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A two-stage joint operation and planning model for sizing and siting of electrical energy storage devices considering demand response programs

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Abstract-

This study describes a computationally efficient model for the optimal sizing and siting of Electrical Energy Storage Devices (EESDs) in Smart Grids (SG), accounting for the presence of time-varying electricity tariffs due to Demand Response Program (DRP) participation. The joint planning and operation problem for optimal siting and sizing of the EESD is proposed in a two-stage optimization problem. In this regard, the long-term decision variables deal were the size and location of the EESDs and have been considered at the master level while the operating point of the generation units and EESDs is determined by the slave stage of the model utilizing a standard mixed-integer linear programming model. To examine the effectiveness of the model in the slave sub-problem, the operation model is solved for different working days of different seasons. Binary Particle Swarm Optimization (BPSO) and Binary Genetic Algorithm (BGA) have been used at the master level to propose different scenarios for investment in the planning stage. The slave problem optimizes the model in terms of the short-term horizon (day-ahead). Additionally, the slave problem determines the optimal schedule for an SG considering the presence of EESD (with sizes and locations provided by the upper level). The electricity price fluctuates throughout the day, according to a Time-of-Use (ToU) DRP pricing scheme. Moreover, the impacts of DRPs have been addressed in the slave stage. The proposed model is examined on a modified IEEE 24-Bus test system.

Index Terms- Energy Storage Systems; Smart Grids Planning; Demand Response Programs; Time-of-Use Tariffs; Binary Particle Swarm Optimization Algorithm; Binary Genetic Algorithm

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