Poster 2:

Flexibility Demand and Availability for Congestion Management in Low Voltage Grids Considering Future Load Scenarios

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The introduced method aims to deal with the question, whether the available flexibility within a grid section could cover the demand of flexible power to prevent the grid from congestion. Therefore, the method evaluates the amount of flexible power demanded in a real existing low voltage grid on the one hand and the flexible power and energy, offered by BSSs located at grid customer sites, on the other hand.

Determination of flexibility available from battery storage systems, installed to optimize self-consumption

To determine the available flexibility, the approach from [1] is used to describe the flexibílity in two dimensions, namely power and energy domain:

Power domain:

$$P_{\text{flex},+}(t) = P_{\text{c,max}} - x_{\text{p,c}}(t) \cdot P_{\text{c}} + x_{\text{p,d}}(t) \cdot P_{\text{d}}$$

$$P_{\text{flex},-}(t) = P_{\text{d,max}} + x_{\text{p,c}}(t) \cdot P_{\text{c}} - x_{\text{p,d}}(t) \cdot P_{\text{d}}$$

with: $x_{\text{p,c}} \in [0,1] \subset \mathbb{R}$, $x_{\text{p,d}} \in [0,1] \subset \mathbb{R}$

Energy domain:

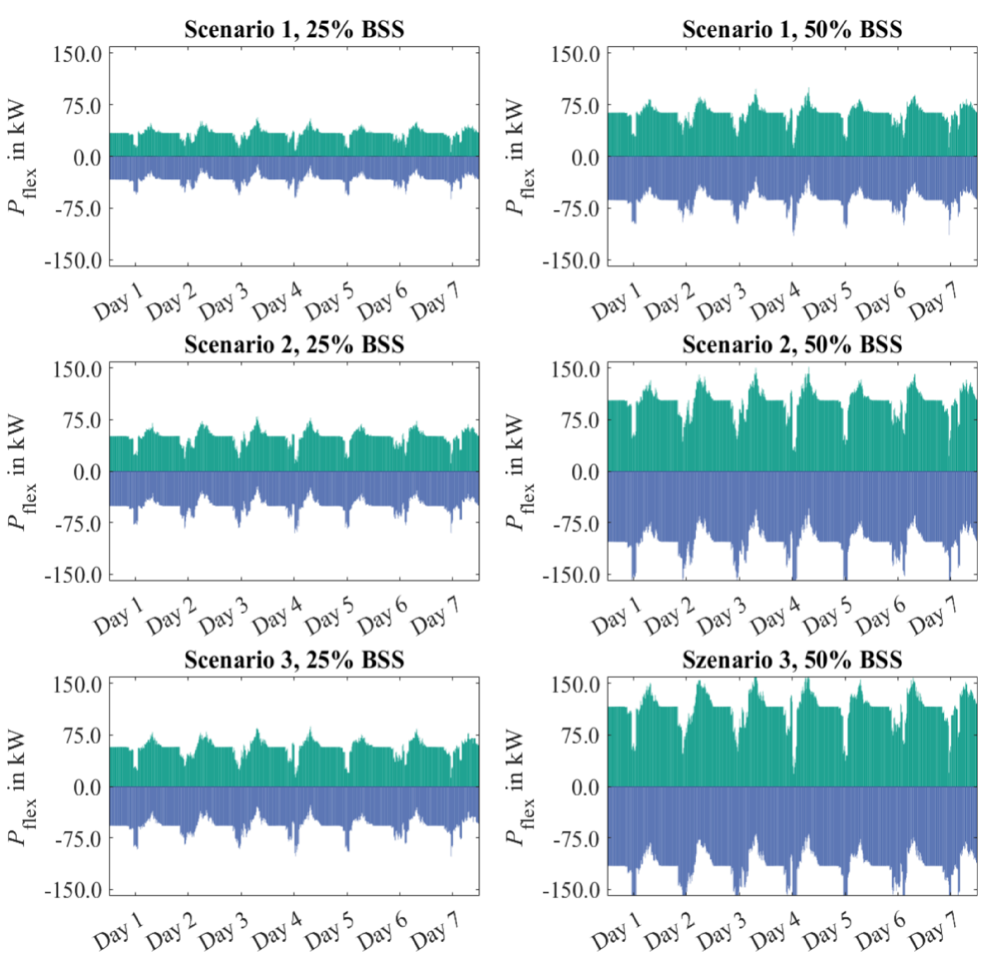
$$E_{\text{flex},+}(t) = E_{\max} - E(t)$$

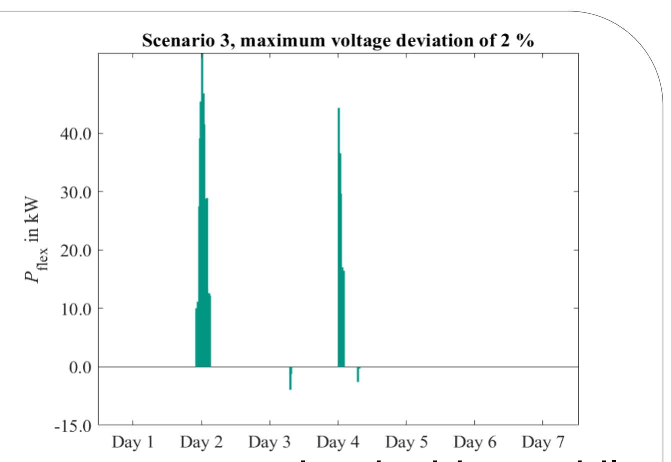
$$E_{\text{flex},-}(t) = E(t)$$

Calculation method for demanded flexibility to prevent the grid from congestion

Linear optimization problem with

- **objective function:** minimize absolute values of flexibility use to prevent the grid from congestion
- **constraints:**
  - linear network equations based on power flow manifold [2-4]
  - grid limitations (maximum voltage deviation)





- No congestion incident while considering a max. voltage deviation of 5 %
- Little demanded flexible power even with narrow voltage deviation limit of 2 %
- Method enables calculation of demanded flexible power to prevent the grid from congestion

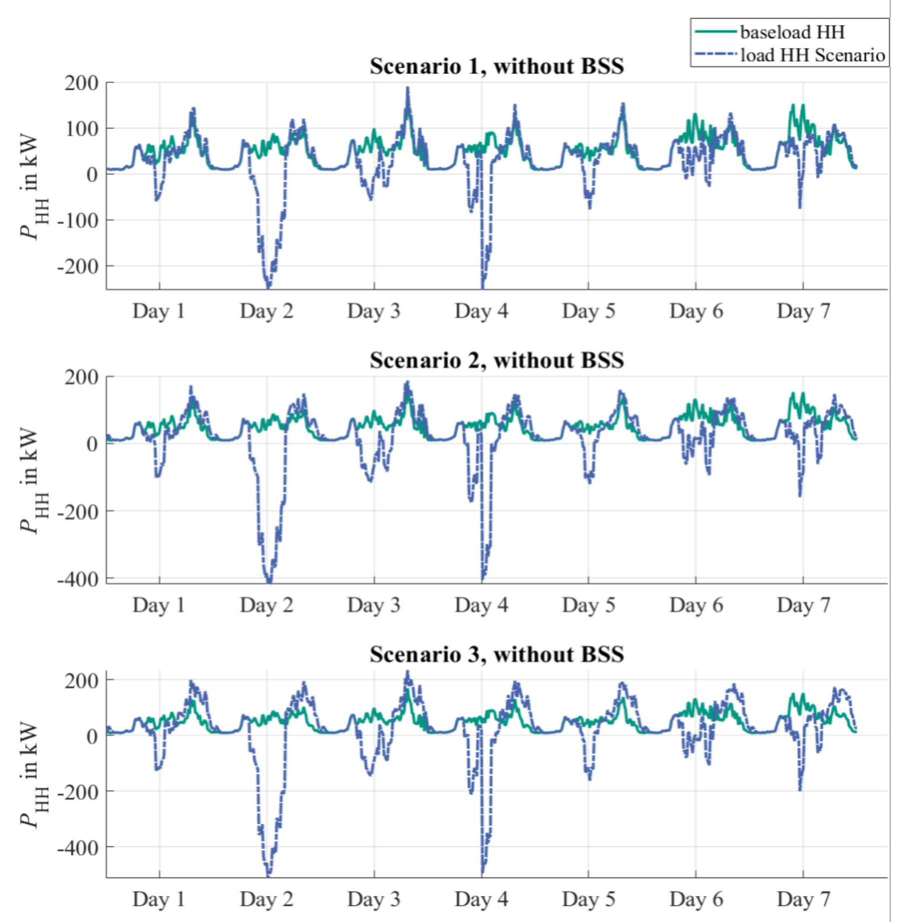
- Flexible power is available in **each timestep in positive and negative direction**
- High concurrency of PV power generation → similar optimized BSS schedules!
- Most of BSSs operate in charging mode during PV peak generation, resulting in less flexible power in positive direction while PV peak generation
- Opposite is valid for evening hours: most of BSSs operate in discharging mode, hence providing less flexible power in negative direction

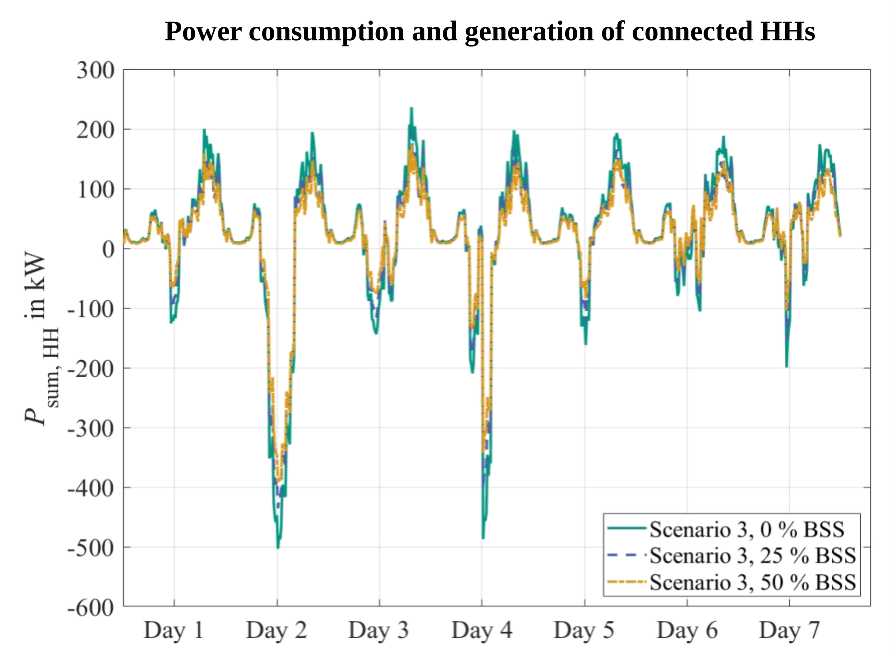
Future load scenarios include increasing numbers of electric vehicles (EV) and photovoltaic systems (PV)

Property	Scenario I	Scenario II	Scenario III
PV	50 %	80 %	100 %
EV	20 %	40 %	80 %

For a real existing low voltage grid, the defined future load scenarios are calculated as realistic as possible.

- Electrical load time series: 54 individual load time series are generated by applying 23 of the predefined households within the load profile generator [5].
- PV generation time series: Rooftop orientation and area is analyzed for all buildings connected to the grid. 80 % of dedicated area is considered for PV generation, with time series from PVGis [6].
- EV charging time series: EV charging power of 11 kW is assumed for each connected charging point. Time series are randomly selected from a pool if 670 charging schedules from [7].
- Dimensioning of BSS: The installed BSS capacity in kWh equals half of the installed PV peak power in kW, power limitations of BSS are set to a quarter of installed PV peak power in kW.





- High availability of flexible power provided by BSSs
- Little demand of flexible power occurring at particular timesteps

→ flexibility usage to prevent the grid from congestion appears like favored solution

Nevertheless, further research has to take into account the following shortcomings of the simulation study:

- Households may have same time series and BSSs using same optimizer; this simultaneity may lead to unrealistic load peaks
- Time series analyses for specific cases are required to calculate the overlap of flexibility demand and provision in time

References

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