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Abstract The power trading model considering operating agents at different levels, such as distribution utility, microgrid operators, and end-users allows for efficient energy resource coordination and effective utilization. The simultaneous and hierarchical optimization of multiple agents has not yet been attempted. The techno-economic aspects can be accomplished more effectively if the energy management framework considers hierarchically coordinated decision-making of all agents. The decisions of all agents are interlinked and can be realized with a hierarchical Stackelberg game model. This article proposes an energy management framework incorporating a three-level hierarchical decision approach, through which multiple operating agents can actively participate in energy management to achieve their respective goals. In this framework, a game-theoretic dynamic pricing scheme is used to enable the interaction of distribution utility and microgrid operators as well as the microgrid operators and end-user aggregators. This arrangement enables end-user aggregators to negotiate adequately with microgrid operators. This article also investigates the impact of risk-averse and risk-seeker decisions of microgrid operators on the operating cost of distribution utility. The numerical results establish the effectiveness of the proposed framework and demonstrate that the proposed participatory strategy can improve economic benefits with technical aspects, such as lower peak demand and improved voltage profiles.

Keywords Batteries; Battery energy storage; Costs; demand response (DR); distribution system (DS); Energy management; energy management; Energy states; info-gap decision theory; Microgrids; multimicrogrid (MMG); plug-in hybrid electric vehicle; Power markets; Uncertainty.