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Decentralized or centralized electrical storage systems for low-voltage grid applications

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Research Perspective

- Grid components e.g. transformers and also the overall grid stability suffer from higher feed-back power flows from the low-voltage grid (LVG) into upper voltage levels.
- The use of energy storage systems (EES) can increase the degree of electrical self-sufficiency (DSS) of a grid segment and decrease the amount of control power to stabilise the grid.
- Avoidance of high costs, related to additional local grid extension measures, due to the use of EES with grid-related control strategies.

Methodology

- Dimensioning of the EES ?
- Control strategy of the EES ?
- Target costs for the economic efficiency ?

Energy System Simulations...

- … are used to determine the self- sufficenicy and grid stability.
- … are scaleable and adaptable for different EES and control strategies.
- … allow variable consumer and producer scenarios.
- … enable holistic analysis of energy systems involving technical, economic and regulatory evaluation criteria.

Simulation Scenario

- Set of one year active and reactive power profiles of 74 German residential buildings [1, 2].
- Grid segment with 347 MWh annual electrical demand, base load power of 12 kW and maximal peak power of 131 kW [1, 2].
- Different producer scenarios with varying penetration of energy sources (PV penetration in the grid segment 0%, 25%, 50%, 75%, 100%).
- Energy storage systems based on the Lithium-Ion battery technology.

Centralized vs. Decentralized Energy Storage Systems in the grid using Redox-Flow Batteries

- Synchronization of energy generation and consumption by using electrical energy storage systems.
- Distinguish between decentralized (figure 3) (DEES) and centralized EES (figure 5) (CEES) and evaluate the performance of the energy system and the grid by appliying different control alogrithms.
- Both approaches will be evaluated and compared based on different assessment criteria e.g. degree of electrical self sufficiency.

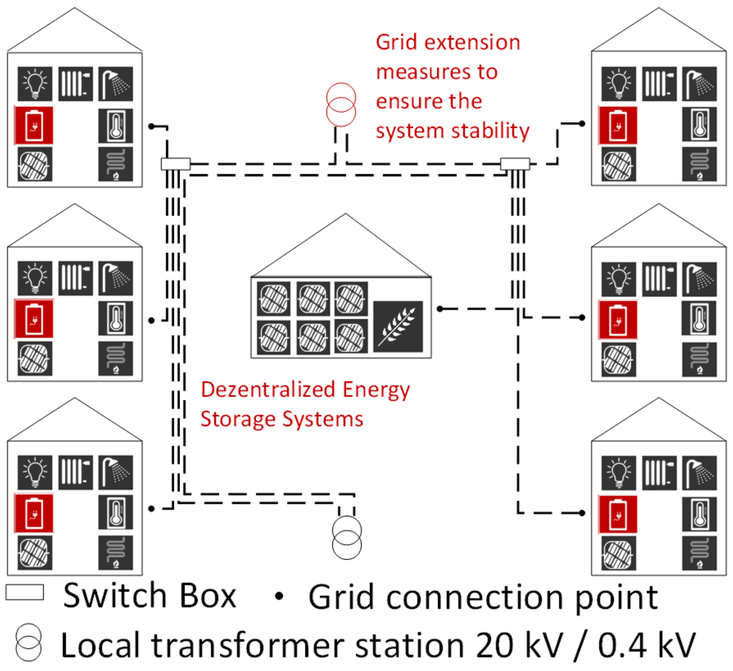

Figure 1: Scenario I with decentralized storages

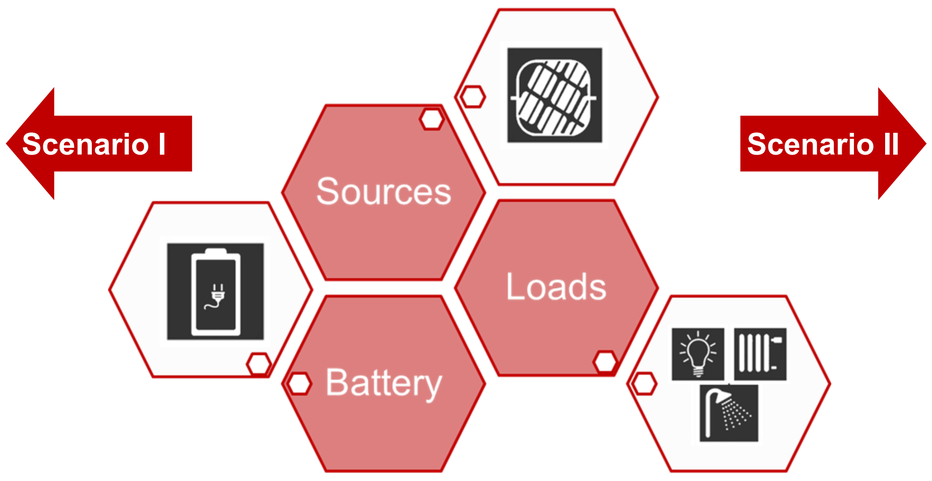

Figure 2: Input Parameter of the Energy System Simulation

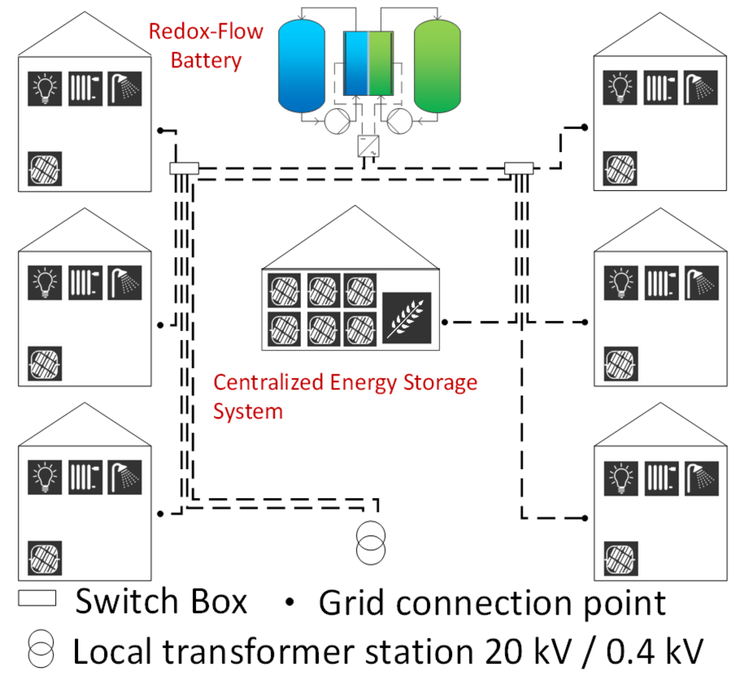

Figure 3: Scenario II with one centralized storage

Results

- Figure 4 shows the results for the DSS in the grid segment using DEES (left bar) or one CEES (right bar). The amount of PV systems in the grid is varried from one to 74 during the simulation. Each household with a PV system is also equipped with a DEES.
- In the CEES case each scenario shows a higher DSS.

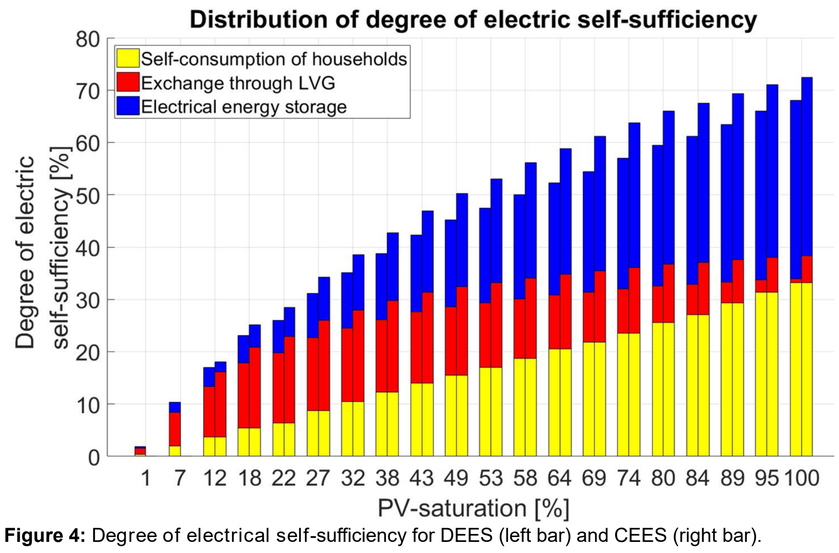

Figure 4: Degree of electrical self-sufficiency for DEES (left bar) and CEES (right bar).

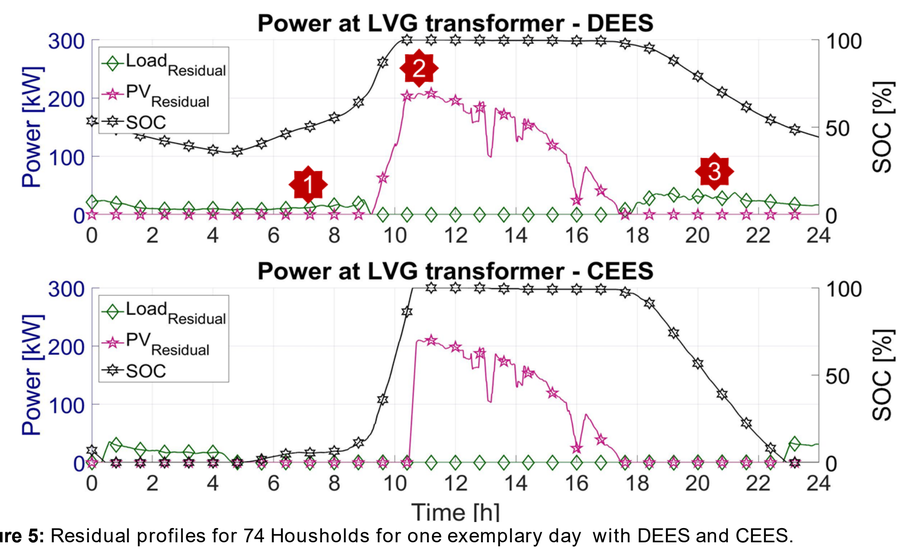

Figure 5: Residual profiles for 74 Housholds for one exemplary day with DEES and CEES.

[1] P. Hoffman, G. Frey, M. Friedrich, S. Kerber-Clasen, J. Marschall, und M. Geiger,:„Praxistest ‚Moderne Energiesparsysteme im Haushalt'", IZES, Saarbrücken, März 2012.
[2] A. Einfalt, A. Schuster, C. Leitinger, D. Tiefgraber, M. Litzlbauer, S. Ghaemi, D. Wertz, A. Frohner, und C. Karner,:„Konzeptentwicklung für ADRES - Autonome Dezentrale Erneuerbare Energie Systeme", Wien, Endbericht, Aug. 2012.

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