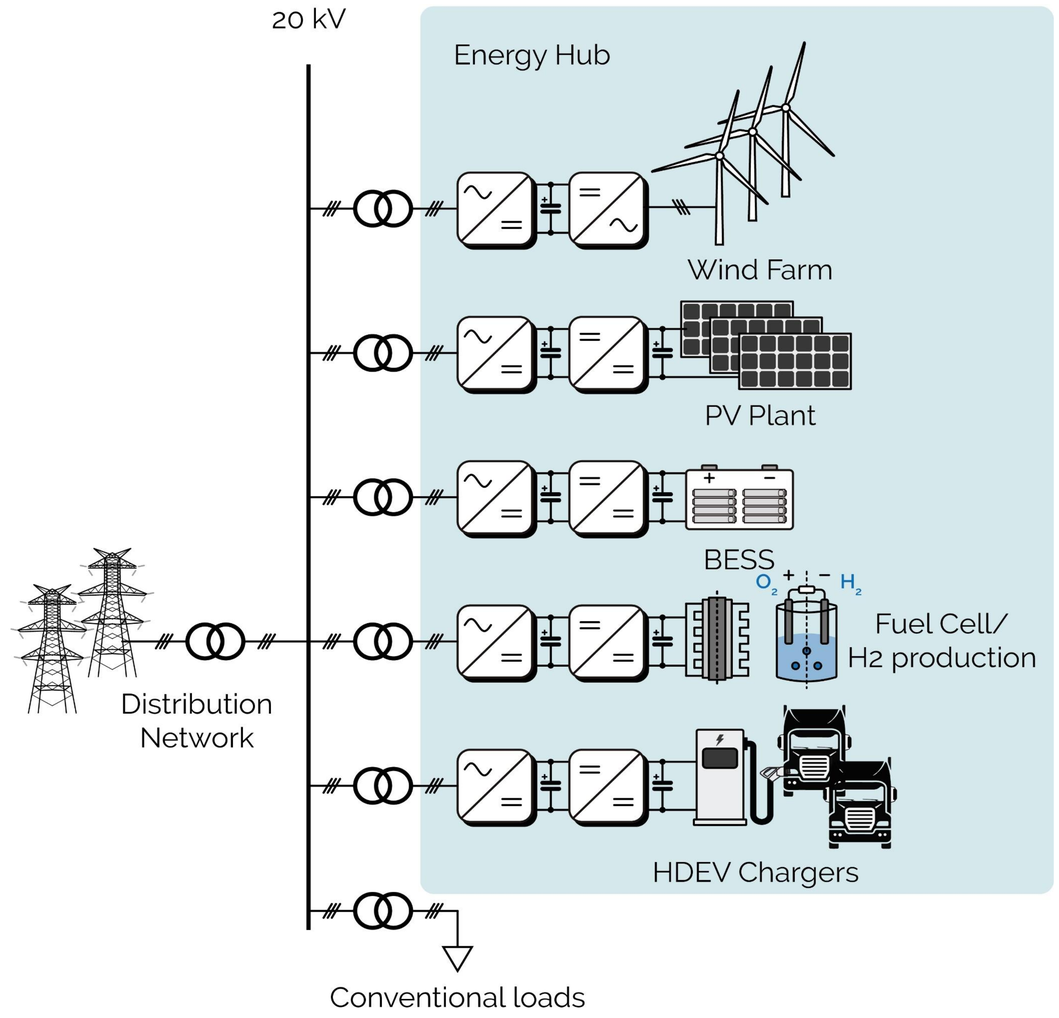
RL-Based EMS for Energy Hubs with Heavy-Duty Electric Vehicle Chargers

Research Goal

Heavy-duty electric vehicles (HDEVs) feature far larger batteries to meet higher power demands over extended distances. The only method to ensure a decent charging time is to employ high-power charging stations (+1 MW for each charger). As a result, uncontrolled charging will have an adverse impact on the power grid. This problem could be alleviated to some extent by connecting renewable energy sources (RESs) and energy storage systems (ESS) to the charging facilities and intelligently controlling the power flow among various subsystems.

The energy management system (**EMS)** can be used to;

- flatten peak demands by shifting the load to off-peak hours,
- take more energy from the grid without boosting its capacity,
- minimize charging costs,
- offer grid services,
- increase self-consumption and reduce dependence on the grid,
- decrease the ESS degradation.



Project Outline

Charging demand estimation at the energy hub

Asset sizing and energy hub configuration

EMS (classical optimization methods)

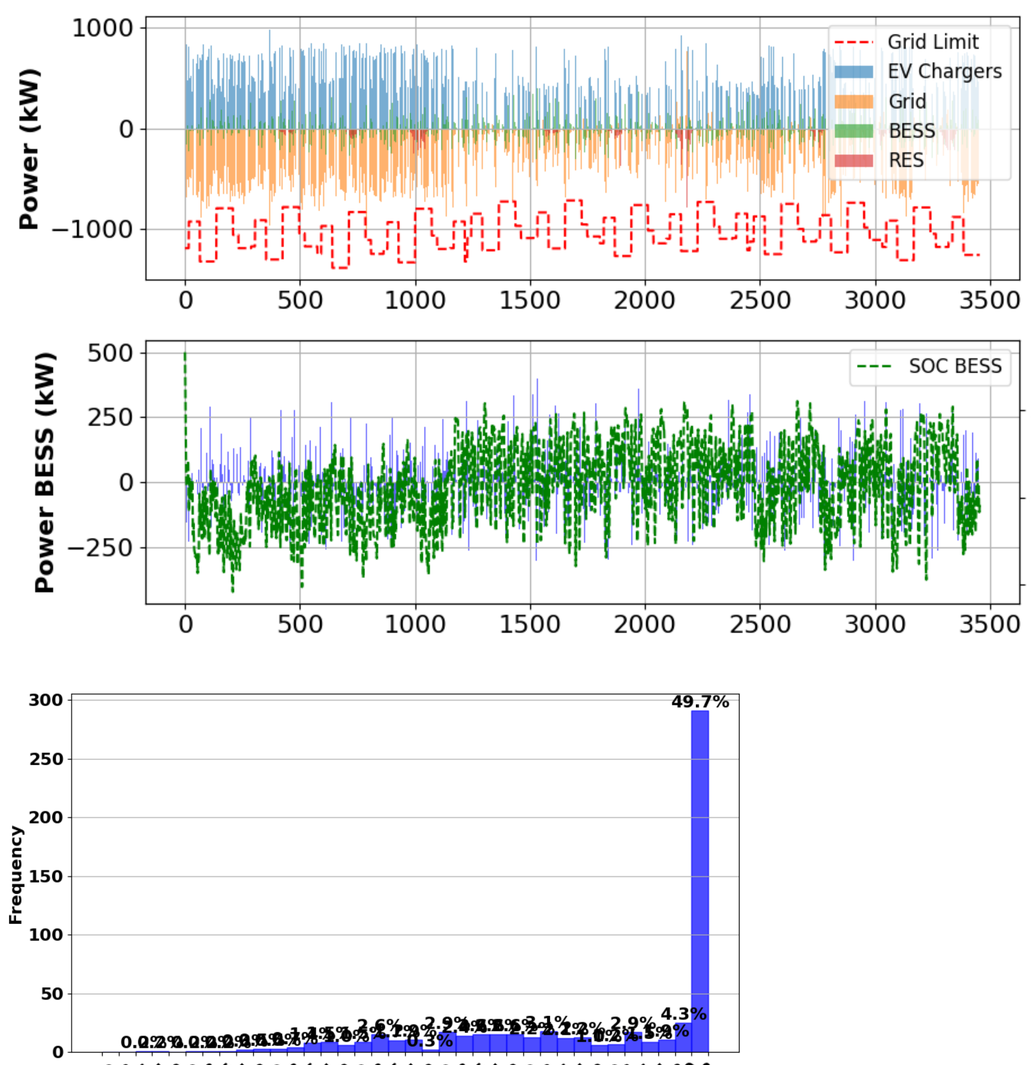
EMS (RL method)

Grid impact study

Test and verify the performance of the defined EMSs

RL-based EMS Results (ongoing)

- PPO learning algorithm
- **Action space:** Power setpoint of a chargers and ESS (indirectly grid power)



Challenges & Future Steps

- **Challenges:**
  - Data collection limitations• Implementing hard system constraints• Long training times for RL models
- **Next Steps:**
  - Develop hybrid EMS (Rolling Horizon + RL)• Study MV grid impact & EMS mitigation• Validate EMS using PHIL setup

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