0304 Equivalent cellular-based electrical network models for voltage regulation using hybrid conversion technologies at the medium-voltage level

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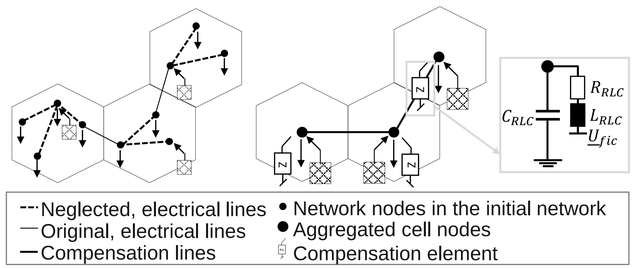
Introduction

Approaches to provide flexibility for energy grids and for enabling their grid-friendly operation while advancing RES expansion are multi-energy systems (MES). Modeling of such MES uses generic and modular approaches, such as cellular approaches. This work uses the hybrid load flow program HyFlow to investigate the influence of hybrid flexibility options at the medium-voltage level.



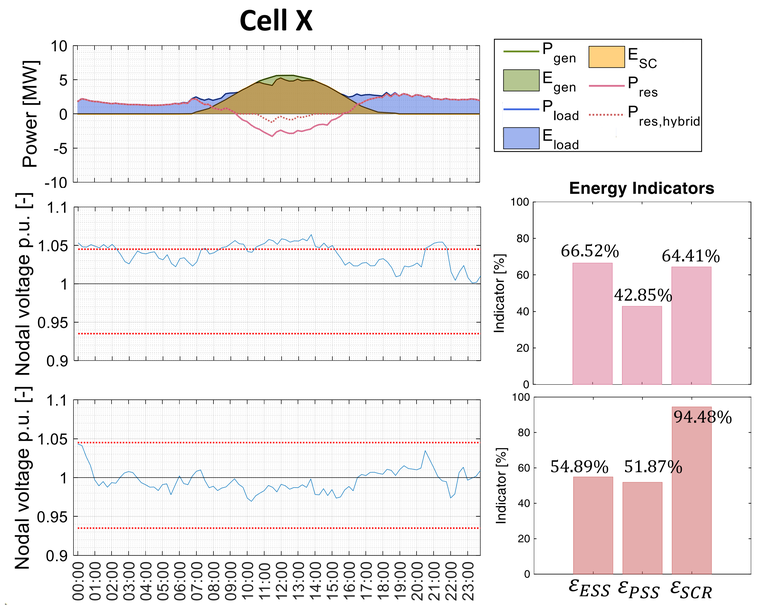
Methods – Hybrid Flexibility Options

For a medium-voltage test grid, Power-to-Gas units (PtG) and heat pumps (HP) are integrated as flexibility options within a expansion scenario of photovoltaic and wind power. To assess the impact of PtG and HP on energy use, energy indicators for energy balancing are used.

- Energy self-sufficiency $\varepsilon_{ESS} = \frac{E_{gen}}{E_{load}} = \frac{\int P_{gen}(t)dt}{\int P_{load}(t)dt}$
- Power self-sufficiency $\varepsilon_{PSS} = \frac{E_{SC}}{E_{load}} = \frac{\int min\{P_{load}(t), P_{gen}(t)\}\,dt}{\int P_{load}(t)dt}$
- Self-consumption ratio $\varepsilon_{SCR} = \frac{E_{SC}}{E_{gen}} = \frac{\int min\{P_{load}(t), P_{gen}(t)\}\,dt}{\int P_{gen}(t)dt}$

Results

For the expansion scenario, nodal voltages fall out of the tolerance range (0.935-1.045 p.u.). However, stabilization can be achieved using hybrid conversion.
Additionally, energy indicators can be improved, in particular, the self-consumption ratio. This indicators shows that little energy generated outside a certain area is needed.



Conclusions

- PtG and HP can stabilize voltages and increase power quality
- MES increase energy system efficiency
- Combination with cellular approach advantageous