Approaching Prosumer Social Optimum via Energy Sharing With Proof of Convergence

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With the advent of prosumers, the traditional centralized operation may become impracticable due to computational burden, privacy concerns, and conflicting interests. In this article, an energy sharing mechanism is proposed to accommodate prosumers' strategic decision-making on their self-production and demand in the presence of capacity constraints. Under this setting, prosumers play a generalized Nash game. We prove main properties of the game: an equilibrium exists and is partially unique; no prosumer is worse off by energy sharing and the price-of-anarchy is 1-$O(1/I)$ where I is the number of prosumers. In particular, the PoA tends to 1 with a growing number of prosumers, meaning that the resulting total cost under the proposed energy sharing approaches social optimum. We prove that the corresponding prosumers' strategies converge to the social optimal solution as well. Finally we propose a bidding process and prove that it converges to the energy sharing equilibrium under mild conditions. Illustrative examples are provided to validate the results

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