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A three-layer game theoretic-based strategy for optimal scheduling of microgrids by leveraging a dynamic demand response program designer to unlock the potential of smart buildings and electric vehicle fleets

S.A. Mansouri; A. Paredes Parrilla; J.M. González González; J.A. Aguado Sánchez

Abstract-

The proliferation of the number of Smart Buildings (SBs) and the fleet of Electric Vehicles (EVs) in Distribution Systems (DSs) makes the need for new strategies to coordinate them with microgrid (MG) scheduling inevitable. Therefore, this article proposes a three-layer risk-averse game theoretic-based strategy to coordinate SBs and EV fleets with MGs scheduling. In the first layer of this strategy, a Demand Response Program (DRP) is designed for SBs where dynamic incentive tariffs are calculated based on the consumption pattern of subscribers. Then, in the second layer, the scheduling of SBs and EV fleets is done in a decentralized space and considering their participation in the designed DRP. Eventually, in the third layer, the operators of MGs have received the power exchange information of SBs in order to carry out their scheduling in accordance with it. In this layer, the Day-Ahead (DA) scheduling of MGs and DS is done through the implementation of a cooperative game theory. Fluctuations of uncertain operational parameters such as load demand, radiation and wind are embedded in the model by scenario-based technique where a Risk-Averse (RA) strategy is adopted to manage them. Running the proposed three-layer strategy on a 69-node DS containing four MGs showed that this strategy can use the potential of SBs and EV fleets to improve the voltage characteristics in the high-demand period and reduce total daily costs by 13.66% with designing a dynamic-tariff DRP. Moreover, the results reveal that MGs using the Peer-to-Peer (P2P) power exchange option have not only reduced the power losses in the system but also reduced the total daily costs by about 8%.

Index Terms- Microgrids; Cooperative game theory; Smart buildings; Vehicle-to-grid services; Demand response programs; Temperature Comfort

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