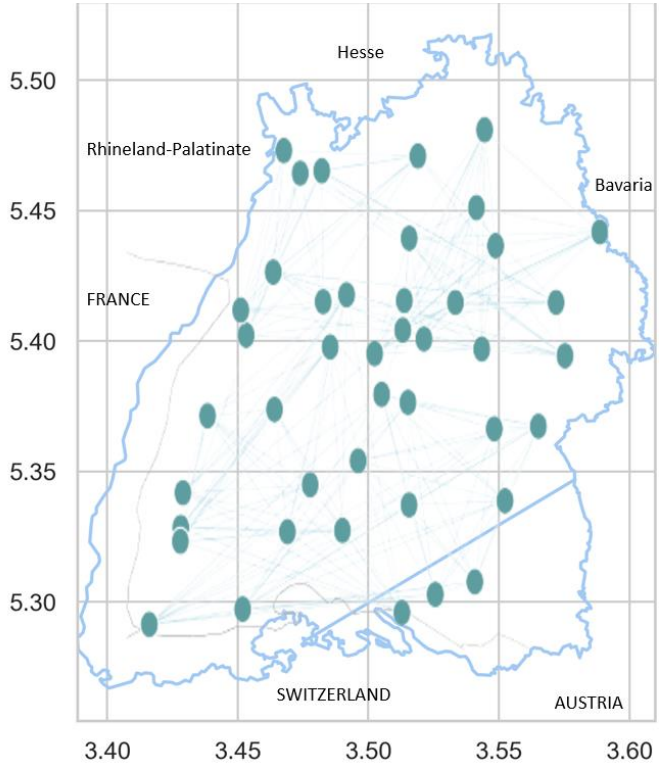
Networks optimized

- **P2P trading deactivated**
- **P2P trading activated**

Results
Built P2P networks

- Interconnected network representing the 4 NUTS-2 BW-communities
- Each NUTS-3 region allocated respectively in its community





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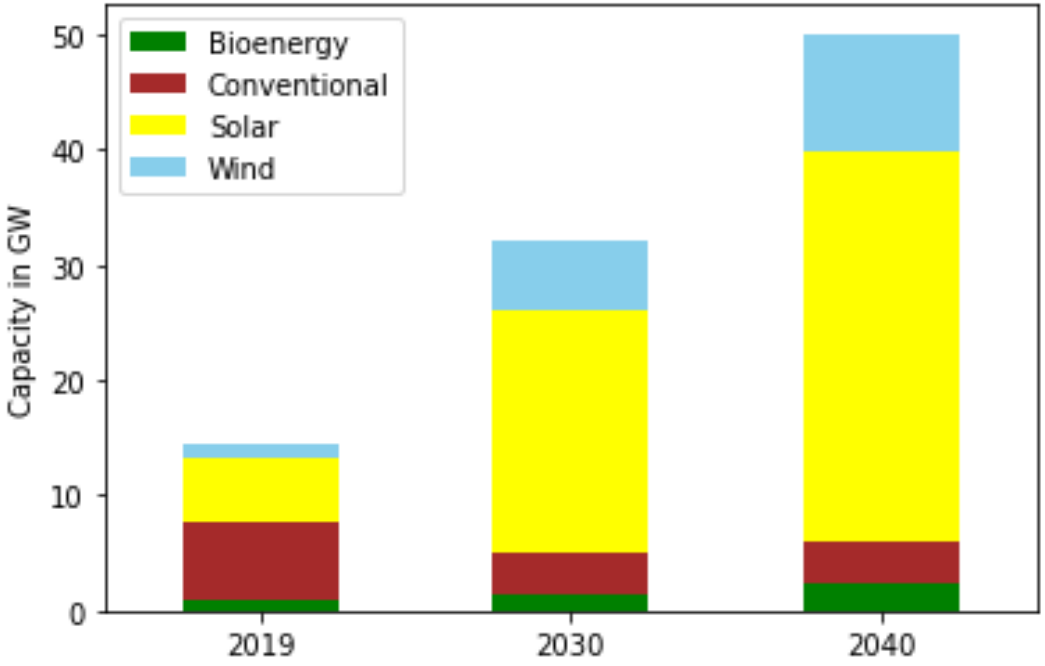
Results
Overview

	2019	2030	2040
Load (TWh)	15.5	18.6	22.5
Total electricity (TWh)	16.6	19.31	23.3
P2P / self consumption (TWh)	0.8	3.5	5.1



Results
Mean Locational Marginal Prices

- Region with high renewable generation
- Based solely on marginal costs
- Indications of positive effect. Decrease of marginal costs
- Decrease on costs correlates with solar generated electricity

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Results
Mean Locational Marginal Prices

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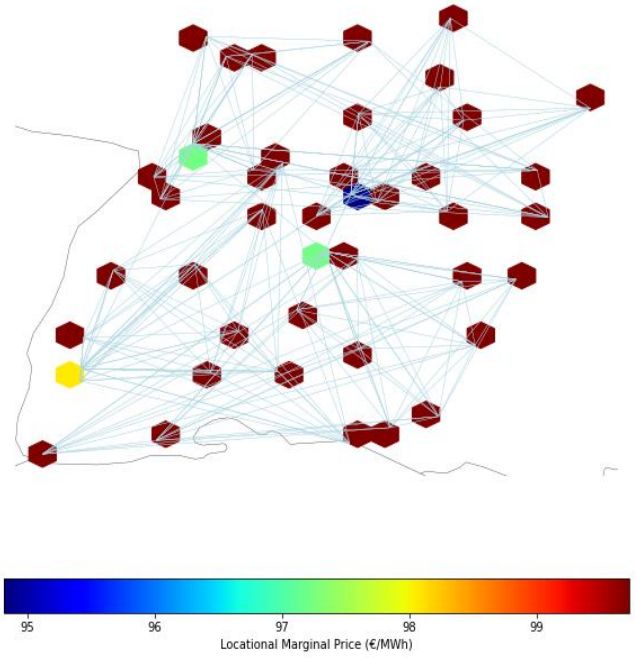
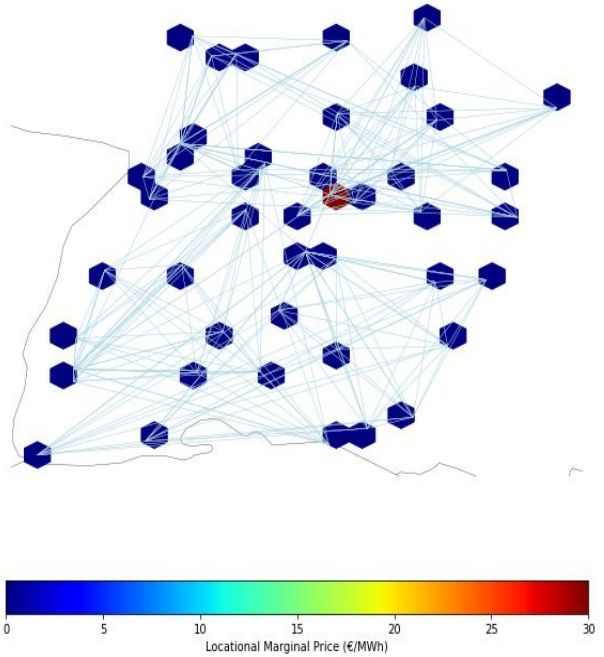
Without P2P-ET





With P2P-ET

Outline
Future work and conclussions

- Model not focusing on social welfare
- Final consumer price could be added
- Optimization to model grid and updating of all technologies.
- Evidence that P2P provides positive impact in grid
- Has Regional P2P a positive effect on the energy system?