需要側管理を考慮したマイクログリッドの技術経済学、最適化、および回復力

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Abstract

Dissertation Title: Techno-economics, Optimization, and Resilience of Microgrids Considering Demand Side Management

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Fossil-fuel generation technologies have been the most popular choice for supplying energy because of their low initial cost, flexibility of operation, and scalability. However, due to the scarcity of fossil fuel supplies, as well as environmental concerns and techno-economic viability, cleaner generation technologies based on wind, solar, hydro, and hydrogen are being strongly emphasized and supported throughout the world. As a result, integrating these technologies has become a priority for microgrids, and their ability to operate with or without the main grid makes them one of the most intriguing research topics today. The major goal of microgrids or hybrid energy systems is to provide local, dependable, and affordable energy security for urban and rural areas, as well as solutions for commercial, industrial, and federal government clients, especially when the utility power supply is not available. Lowering greenhouse gas (GHG) emissions and reducing stress on the transmission and distribution system are two benefits from the deployment of microgrids that extend to utilities and the community as a whole.

Integration and coordination of renewable energy technologies with conventional power generators presents significant challenges in terms of reliable operation, energy management, and control. These issues can be exacerbated by the presence of multi-energy load demand (such as heating plus electrical) and a variety of demand side measures, such as electric vehicles and demand response schemes. Furthermore, given the world's frequent natural disasters, ensuring the resilience of power and energy supply networks, particularly for microgrids, has never been more important than now. This thesis attempts to address these issues by designing the optimal microgrid system. The optimal and intelligent dispatch strategy of the microgrid is also discussed in different weather and loading condition. As for demand side management, a time of use (ToU) demand response strategy is proposed, and an electric vehicle (EV) charging station connected to the microgrid is considered. Integrating diverse energy sources, such as electricity, heat, and electrified mobility, presents several potential and obstacles. To obtain optimum advantages and dependability, the operation of many energy sources must be coordinated and optimized. Hence, this work presents a mixed integer linear optimization (MILP) model that determines an optimized combination of energy sources (battery, combined heat and power units, thermal energy storage, gas boiler, and photovoltaic generators), size, and associated dispatch to address the electrical, thermal, and transportation electrification energy demands in a sustainable and environmentally friendly multi-energy microgrid. Based on an hourly electrical and thermal demand profile, the proposed energy management system tries to reduce overall yearly expenditures while simultaneously increasing system resilience during lengthy grid disruptions. The optimization and simulation studies have been carried out using the different well-known tool- MATLAB, HOMERpro, and Python based Pyomo.

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