Power Network With Distributed Generation and Storage, an Extended-MFG model

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Abstract

We consider a stylized model for a power network with distributed local power generation and storage. This system is modeled as network connection a large number of nodes, where each node is characterized by a local electricity consumption, has a local electricity production (e.g. photovoltaic panels), and manages a local storage device. Depending on its instantaneous consumption and production rates as well as its storage management decision, each node may either buy or sell electricity, impacting the electricity spot price. The objective at each node is to minimize energy and storage costs by optimally controlling the storage device . In a non-cooperative game setting, we are led to the analysis of a non-zero sum stochastic game with N players where the interaction takes place through the spot price mechanism. For an infinite number of agents, our model corresponds to an Extended Mean-Field Game (EMFG). In a linear quadratic setting, we obtain an explicit solution to the EMFG, we show that it provides an approximate Nash-equilibrium for N-player game, and we compare this solution to the optimal strategy of a central planner.

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