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A multi-stage joint planning and operation model for energy hubs considering integrated demand response programs

S.A. Mansouri; A. Ahmarinejad; F. Sheidaei; M.S. Javadi; A.R. Jordehi; A. Esmaeel Nezhad; J.P.S. Catalão

Abstract-

Energy hub systems improve energy efficiency and reduce emissions due to the coordinated operation of different infrastructures. Given that these systems meet the needs of customers for different energies, their optimal design and operation is one of the main challenges in the field of energy supply. Hence, this paper presents a two-stage stochastic model for the integrated design and operation of an energy hub in the presence of electrical and thermal energy storage systems. As the electrical, heating, and cooling loads, besides the wind turbine’s (WT’s) output power, are associated with severe uncertainties, their impacts are addressed in the proposed model. Besides, demand response (DR) and integrated demand response (IDR) programs have been incorporated in the model. Furthermore, the real-coded genetic algorithm (RCGA), and binary-coded genetic algorithm (BCGA) are deployed to tackle the problem through continuous and discrete methods, respectively. The simulation results show that considering the uncertainties leads to the installation of larger capacities for assets and thus a 8.07% increase in investment cost. The results also indicate that the implementation of shiftable IDR program modifies the demand curve of electrical, cooling and heating loads, thereby reducing operating cost by 15.1%. Finally, the results substantiate that storage systems with discharge during peak hours not only increase system flexibility but also reduce operating cost.

Index Terms- Energy Hub Planning; Genetic Algorithm; Integrated Demand Response Programs; Wind Turbine; Energy Storage Systems; Stochastic Programming

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