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Personalized retail pricing design for smart metering consumers in electricity market

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Summary

Local energy markets (LEM) have recently attracted great interest as they enable effective coordination of small-scale distributed energy resources (DER) at the customer side and avoidance of distribution network reinforcements. However, the introduction of LEM has also significant implications on the strategic interactions between the customers and incumbent electricity suppliers. This paper explores these interactions by utilizing a novel multi-period bi-level optimization problem, which captures the pricing decisions of a strategic supplier and the response of energy communities (flexible consumers, microgenerators, energy storage systems) either individually or after being integrated through a LEM. Case studies are carried out to demonstrate the benefits of LEM in both physical and economic terms, while the effects on the tariff's design are explored through the analysis of supplier's pricing strategies.

Highlights

- This paper develops a multi-period bi-level optimisation problem formulation where the supplier's business objectives define the upper-level problem and either the prosumers or the LEM set the lower-level problems.
- This paper proposes a novel binary relaxation approach and derives a primal-dual reformulation of the non-convex LL problem, as well as the penalization of the associated duality gap to deal with the non-conversity of the lower-level LEM problem.
- The introduction of LEM is able to mitigate the strategic supplier's market power by reducing the price differentials between the buy and sell prices, towards the competitive wholesale price. On the other hand, all market participants economically benefit from the LEM operation.