Abstract

This thesis works on the scheduling optimization on the city district level with a distributed algorithm to exploit the operational flexibility potential from a local energy system. With the Distributed Energy Resource penetration, the residential customers can be actively involved in power portfolio optimization for the city district. Based on this, the distributed optimization framework applied in this thesis adopts the hierarchical Demand Response architecture, which identifies the coordination and the independent information exchange between the aggregator and its customers. This thesis additionally considers the Alternating Current Optimal Power Flow constraints for the low voltage grid level. Three linear approximation models based on different assumptions are applied to linearize the Optimal Power Flow formulation to implement the distributed convex optimization. This work adapts the distributed Alternating Direction Method of Multipliers optimization algorithm to decompose the original optimization problem to the locals. In accordance with the Demand Response structure, the aggregator and local energy units possess individual optimization formulations and enable local optimization problems to be solved independently and parallelly. This thesis evaluates the application of the Alternating Direction Method of Multipliers optimization algorithm with energy cost minimization and peak-shaving as the objectives and analyzes its performance compared to the central optimization. The effectiveness and the adaptability of the Optimal Power Flow and the linear models are analyzed based on different flexibility metrics. The scheduling result optimized by the distributed model shows that distributed optimization performs well on exploiting the operational flexibility potential of the city district in consideration of the Optimal Power Flow constraints and shows good adaptability for the minimization of the system energy cost and the peak power reduction on the system level.

Keywords: Distributed Optimization, Demand Response, Alternating Current Optimal Power Flow, Linear Approximation, Alternating Direction Method of Multipliers, Operational Flexibility