Analysis of distributed optimization techniques for demand side management considering low voltage grid and market constraints

In future energy markets the aggregator provides services for the electricity distribution system by scheduling flexibility on the demand side. For privacy reasons on electricity customer side this scheduling is done in a distributed fashion, which is also more favorable considering the decentralized energy system of tomorrow.
This work aims to develop a distributed optimization algorithm based on the alternating direction method of multiplieres (ADMM) to perform an optimized energy scheduling for different electricity markets, while keeping the low voltage distribution grid in a safe operating area. To achieve this, a convex relaxation of the well known optimal power flow problem will be applied. Meanwhile the responsibilities of different market participants shall not be disregarded. Additionally, uncertainties in the aggregator's decision making process for different electricity markets, namely derivatives and spot market, respectively day-ahead and intraday, are addressed by two-stage stochastic programming.
For a simple radial distribution grid the advantages of this framework are analyzed. We can show the additional benefit of using a grid model for the scheduling, which is a slight reduction of operational cost. However, the highly increased complexity hinders this approach from being combined with stochastic programming, for which reason simplified constraints are introduced. Solving the here-and-now problem shows only a low cost reduction for the aggregator compared to a deterministic solution, while an improved prediction of uncertain conditions (weather, market and consumption) shows great potential.

Keywords: demand side management, distributed scheduling, grid constraints, uncertainties, electricity market, ADMM