

# **A three-stage mechanism for flexibility-oriented energy management of renewable-based community microgrids with high penetration of smart homes and electric vehicles**

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## **Abstract-**

**A multi-stage mechanism for flexibility-oriented energy management (FOEM) of the distribution system is developed in this article, which main novelty is providing the flexibility requirements of the main grid by resources within renewable-based microgrids (RBMGs), including distributed generations (DGs), storage systems (SDs), internet-of-things enabled smart homes (IESHs), and plug-in electric vehicles (PEVs). In the first stage, IESHs are programmed in a decentralized space subject to satisfying the residents' satisfaction index (SI). In the second stage, RBMGs are programmed according to the announced plan of IESHs. Ultimately, in the third stage, the main grid operator calculates the required flexibility capacities of the system according to the announced plans of RBMGs, where a risk-averse strategy is adopted to manage the risk of programming. Next, the main grid operator announces the required flexibility capacities to RBMGs and IESHs so that they can re-plan with the possibility of participating in flexibility markets. The numerical results clarify that the participation of RBMGs, IESHs, and plug-in electric vehicles (PEVs) in providing flexibility capacities not only reduces the dependence of the distribution system on the upstream grid (UG), but also reduces the total daily costs by 30.7%.**

**Index Terms-** Microgrid Energy management; flexibility services; Renewable energy sources; Smart homes; Storage devices; Plug-in electric vehicles

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