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An IoT-enabled hierarchical decentralized framework for multi-energy microgrids market management in the presence of smart prosumers using a deep learning-based forecaster

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Abstract-

The integrated exploitation of different energy infrastructures in the form of multi-energy systems (MESs) and the transformation of traditional prosumers into smart prosumers are two effective pathways to achieve net-zero emission energy systems in the near future. Managing different energy markets is one of the biggest challenges for the operators of MESs, since different carriers are traded in them simultaneously. Hence, this paper presents a hierarchical decentralized framework for the simultaneous management of electricity, heat and hydrogen markets among multi-energy microgrids (MEMGs) integrated with smart prosumers. The market strategy of MEMGs is deployed using a hierarchical framework and considering the programs requested by smart prosumers. A deep learning-based forecaster is utilized to predict uncertain parameters while a risk-averse information gap decision theory (IGDT)-based strategy controls the scheduling risk. A new prediction-based mechanism for designing dynamic demand response (DR) schemes compatible with smart prosumers’ behavior is introduced, and the results illustrate that this mechanism reduces the electricity and heat clearing prices in peak hours by 17.5% and 8.78%, respectively. Moreover, the results reveal that the introduced structure for hydrogen exchange through the transportation system has the ability to be implemented in competitive markets. Overall, the simulation results confirm that the proposed hierarchical model is able to optimally manage the competitive markets of electricity, heat and hydrogen by taking advantage of the potential of smart prosumers.

Index Terms- Multi-Energy Systems; Smart Prosumers; Machine Learning; Internet of Things; Power-to-Hydrogen Technologies; Electric and Fuel Cell Vehicles

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