TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

From Single Family Buildings to Energy Communities – Economic Viability of Upscaling Battery Storage Systems

Albert Hiesl, EEG, TU Wien

Agenda

- Research question & methodology
- PV & Battery Storage in Single Family Buildings
- Case Study for Multi-Family Buildings & Energy Communities
- Development of investment costs for decentralized battery storage systems and necessary cost reduction for Single Family Buildings, Multi-Family Buildings and Energy Communities

Research question

How does the economic viability of a battery storage system change when operated in a Multi-Family building or in an Energy Community compared to a Single-Family building?

What are limiting factors?

Methods & Assumptions

- Linear optimization model implemented in Matlab using Gurobi Solver /Yalmip Toolbox
  - Time horizon: 25 years
  - Time resolution: hourly
  - Degradation of PV & Battery Storage are considered
  - Lifetime of the battery storage: 12 years
  - Efficiency of the storage: 90%
  - Measured load profiles

Methods & Assumptions

Economic calculation:

$$NPV = -I_{batt,total} + \sum_{t=1}^{25} \frac{\Delta C_t}{(1+i)^t} = 0$$

$$I_{batt,total} = \sum_{t=1}^{25} \frac{\Delta C_t}{(1+i)^t}$$

Interest rate (i): 1%
Electricity price (energy related components): 15 c/kWh
Feed-in remuneration: 3 c/kWh

NPV = Net Present Value

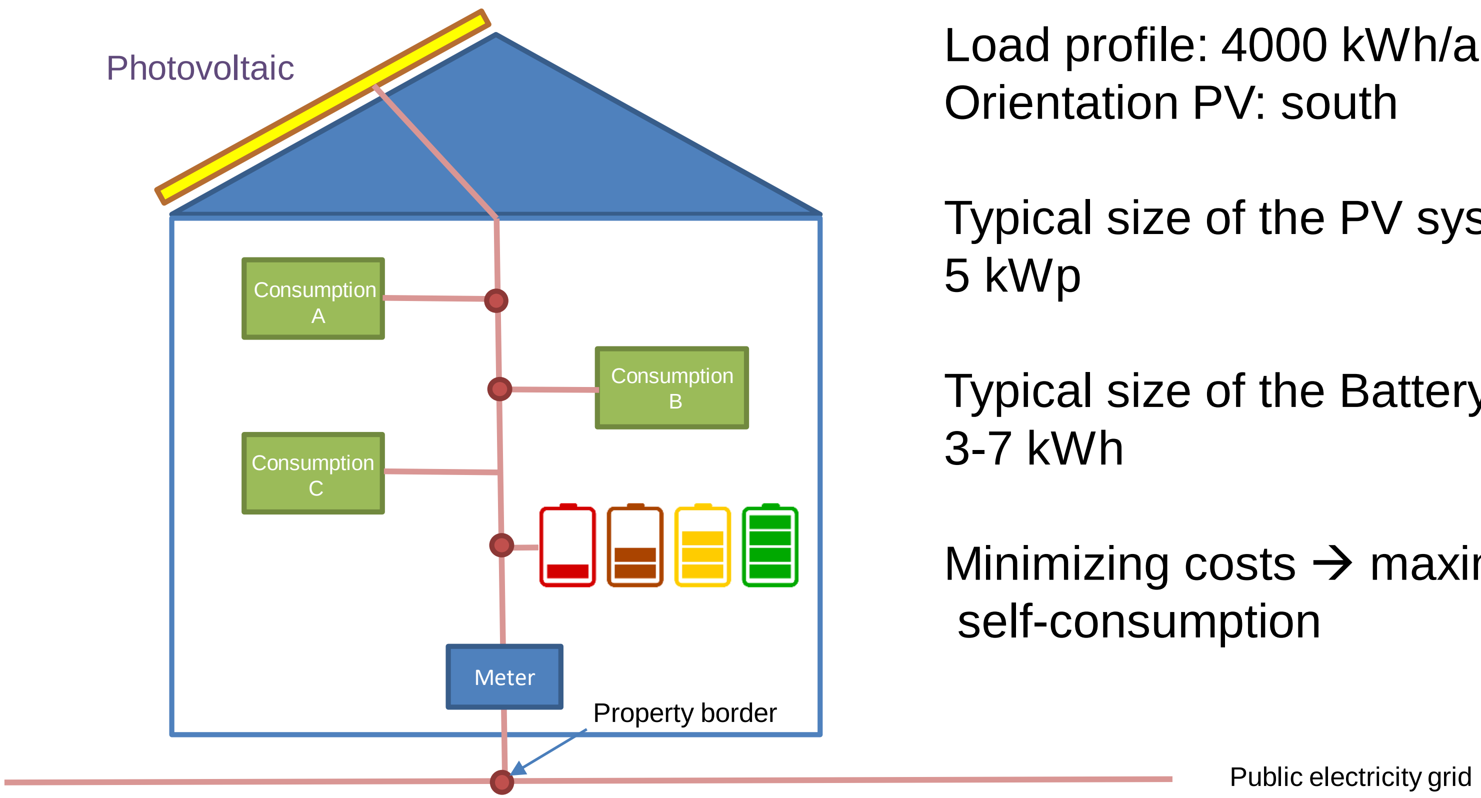
$I_{batt,total}$ = Maximum possible additional investment costs

ΔCt = Cash-flow including the battery storage – Cash-flow without battery storage

i = Interest rate

Assumption: Investment costs of battery storages drop to 70% of actual costs

Single Family Buildings



Load profile: 4000 kWh/a
Orientation PV: south

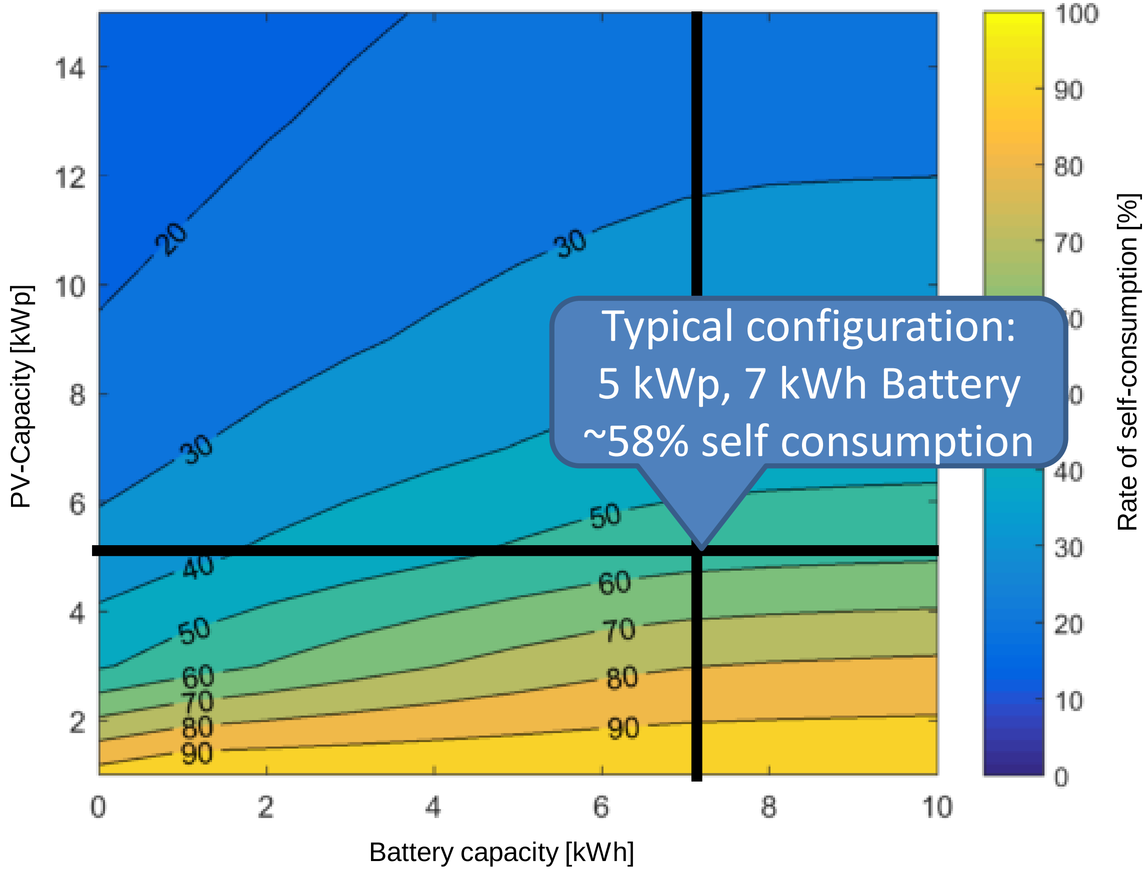
Typical size of the PV system:
5 kWp

Typical size of the Battery storage:
3-7 kWh

Minimizing costs → maximizing
self-consumption

Single Family Buildings

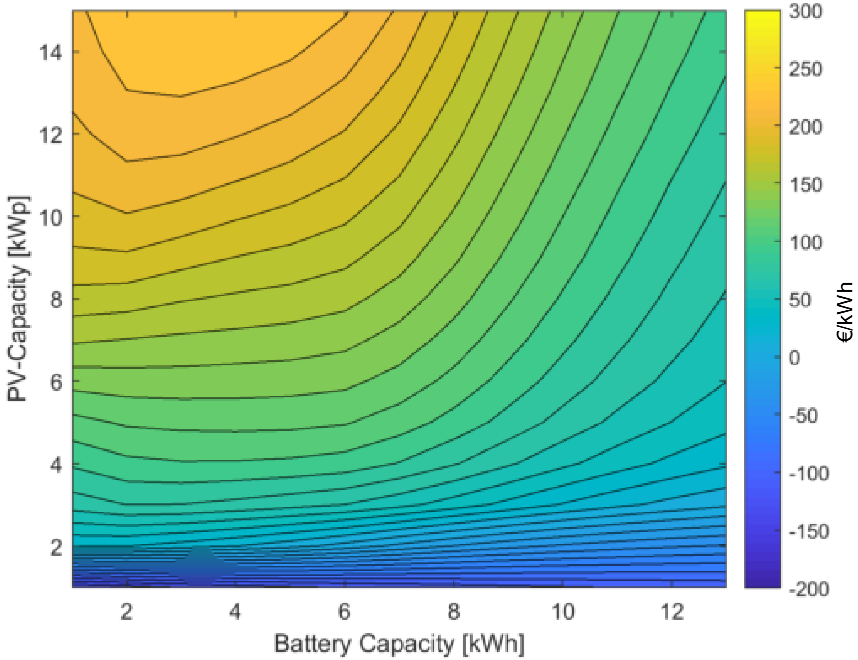
Rate of self-consumption

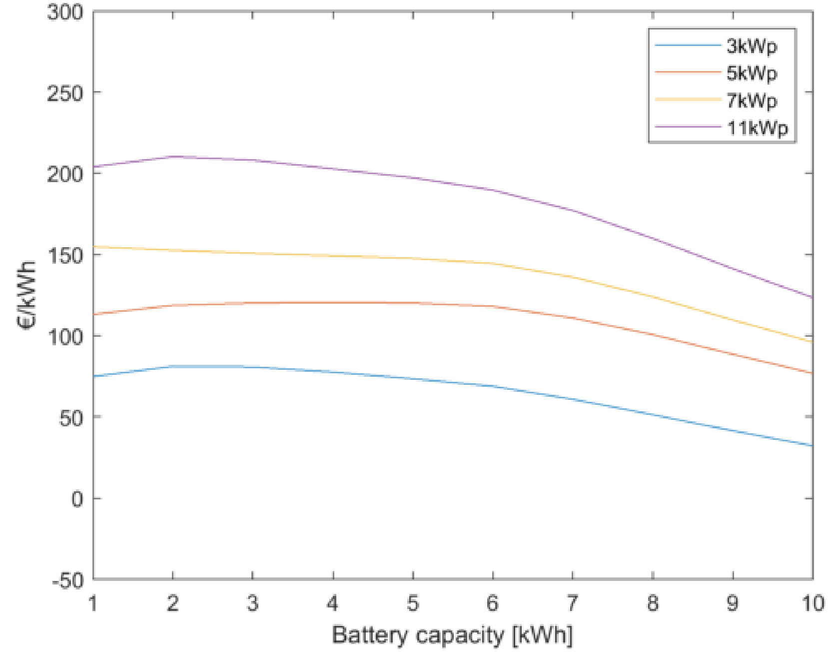


Single Family Buildings

Maximum additional investment costs for Battery storage systems

Expected average yearly interest rate: 1%





- max. additional investment costs: 236 €/kWh
- min. additional investment costs: -134 €/kWh

Multi-Family Buildings & Energy Community

Project Pocket Mannerhatten Ottakring: www.pocketmannerhatten.at

What is this project about?

An innovative urban development tool on the basis of spatial and functional interlinking of buildings, moderated participation processes and a public welfare-oriented support system.

Potentials?

- Cross-property interlinking of buildings
- Citizen participation
- Non-monetary support options

Multi-Family Buildings & Energy Communities

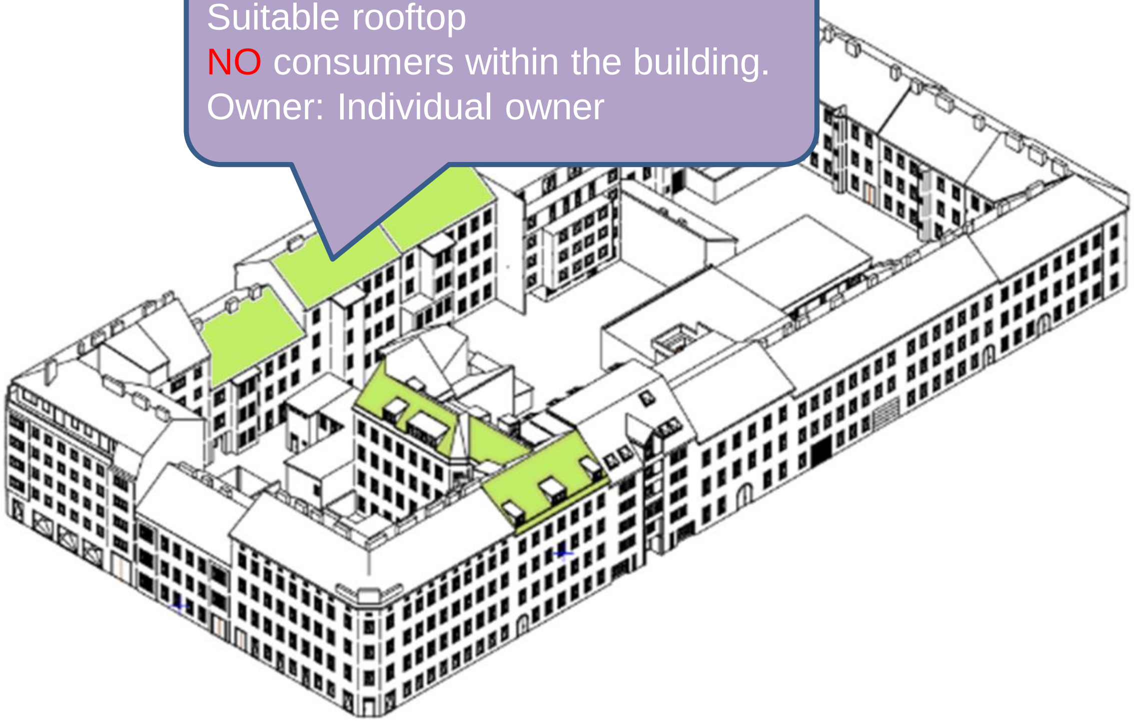
Property owners interested in PV (+Battery Storage)

Suitable rooftop
Consumers within the building
Owner: Invidual owners

Multi-Family Buildings & Energy Communities

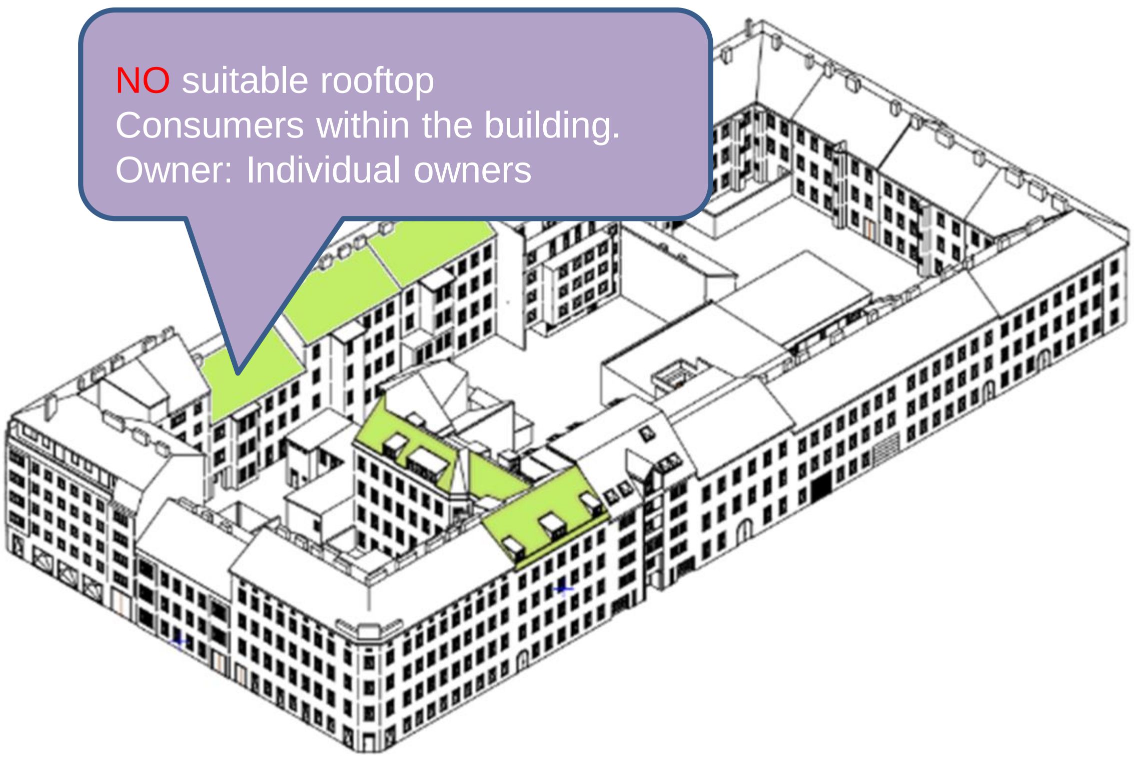
Property owners interested in PV (+Battery Storage)

Suitable rooftop
NO consumers within the building.
Owner: Individual owner



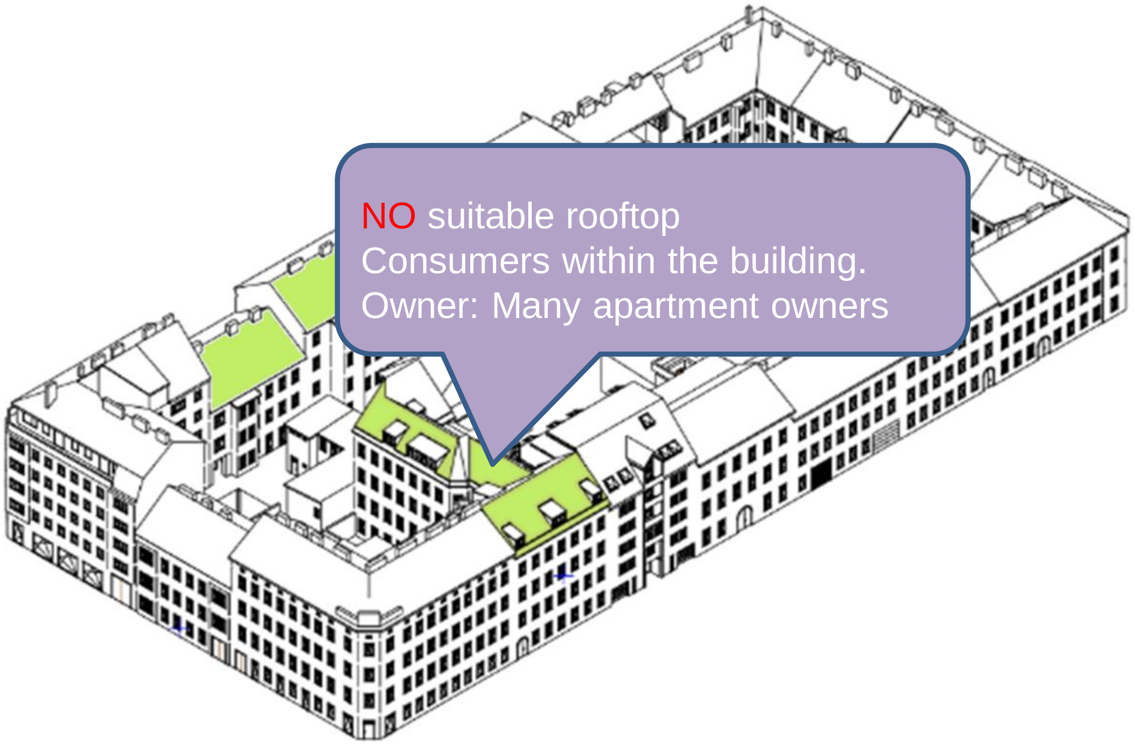
Multi-Family Buildings & Energy Communities

Property owners interested in PV (+Battery Storage)

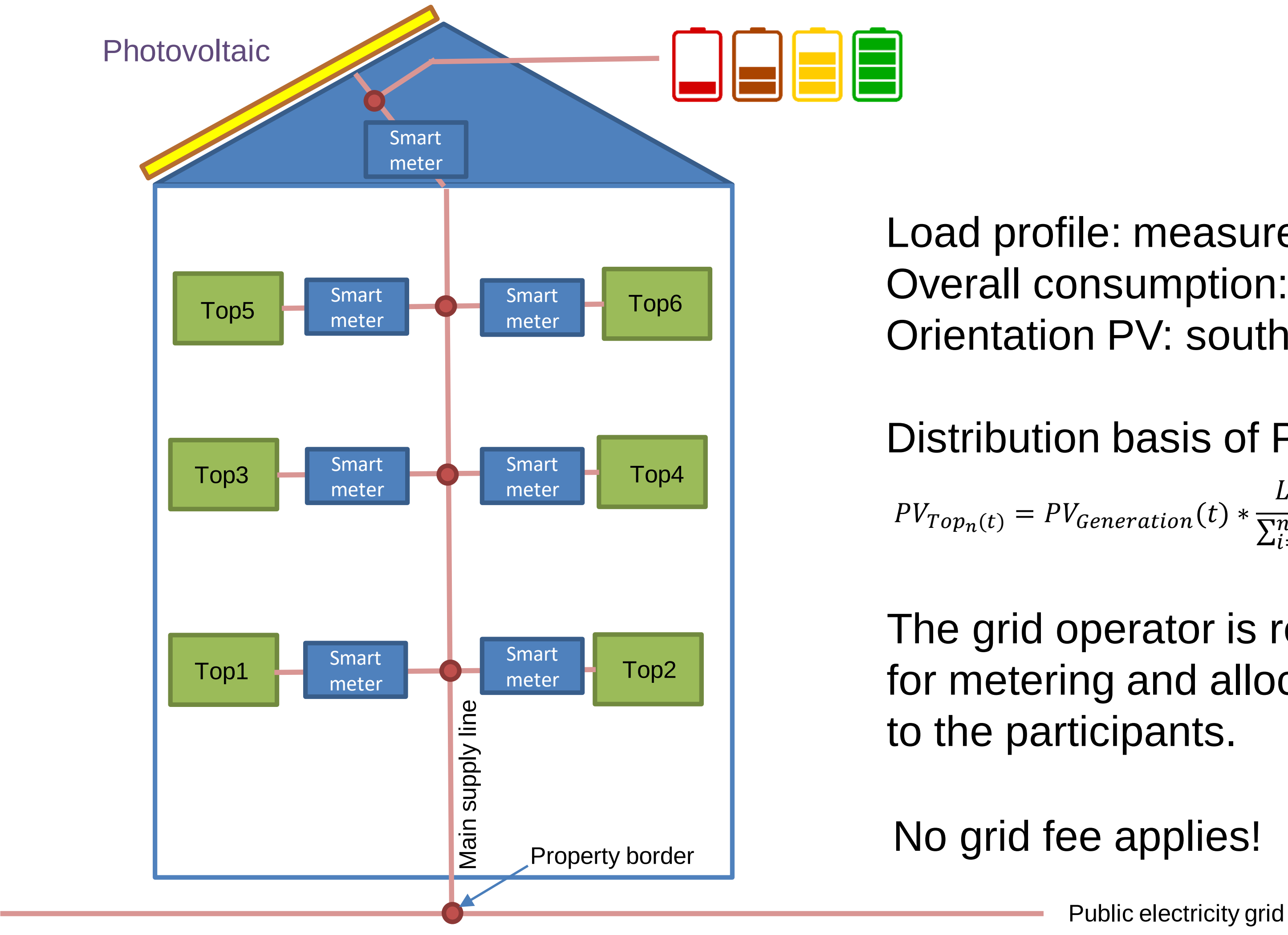


Multi-Family Buildings & Energy Communities

Property owners interested in PV (+Battery Storage)



Multi-Family Buildings



Load profile: measured load profiles
Overall consumption: 20.000 kWh/a
Orientation PV: south

Distribution basis of PV – Electricity

$$PV_{Top_n(t)} = PV_{Generation}(t) * \frac{Load_{Top_n(t)}}{\sum_{i=1}^{n} Load(i,t)}$$

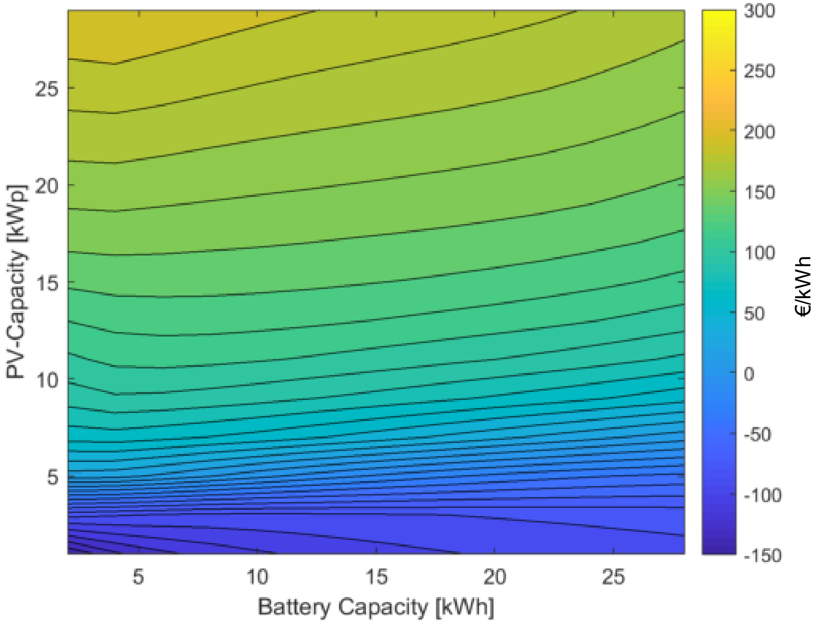
The grid operator is responsible for metering and allocating the shares to the participants.

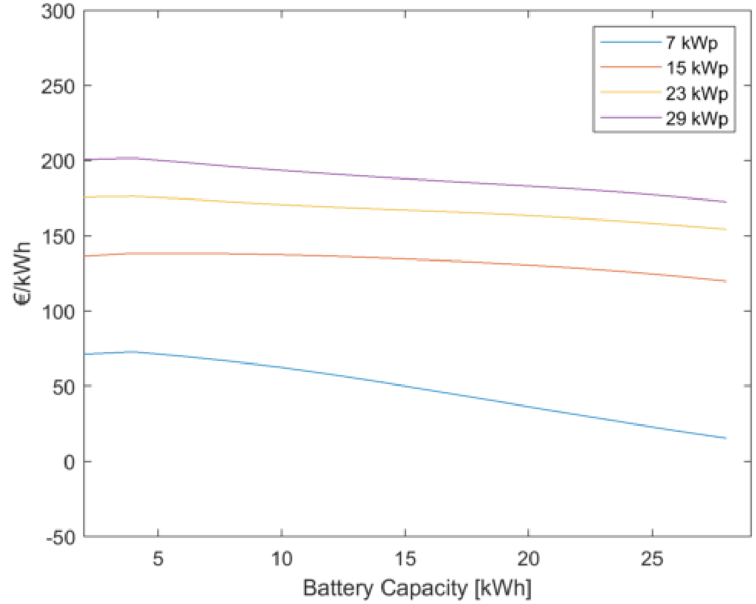
No grid fee applies!

Multi-Family Buildung

Maximum possible additional investment costs for Battery storage systems

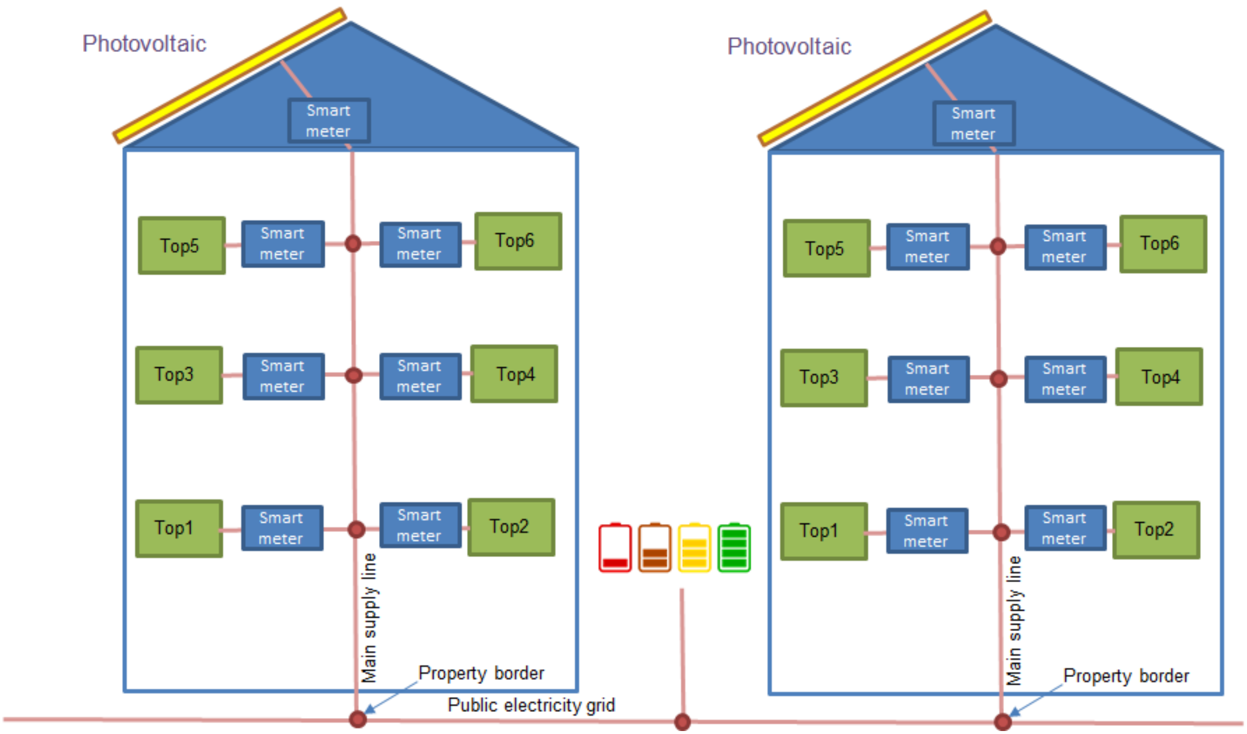
Expected average yearly interest rate: 1%





- max. additional Investment costs: 202 €/kWh
- min. additional Investment costs: -147 €/kWh

Energy Community



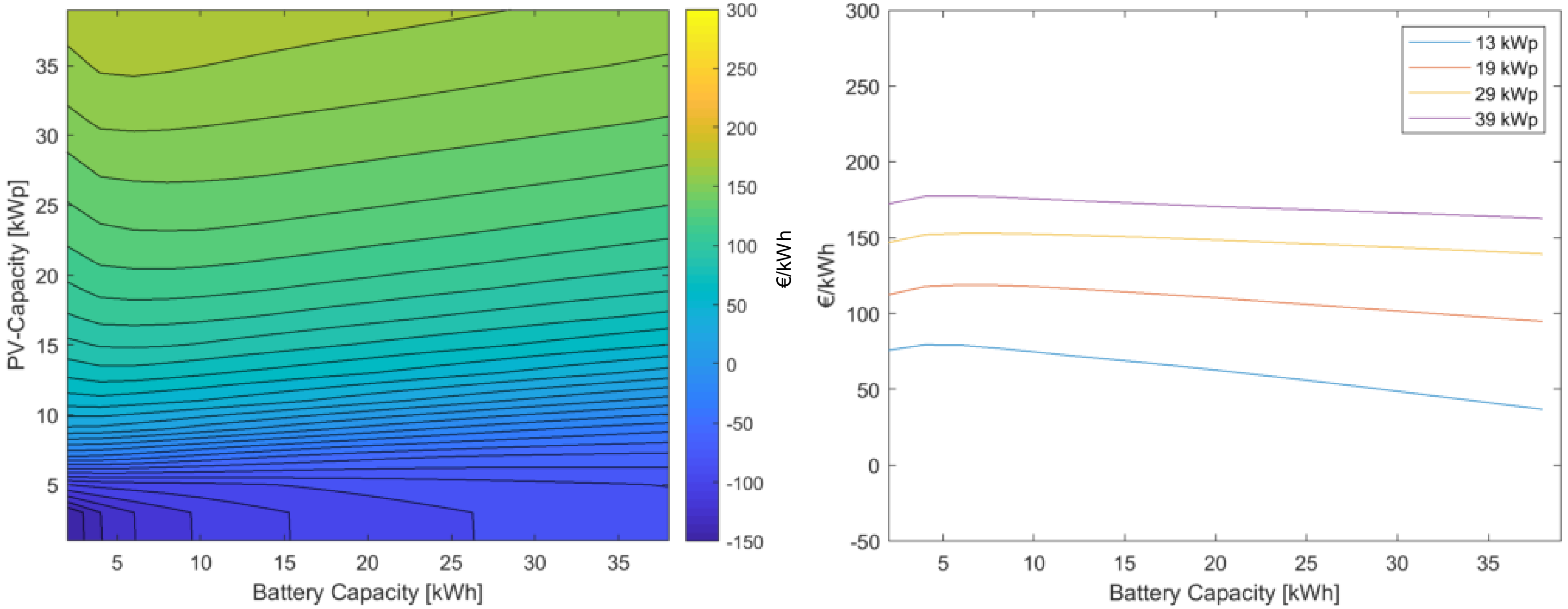
Assumption: Produced PV energy & Battery storage can be used equally by both (several) buildings

Overall consumption: 30.000 kWh/a

Energy Community

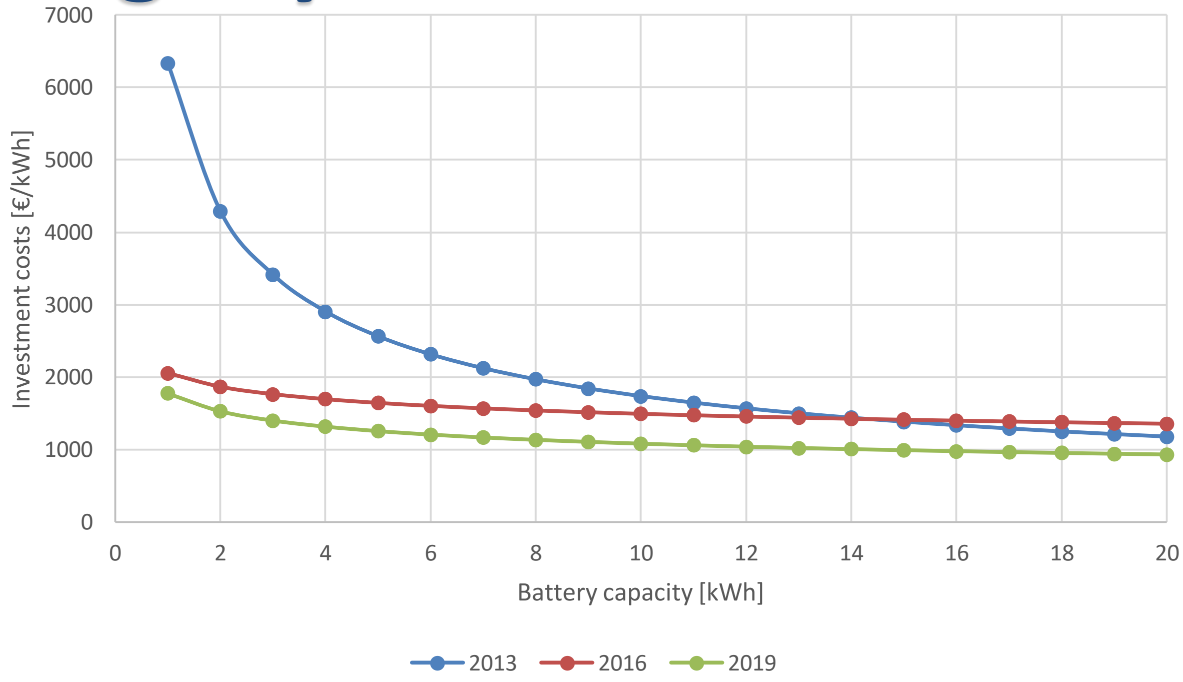
Maximum possible additional investment costs for Battery storage systems

Expected average yearly interest rate: 1%



- max. additional Investment costs: 177 €/kWh
- min. additional Investment costs: -147 €/kWh

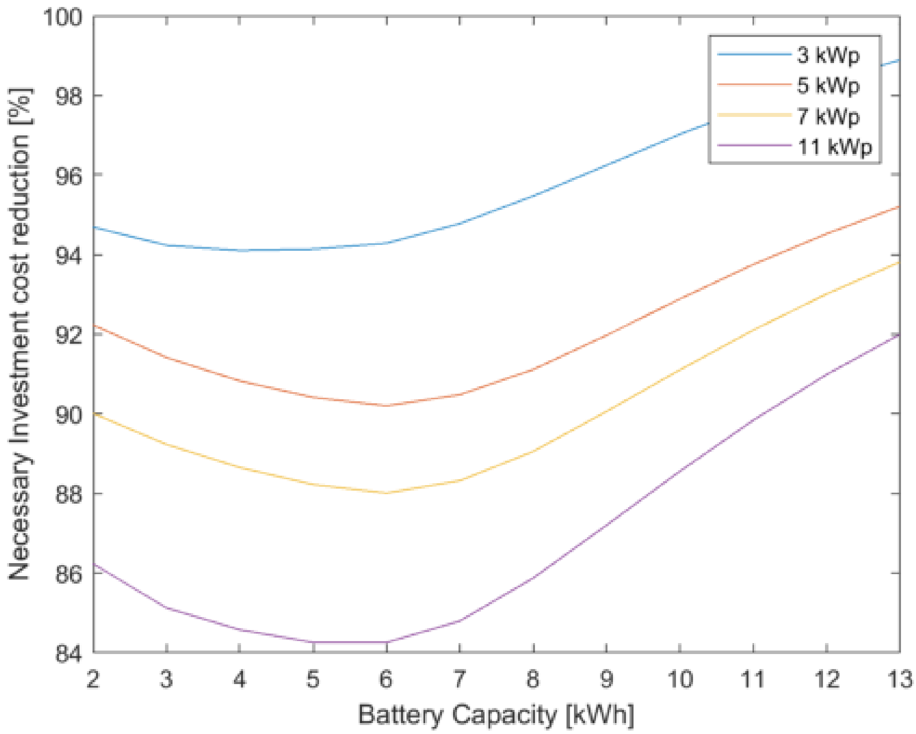
Specific investment costs of Battery Storage systems



- Reduction at typical household capacities
- Almost no capacity dependency anymore (compared to 2013)

Necessary reduction of investment costs in 2019

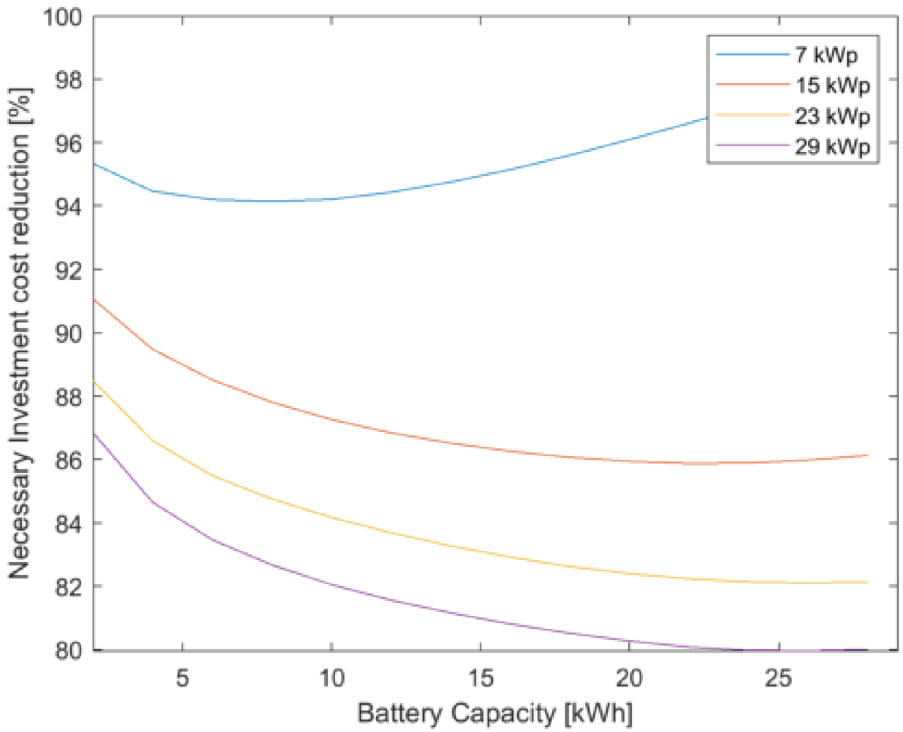
Single Family Building



Min: 84% reduction
Max: 99% reduction

Necessary reduction of investment costs in 2019

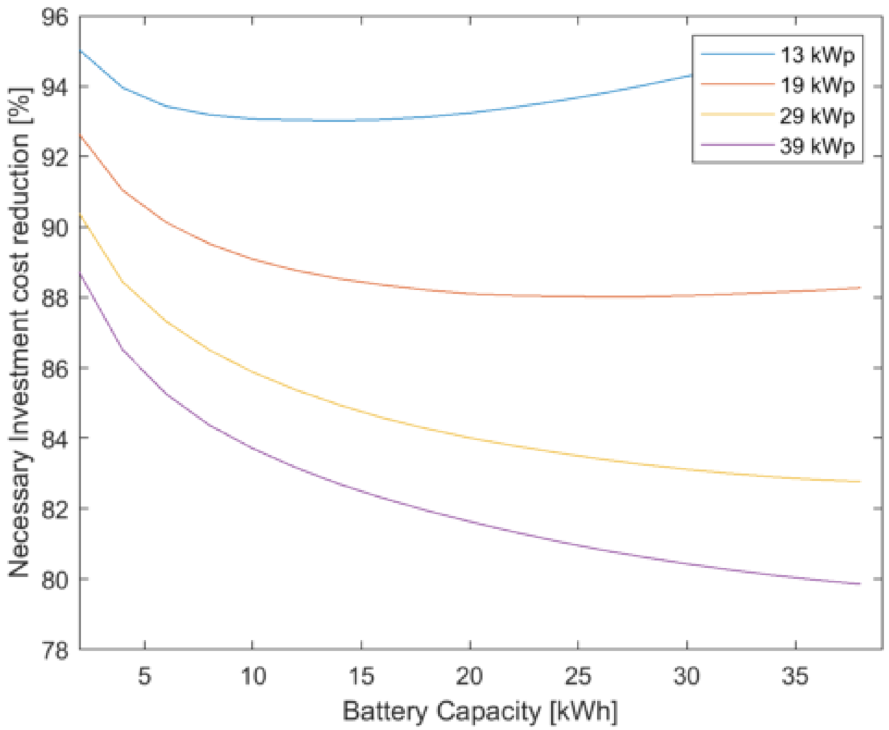
Multi-Family Building



Min: 80% reduction
Max: 98% reduction

Necessary reduction of investment costs in 2019

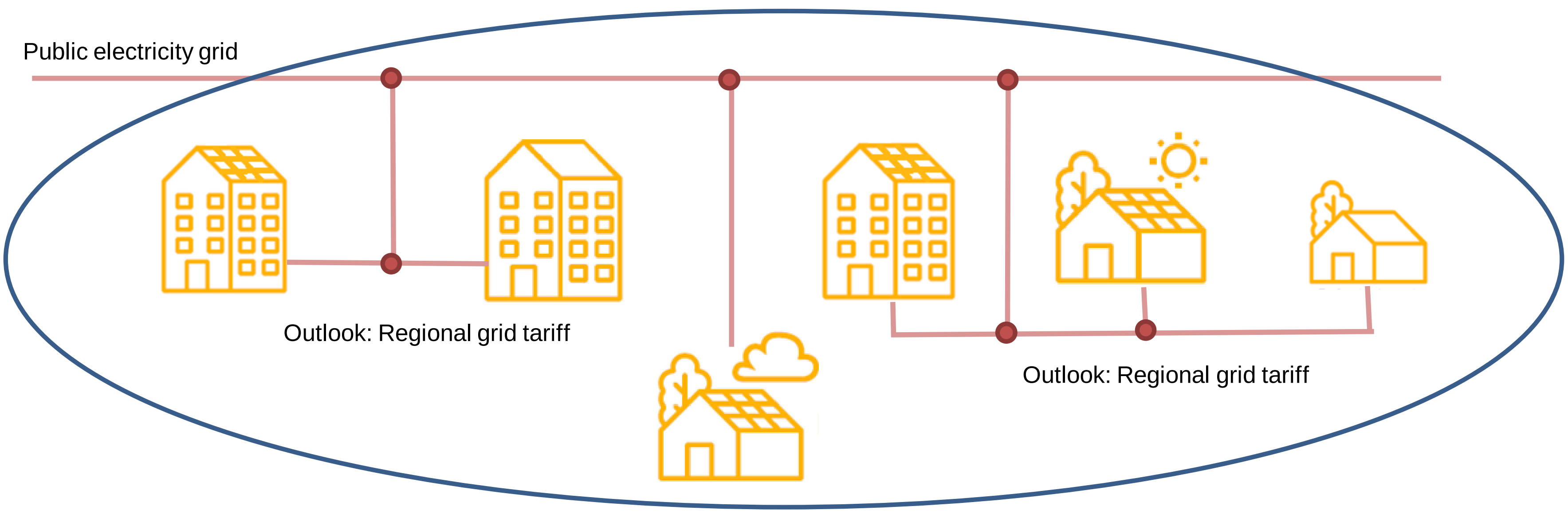
Energy Community



Min: 80% reduction
Max: 95% reduction

Alternatives?

- E-Mobility as additional storage especially car-sharing concepts
- Power to x, most probably power to heat
- Additional peer to peer energy trading, using plattforms (e.g. efriends in Austria) within the community
  - Exchange of PV-electricity within customers with PV (zero energy costs)
  - Directly sold PV electricity to customers without PV



Summary & Conclusions

- Revolution in terms of investment costs for small scale systems – dramatically dropped since 2013 (6000 €/kWh vs. 1700 €/kWh)
- Almost no economies of scale anymore
- Battery Storage Systems are far too expensive for simple increasing self consumption
- Especially in MultiFamily Buildings or Energy Communities where you are able to supply various customers with various load profiles in a very dynamic way
- Limitations: Suitable rooftops for PV in relation to electricity consumption and activations of participants

Thank you for your attention!

Contact:

Albert Hiesl

Technische Universität Wien
Institute of Energy Systems and Electrical Drives
Energy Economics Group – EEG
Tel: +43(0)-1-58801-370371
Web: http://eeg.tuwien.ac.at/
E-Mail: hiesl@eeg.tuwien.ac.at