



Blockchain Grid

Blockchain-enabled flexibility activation for distribution grid management

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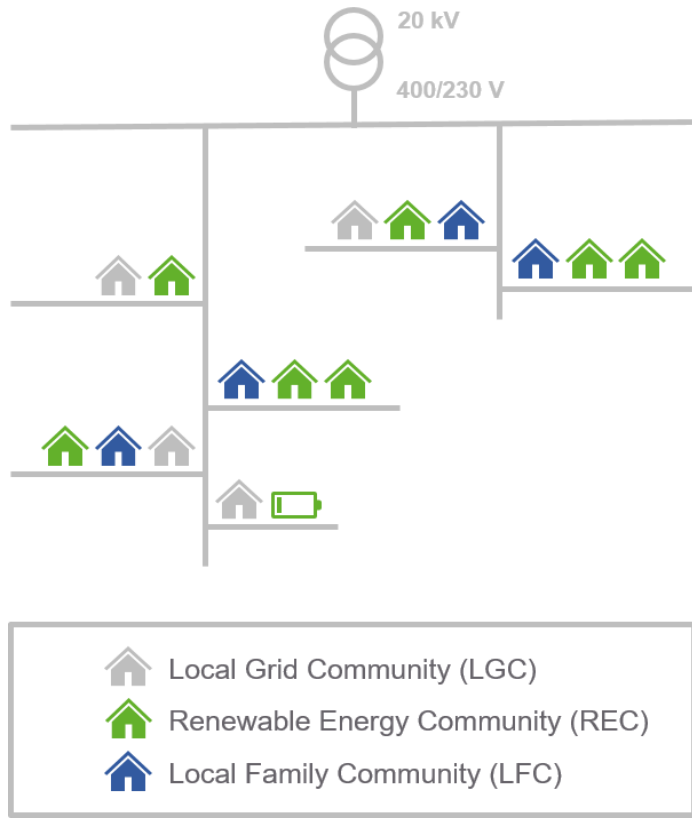


Motivation



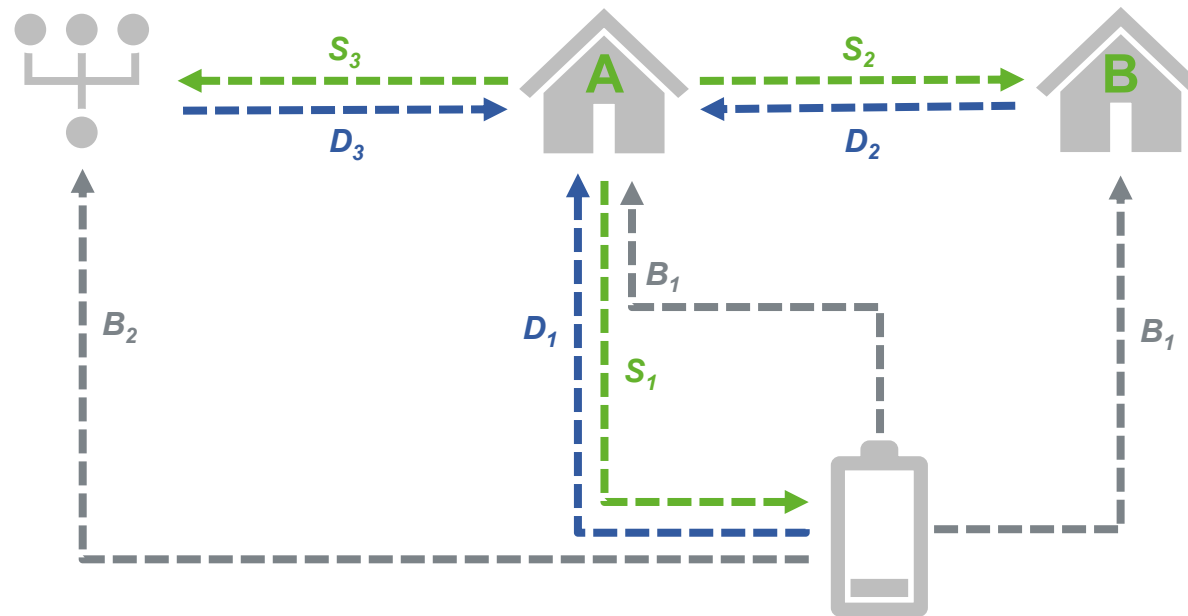
- New challenges for low-voltage grids
 - Increasing share of decentralized renewable generation plants
 - Progressive electrification of various sectors
 - High power levels
- Basis of grid planning: predictable behavior of grid customers
 - Can no longer be guaranteed
- **Blockchain Grid**
 - NOT: Resolution of overload situations
 - SPECIFICALLY:
 - Optimal utilization of free (time-varying) grid resources (power, voltage).
 - For prosumers and energy communities
 - Local use of locally generated energy (peer-to-peer, storage).
 - Blockchain-based architecture

Customers and Use Cases



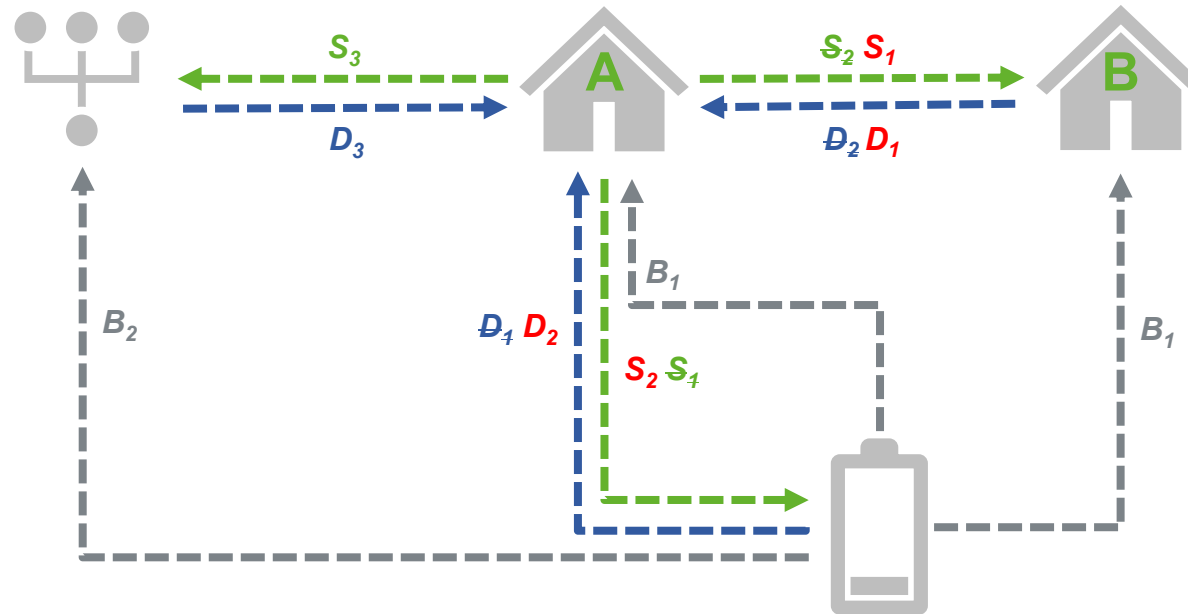
- Self-Consumption Optimization
- Peer-to-Peer Energy Sharing
- Grid Capacity Management

Self-Consumption Optimization



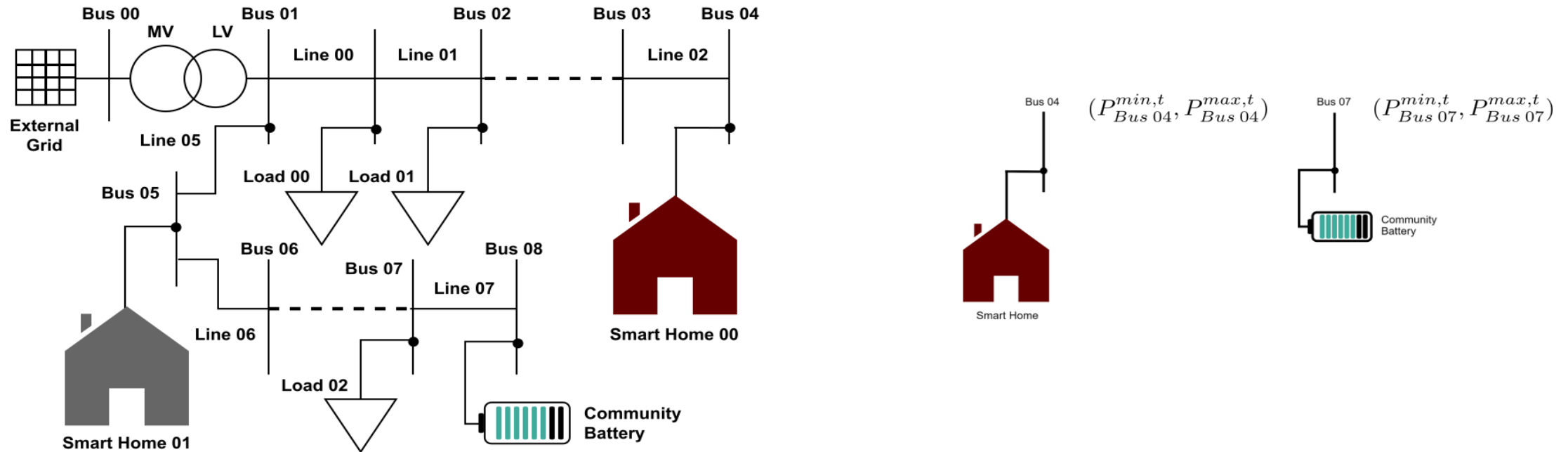
D_x ... Demand
 S_x ... Surplus
 B_x ... Battery release

Peer-to-Peer Energy Sharing



D_x ... Demand
 S_x ... Surplus
 B_x ... Battery release

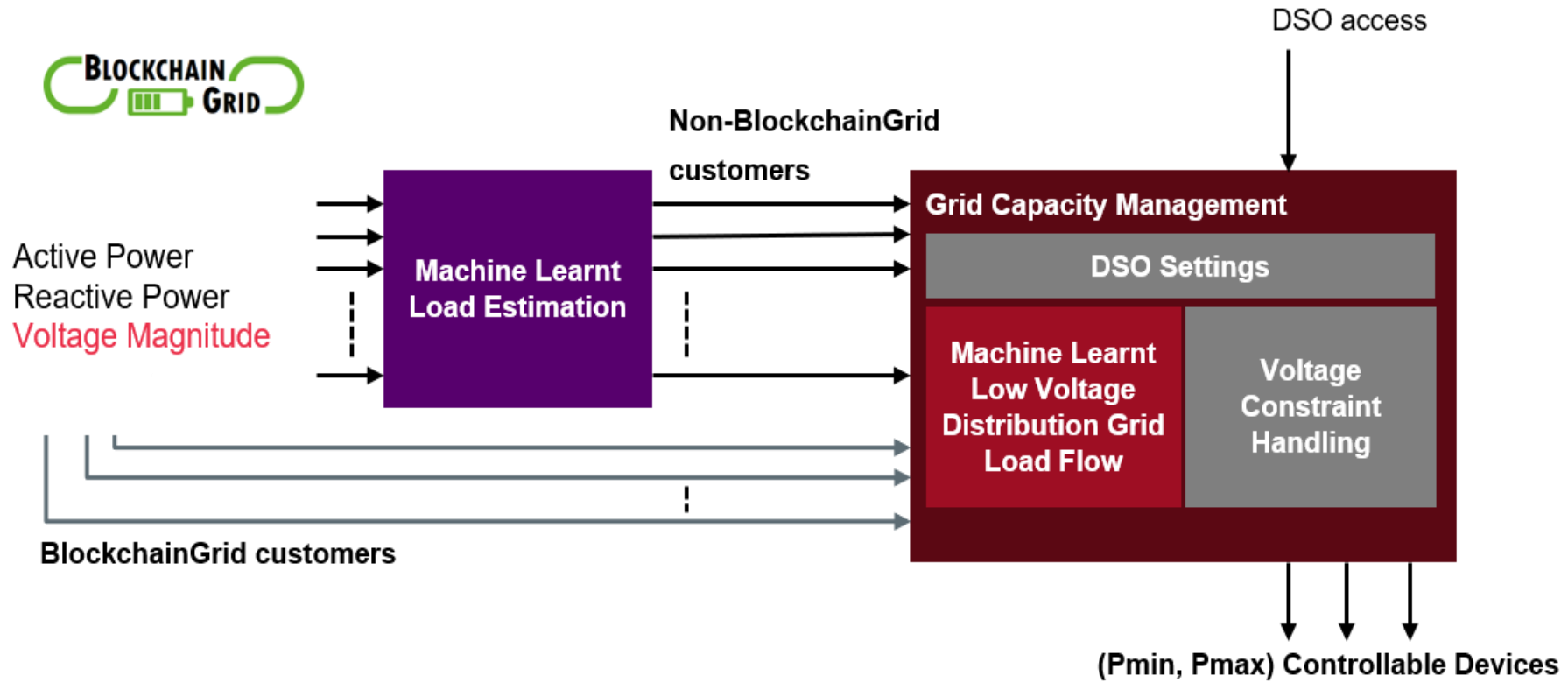
Grid Capacity Management (GCM)



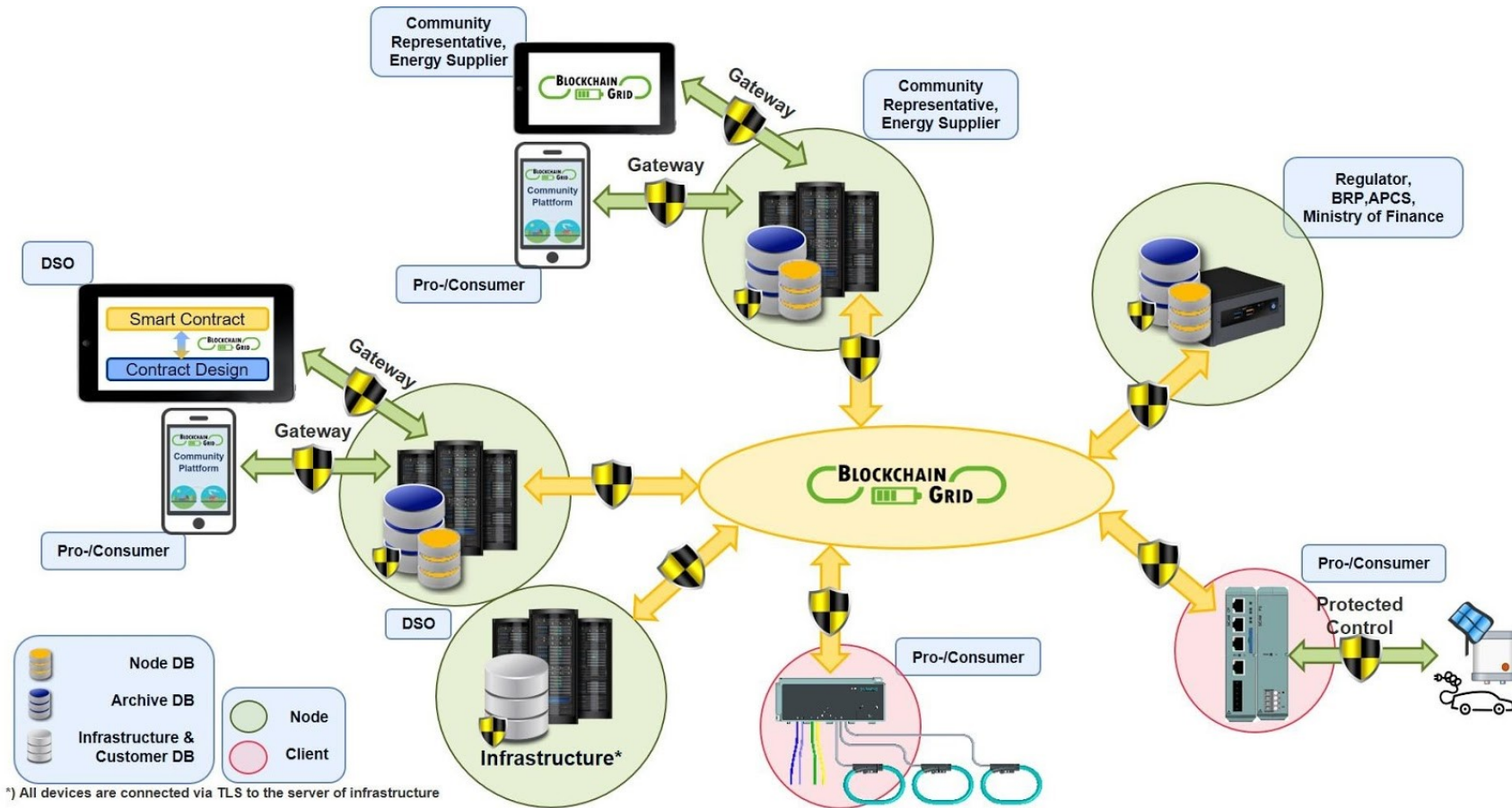
- **B. V. Rao**, M. Stefan, T. Brunnhofer, R. Schwalbe, R. Karl, F. Kupzog, G. Taljan, F. Zeilinger, P. Stern und M. Kozek, „Optimal Capacity Management applied to Low Voltage Distribution Grid in a Local peer-to-peer Energy Community,“ *International Journal of Electrical Power & Energy Systems*, January 2022.
- **B. V. Rao**, M. Stefan, R. Schwalbe, F. Zeilinger, A. Schenk, A. Frischenschlager, P. Stern und G. Taljan, „Grid Capacity Management for peer-to-peer Local Energy Communities,“ in *IEEE Power & Energy Society General Meeting (PESGM)*, Montreal, QC, Canada, 2020.
- **B. V. Rao**, M. Stefan, R. Schwalbe, R. Karl, F. Kupzog und M. Kozek, „Stratified Control applied to a Three-phase Unbalanced Low Voltage Distribution Grid in a Local peer-to-peer Energy Community,“ *MDPI Energies*, May 2021.

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Grid Capacity Management

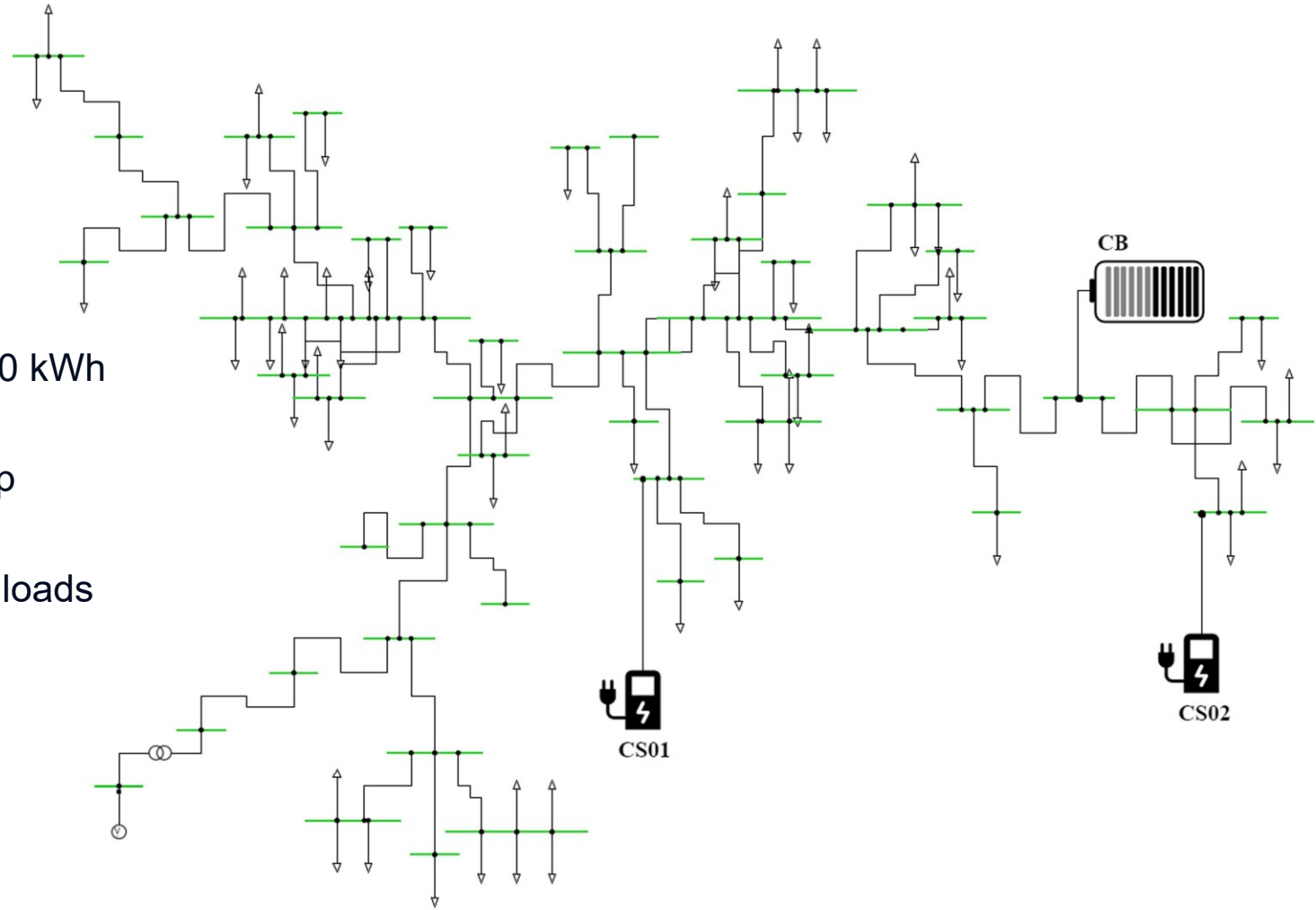


Blockchain-based Architecture

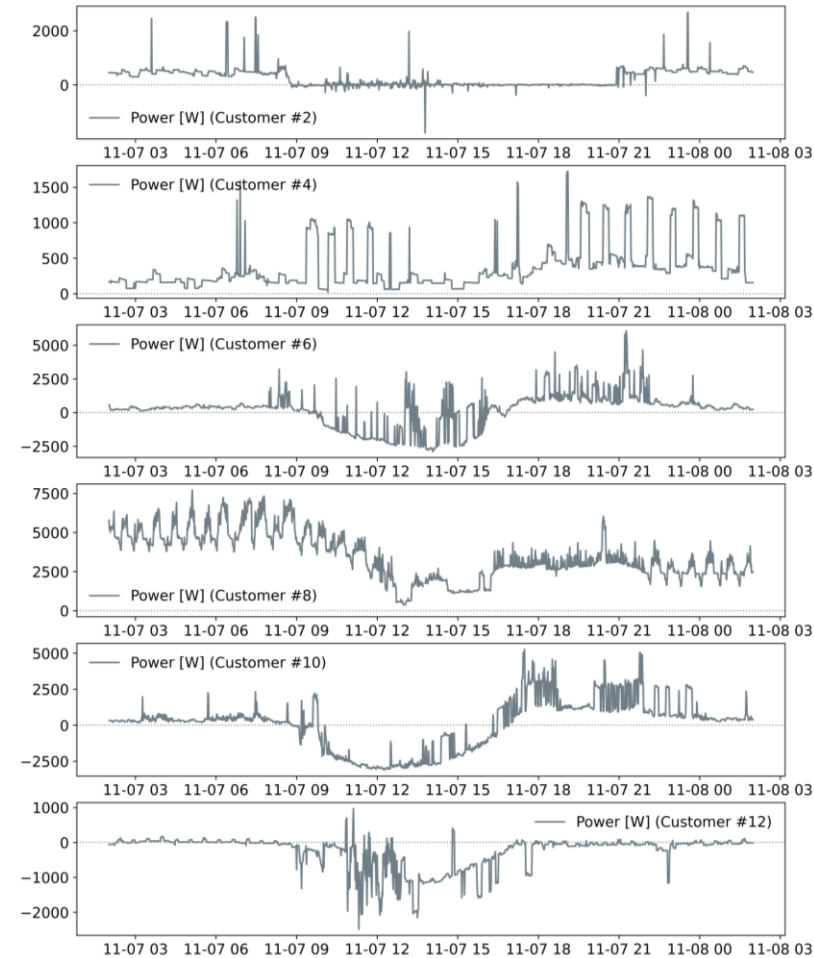
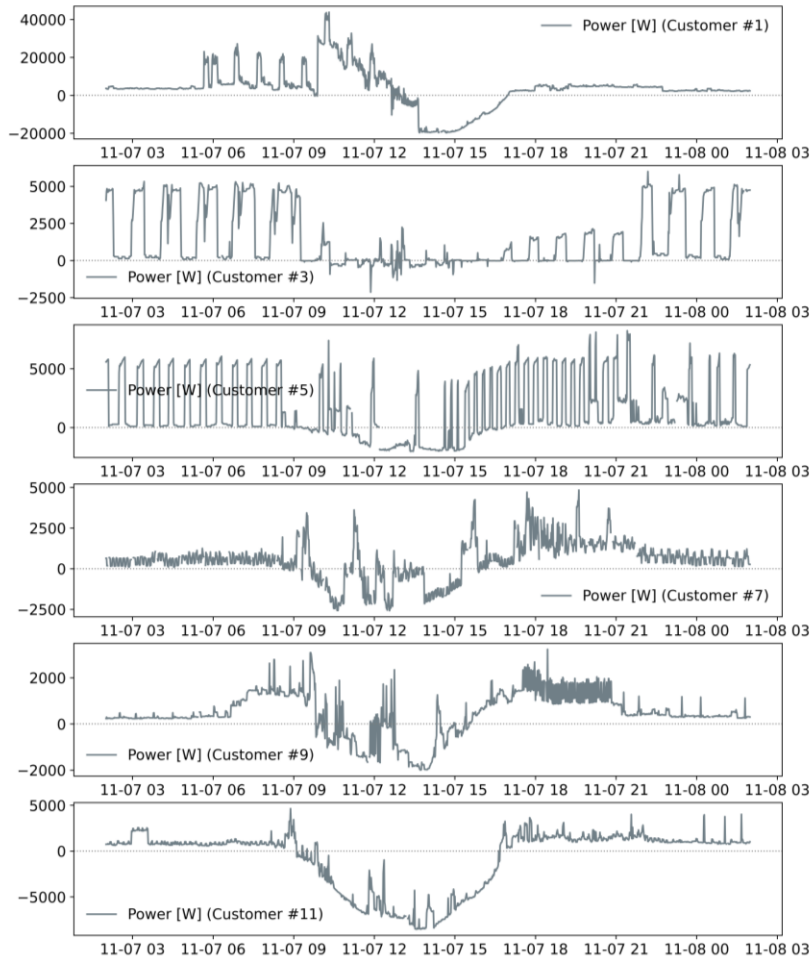


Field Demonstration

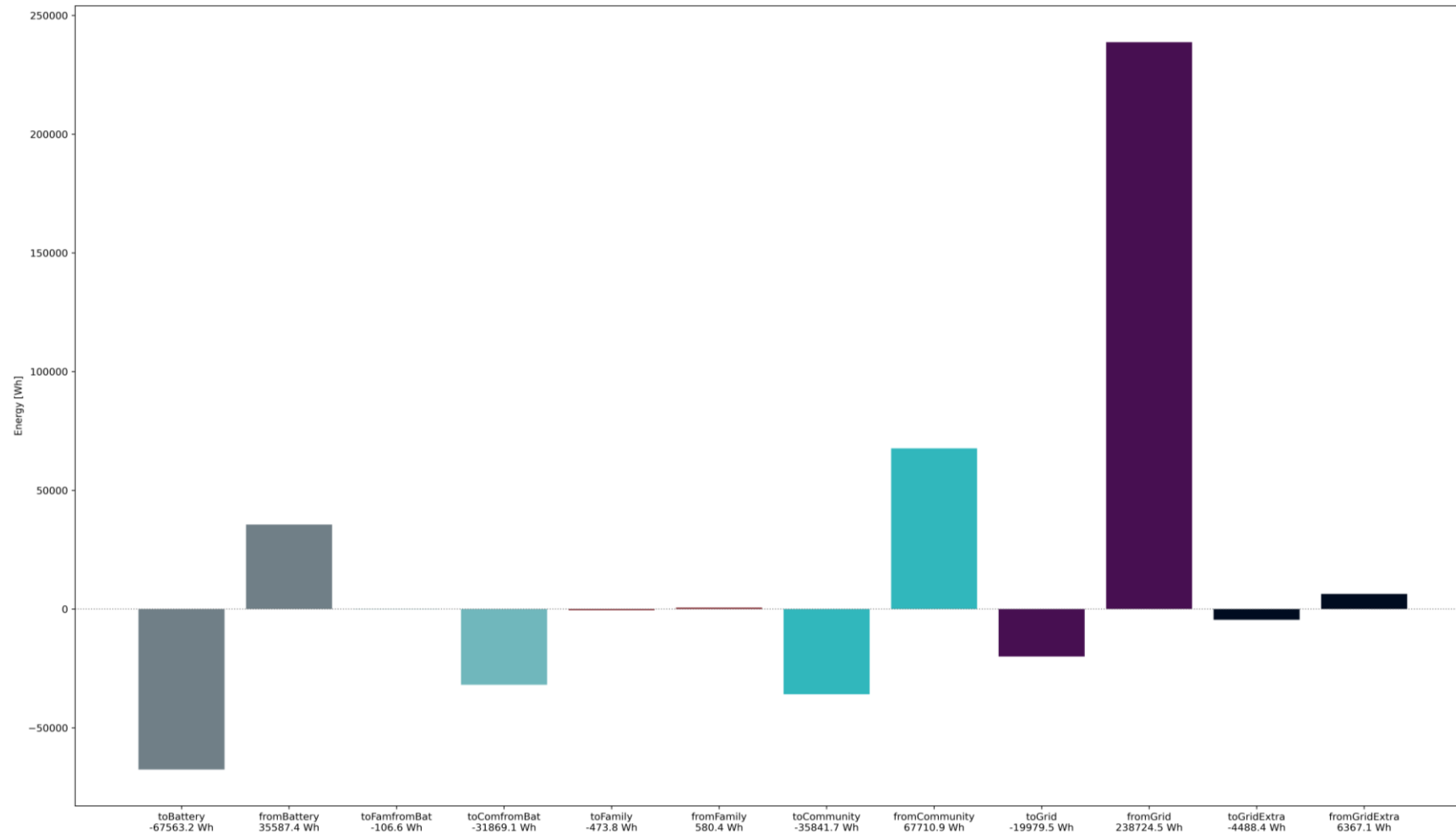
- 12 Customers
(11 Prosumer, 1 Consumer)
- 1 Local Family Community
- Battery storage system 100 kW / 100 kWh
- Total PV generation power: 100 kWp
- High PV penetration and increasing loads
(e.g., due to charging infrastructure)
- **Grid reinforcement or use of Grid Capacity Management**



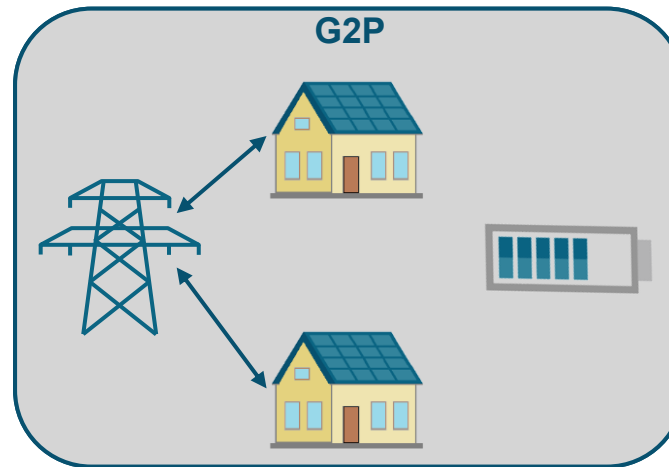
Customers



Peer-to-Peer Energy Sharing within the community

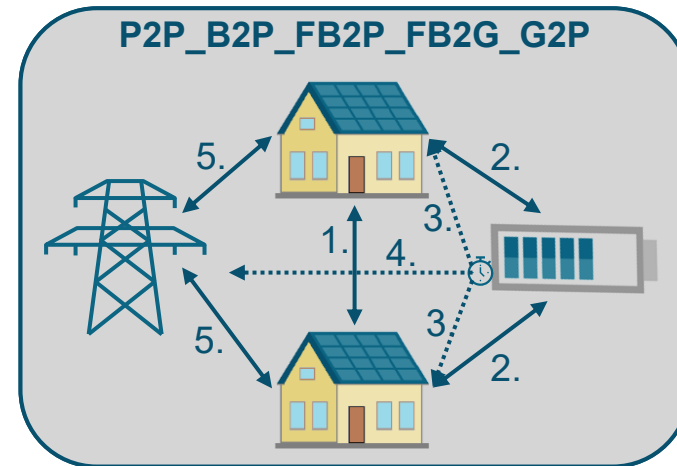
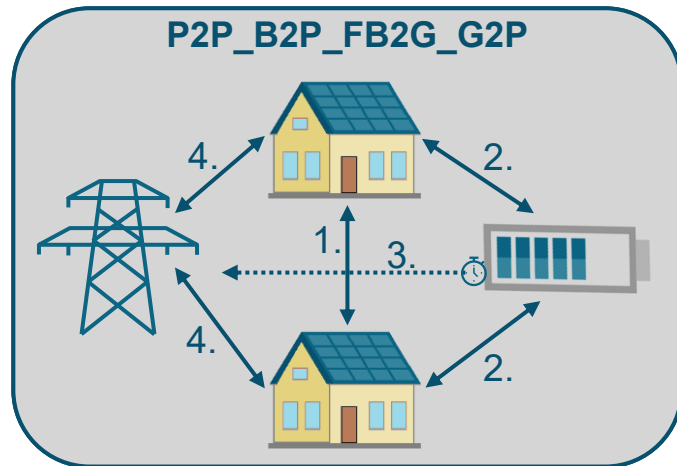
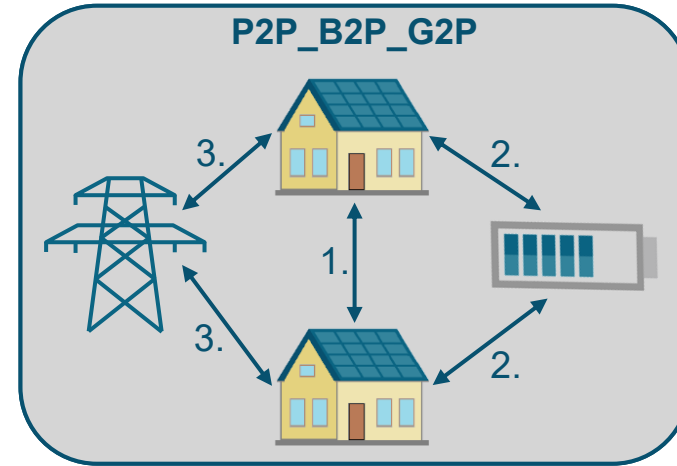
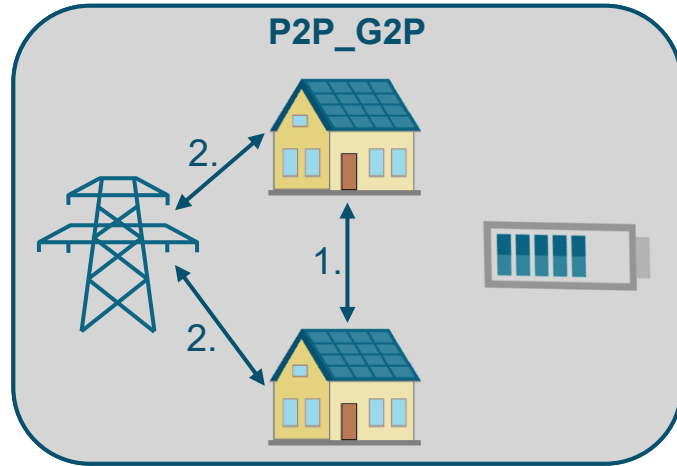


Simulation: Basis-Szenario



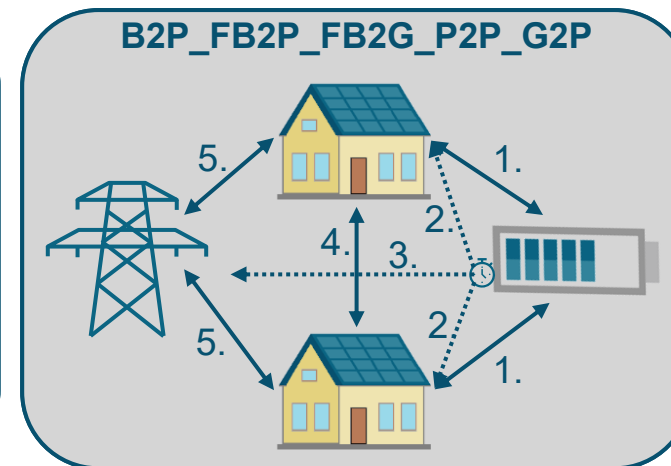
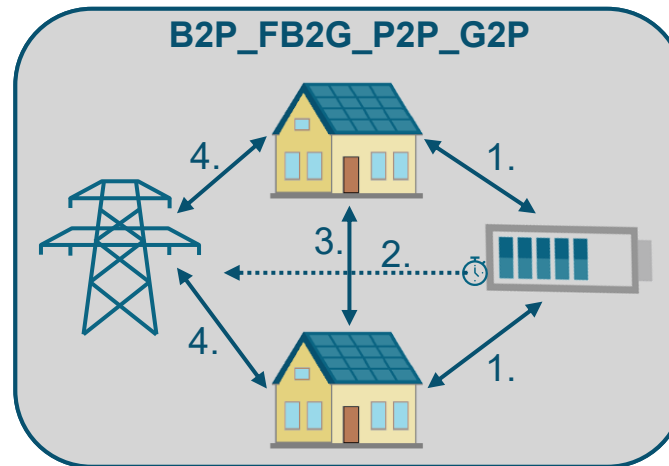
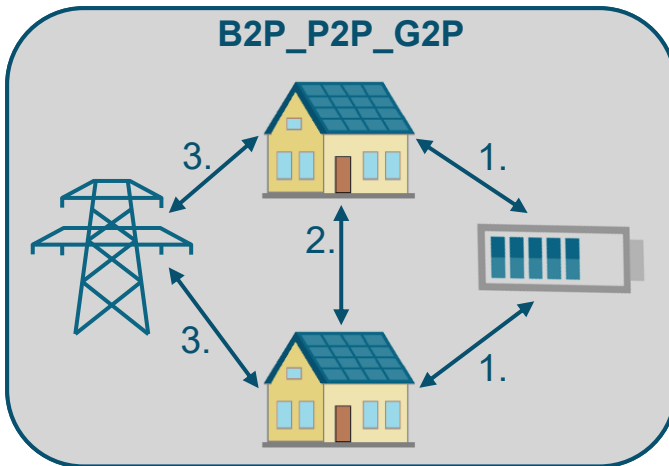
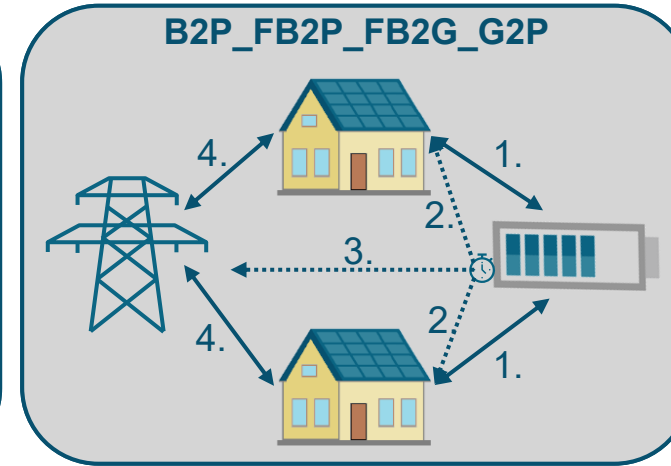
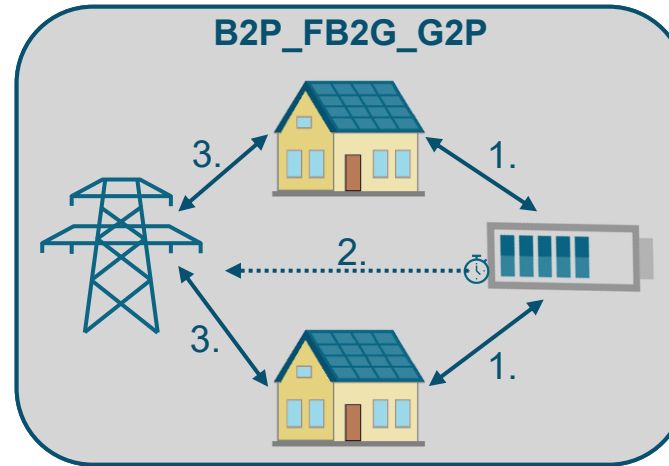
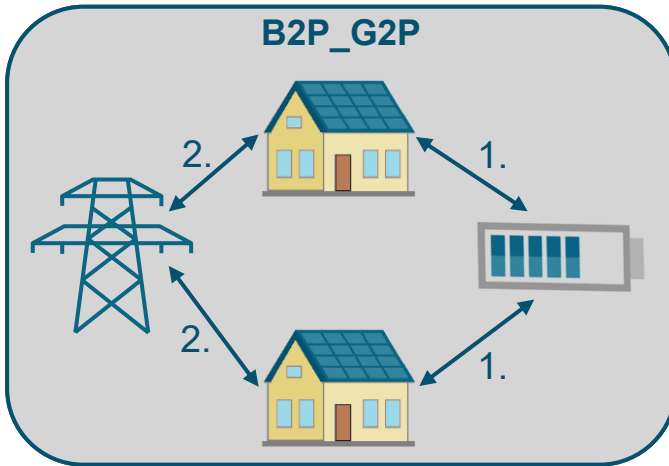
G	Grid
P	Peer
B	Battery
FB	Free Battery

Simulation: Peer-to-Peer Energy Sharing



G	Grid
P	Peer
B	Battery
FB	Free Battery

Simulation: Self-Consumption Optimization



G	Grid
P	Peer
B	Battery
FB	Free Battery



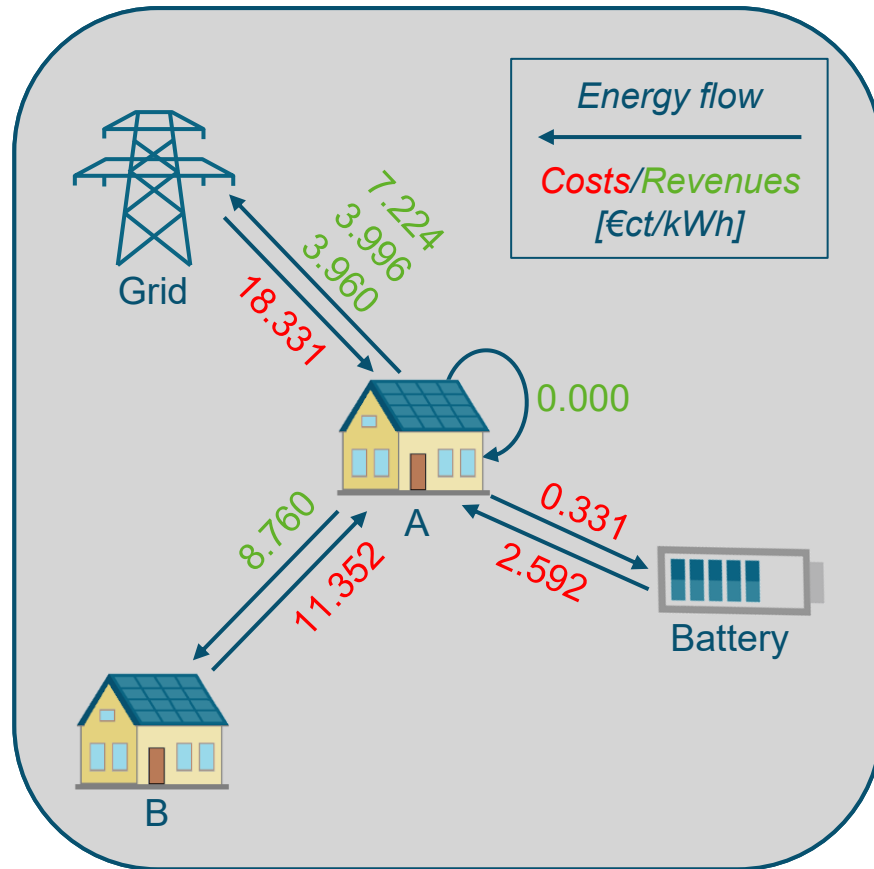
Simulation Settings



	Blockchain Grid	Heimschuh
Demand/Generation	12/9	125/20
Total consumption	184.954 kWh (76,2 %)	960.638 kWh (88,5%)
Total generation	57.777 kWh (23,8 %)	124.263 kWh (11,5%)
Battery capacity	100 kWh	100 kWh
Release time	14/36 hrs	14/36 hrs
Simulation time	365 days	365 days
Resolution	15 minutes	15 minutes

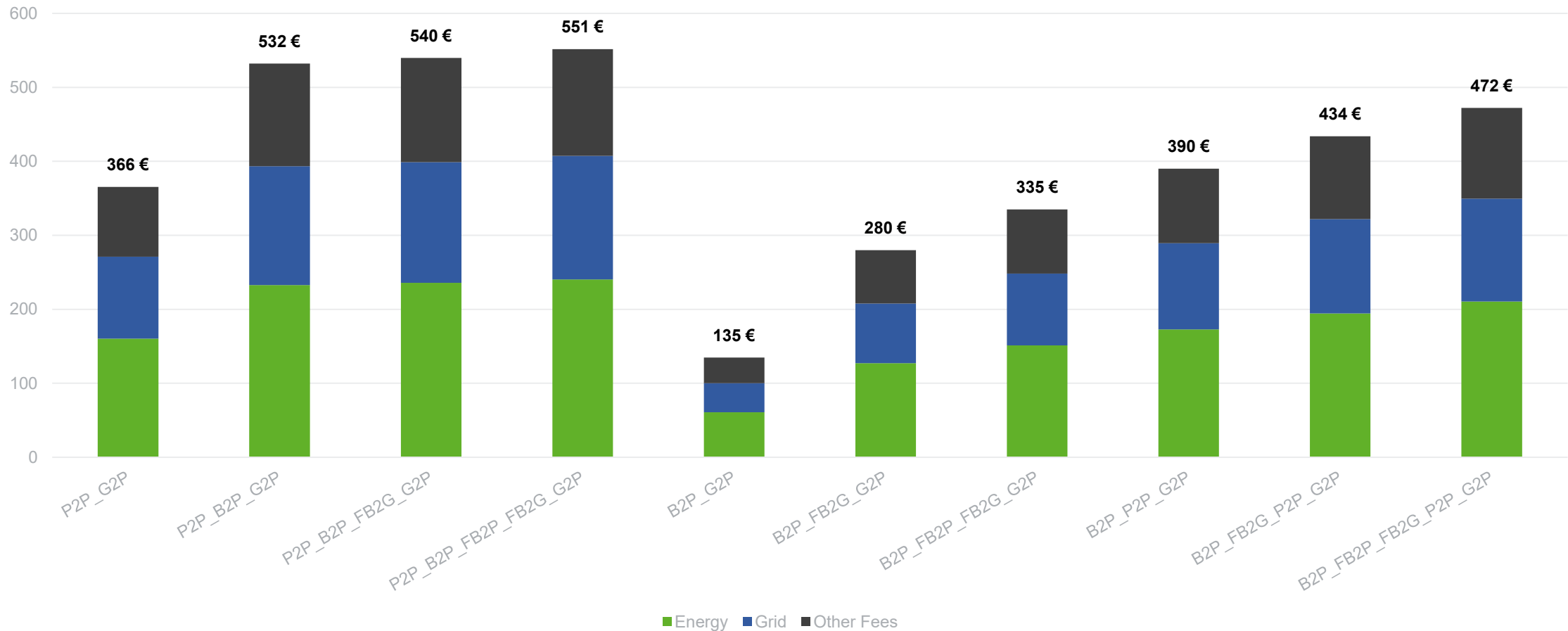


Costs & Revenues

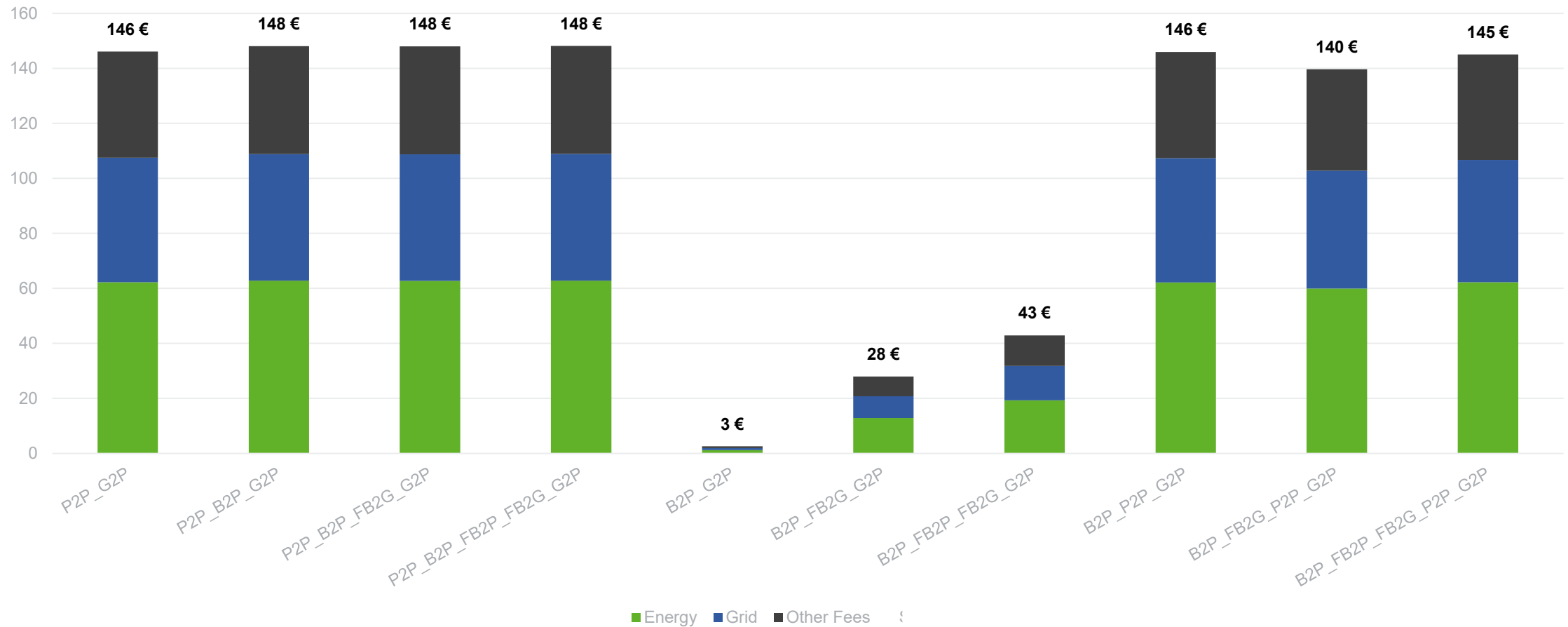


	Energy [€ct/kWh]	Grid [€ct/kWh]	Other [€ct/kWh]	Total (incl. VAT) [€ct/kWh]
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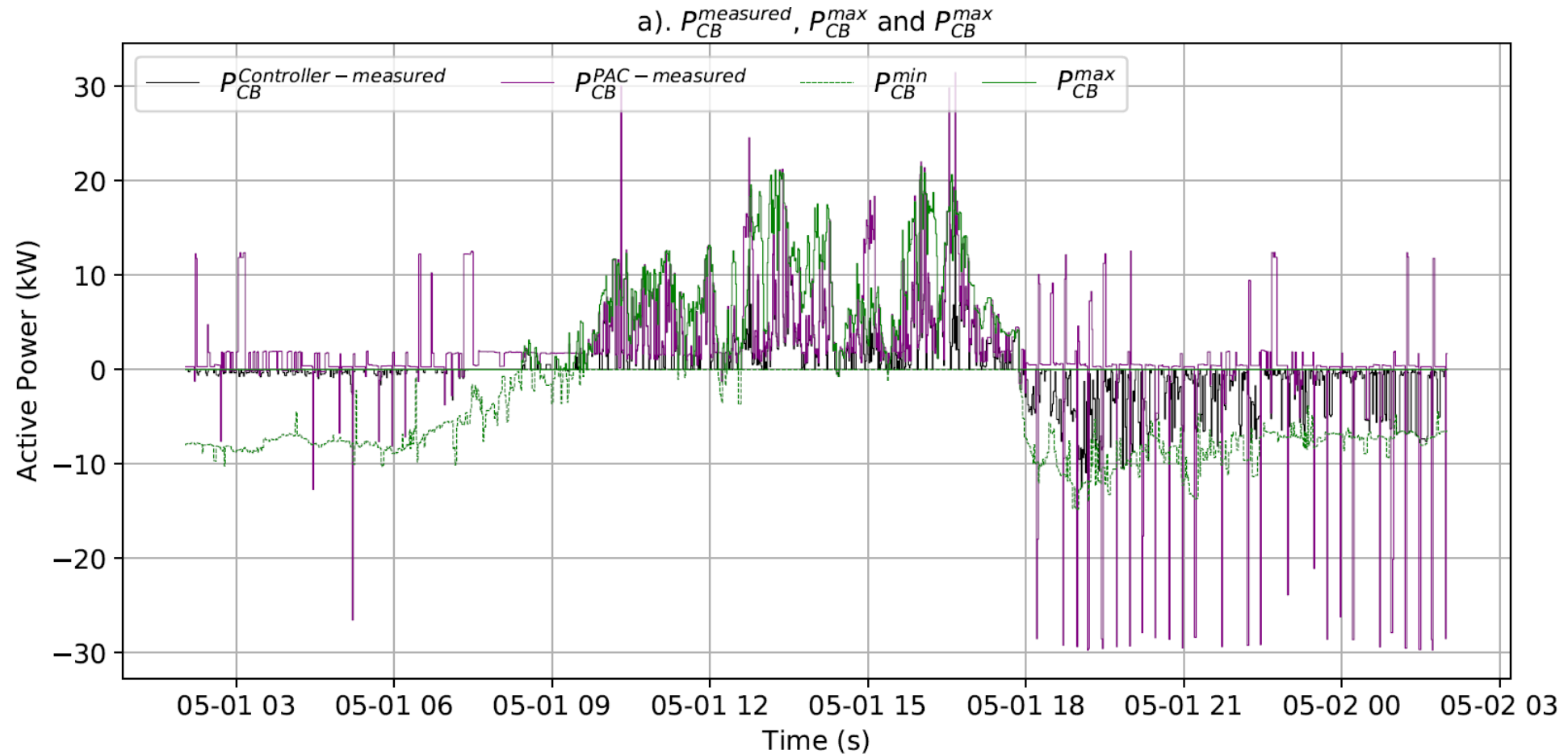
Potential of cost savings for small community (12 customers)



Potential of cost savings for small community (125 customers)



Grid Capacity Management



Summary

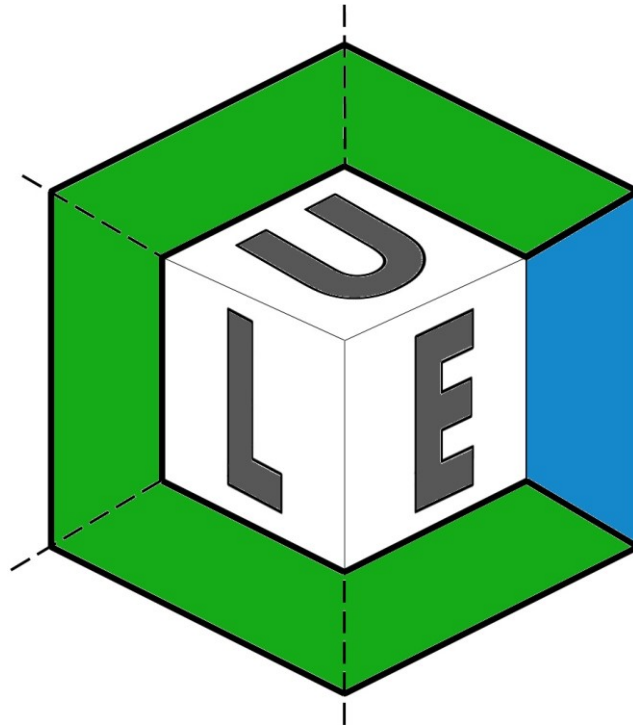


- Savings potential for energy community participants of over 550 € per year.
- Actual savings:
 - Relationship and timing between generation and consumption
 - Reduced grid tariffs
- Grid capacity management:
 - PV in Heimschuh: additional 40 kWp
 - Grid supporting measures of the community, costs of grid expansion
 - Charging power of 22 kW
- Blockchain-based architecture
 - Requirements of field operation → IoT (embedded systems)
 - Smart Contract (Blockchain) → simple algorithms
 - Documentation → Blockchain

Outlook



- **CLUE | Concepts, Planning, Demonstration and Replication of Local User-friendly Energy Communities**



Thank you very much for your attention!

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