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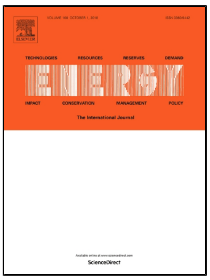

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A cyber-physical-social system with parallel learning for distributed energy management of a microgrid

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***Abstract*—A novel cyber-physical-social system (CPSS) with parallel learning is presented for distributed energy management (DEM) of a microgrid. CPSS is developed by extending the conventional cyber-physical system to the social space with human participation and interaction. Each energy supplier or each energy demander is regarded as a human in the social space, who is able to learn the knowledge, co-operate with others, and make a decision with various preference behaviors. The correlated equilibrium (CE) based general-sum game is employed for realizing the human interaction on the complex optimization subtask, while the novel adaptive consensus algorithm is used for achieving that on the simple optimization subtask with multi-energy balance constraints. A real-world system and multiple virtual artificial systems are introduced for parallel and interactive execution based on the small world network, thus a higher quality optimum of DEM can be rapidly emerged with a high probability. Case studies of a microgrid with 11 energy suppliers and 7 energy demanders demonstrate that the proposed technique can effectively achieve the human-computer collaboration and rapidly obtain a higher quality optimum of DEM compared with other centralized heuristic algorithms.**

***Keywords* – Cyber-physical-social system; Parallel learning; Correlated equilibrium; Adaptive consensus algorithm; Distributed energy management**

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