RWTH AACHEN UNIVERSITY

E.ON Energy Research Center
ACS | Institute for Automation of Complex Power Systems

Master-Thesis:

Design of a multi-microgrid management system for resiliency improvement using electric vehicles

Context:
The growing severity and frequency of natural catastrophes has piqued the interest of power sector researchers, who are working to improve the resilience of power networks. Microgrids are being explored as a possible option for improving power system resilience by utilizing local resources such as renewable energy sources, electric vehicles (EVs), and energy storage devices. During the course of this thesis work, the usage of such flexibility resources are investigated for enhancing the resiliency of multi-microgrid systems during contingency periods (Figure 1). Initially, the student is provided with some literature material regarding resiliency in power systems, microgrid management, EV charging/discharging algorithms, etc. [1, 2]. The student is supposed to mathematically formulate the optimization problems for the local and central Energy Management Systems (EMS) with the objective of operational cost minimization while enhancing the system resiliency (Figure 2). In this regard, Python scripts for maximizing the self-consumption within a microgrid and EV (dis)charging scheduling are at student's disposal which will be further developed during the course of the research work. The algorithms will be developed for both normal and contingency cases and different scenarios will be investigated depending on the availability of electric vehicles and other flexibility resources.

Your tasks:

- Conduct literature review with respect to microgrid resiliency enhancement using renewables.
- Mathematical modelling of the optimization problem and the resiliency index.
- Setting up the simulation environment using Pyomo modelling language [3].
- Implementation of the simulations under different exemplary validation scenarios, e.g., complete isolation of the islanded microgrid due to contingency, partial isolation of the islanded microgrid (still connected with other microgrids), resiliency enhancement with and without EVs, etc.
- Post-processing of the results (resiliency index evaluation, sensitivity analysis, etc.)

Your profile:

- Student of electrical engineering or information technology preferably from RWTH Aachen University.
- Experience with modelling and simulation using Python language.
- Basic knowledge about electrical distribution systems and statistics.
- Interest in mathematical programming languages (AMPL).
- Willing to learn and test optimization algorithms
- Working capability in autonomy and in a proactive way.

Contact:

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Figures:

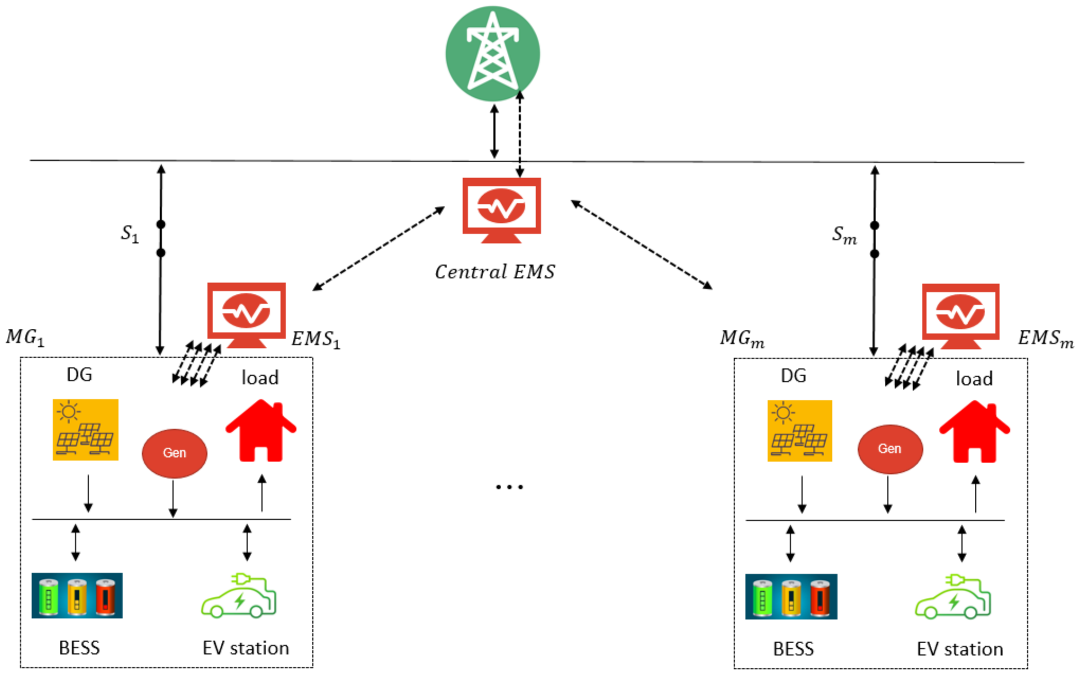
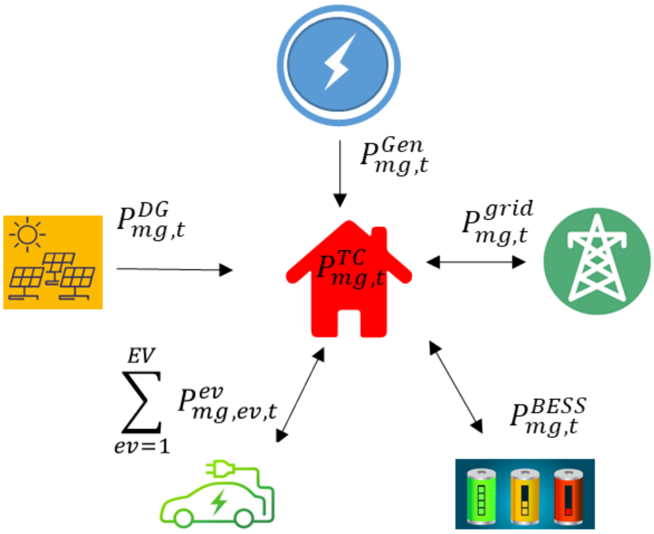


Figure 1: Exemplary architecture for a monitoring system



$$P_{mg,t}^{Gen} + P_{mg,t}^{grid} + P_{mg,t}^{DG} + P_{mg,t}^{BESS} + \sum_{ev=1}^{EV} P_{mg,ev,t}^{ev} = P_{mg,t}^{TC}$$

Figure 2: A typical mathematical constraint of local EMS with respect to the power balance

References:

[1] Ali, A.Y.; Hussain, A.; Baek, J.-W.; Kim, H.-M. Optimal Operation of Networked Microgrids for Enhancing Resilience Using Mobile Electric Vehicles. *Energies* **2021**, *14*, 142. https://doi.org/10.3390/en14010142

[2] E. Gümrükcü et al., "V2G Potential Estimation and Optimal Discharge Scheduling for MMC-based Charging Stations," 2020 5th IEEE Workshop on the Electronic Grid (eGRID), 2020, pp. 1-6, doi: 10.1109/eGRID48559.2020.9330677.

[3] www.pyomo.org