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A multi-level multi-objective strategy for eco-environmental management of electricity market among micro-grids under high penetration of smart homes, plug-in electric vehicles and energy storage devices

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Abstract-

This article develops a stochastic multi-level multi-objective strategy to facilitate the electricity market clearing process among micro-grids considering the environmental impacts of fossil fuel powered generation units. Various types of distributed renewable energy resources (DRERs), plug-in electric vehicles (PEVs) and internet-of-things (IoT)-enabled smart homes (SHs) are considered in the proposed concept. In addition, energy storage devices (ESDs) are installed in SHs, micro-grids and distribution network to handle the negative impacts of operational uncertainties arising from DRERs and load demand. Scenario-based stochastic (SBS) method is adopted to model the scenarios of uncertain parameters. In the proposed methodology, micro-grids build their bids/offers for market participation by using the weighted fuzzy method with regard to the SHs optimal programs and aiming to minimizing operational and emission costs. SHs have PEVs and ESDs, and control their controllable appliances via the IoT. The proposed methodology is formulated in linear form and is implemented on a modified IEEE 33-node distribution network comprising three micro-grids. The simulation results prove that the IoT infrastructure in SHs has led to their effective participation in the electricity market and subsequently lowering their costs by 9.13 %. Besides, the results reflect that the provision of vehicle-to-grid services by PEVs along with the optimal operation of ESDs not only lowers the market settlement price (MSP) by about 25 % during the high-demand period, but also reduces daily operation costs and carbon emissions by 32.85 % and 27.65 %, respectively.

Index Terms- Micro-grids; Electricity market; Bidding strategy; Vehicle-to-grid services; Energy storage devices; Emission

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