

Master-Thesis / Diplomarbeit:

Distributed OPF Algorithm for System-Level Control of DC Distribution Grids Considering Uncertainties

Context:

The high integration of converter-interfaced renewable energy sources (RES) and energy storage systems (ESS) and the advancements in power electronics stimulate the development of DC distribution grids. The fast dynamics in the converter-dominated system and the volatility of the RES necessitates fast control actions. Fast control and coordination of the system components can be achieved by the combination of secondary and tertiary control levels in the hierarchical control structure. The system-level control of the DC distribution grid takes the form of the optimal power flow (OPF), which provides fast the voltage and power set-points to the components of the system. In this context, the research project FEN focuses on the development of new control and operation methods for DC distribution grids. In the framework of the FEN project, the ACS Institute participates in the development of distributed OPF algorithms.

In literature there are several techniques and algorithms for the OPF problem, following centralised or distributed approaches. The distributed algorithms require shorter computation time and less data storage, overcome the issue of the single-point-failure and facilitate the data privacy of the power units' owners [1]. In such algorithms, the OPF problem is distributed in smaller local OPF sub-problems, each solved by a distributed control unit (DCU). For the consistency of the local solutions, the DCUs exchange locally computed quantities through a communication network. However, the formulation of the OPF problem includes several uncertain parameters, e.g. the system model parameters (lines, converters) or the RES available power. The objective of this thesis is to develop a distributed OPF algorithm, which provides a realistic OPF solution of the DC distribution grid.

Your tasks:

The student shall work on the development of the distributed OPF algorithm for DC distribution grids. Specifically, the fully-distributed OPF algorithm for DC systems, already developed in the ACS Institute, should be modified to consider the system uncertainties. For this purpose, the possible sources of uncertainties should be analysed and modelled. Then the OPF problem should be modified to include the uncertainties models. Furthermore, suitable techniques should be developed to solve the new OPF problem. The problem should be solved

in a distributed manner. The algorithm will be tested with regard to various metrics, namely the convergence speed, the scalability and modularity of the algorithm. The work will be performed in Python.

Your profile:

- Good knowledge of (distributed) optimisation algorithms, preferably for OPF problem
- Knowledge of Python is not a prerequisite but preferable skill

The collaboration with the supervisor will be done in English and the thesis should be written in English.

References:

[1] S. Magnússon, P. C. Weeraddana and C. Fischione, "A Distributed Approach for the Optimal Power-Flow Problem Based on ADMM and Sequential Convex Approximations," in IEEE Transactions on Control of Network Systems, vol. 2, no. 3, pp. 238-253, Sept. 2015.

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