Optimizing P2P Energy Markets: A Multi-Objective Approach to Prosumers' Trading Decisions

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ABSTRACT:
Recent advances in decentralized energy systems have enabled prosumers to actively participate in peer-to-peer (P2P) markets. This study introduces a Multi-Objective Trading Decision Optimizer (MO-TDO) that jointly minimizes electricity costs and scheduling dissatisfaction for flexible loads. The MO-TDO employs a dynamic look-ahead genetic algorithm to generate hourly offer quantities and prices based on each prosumer's load profile, solar generation, and battery state. We assess the impact of MO-TDO adoption across three P2P market mechanisms—Uniform Price Double Auction (UPDA), Innovative Coalition Business Model (ICBM), and Hybrid Auction-Coalition (HAC)—using a discrete-event simulation of 100 Australian households over seven days, with adoption rates varying from 0% to 100% in 10% increments. Performance is measured by average community electricity bills, local matching (P2P clearing) efficiency, daily peak-load reduction, and profit distribution equity via the Gini index.
Results show that increased MO-TDO penetration leads to substantial community bill reductions—up to 28% under UPDA, 16% under HAC, and 12% under ICBM—as well as higher P2P clearing ratios and lower reliance on the central grid. Peak-load smoothing is most pronounced in ICBM, reflecting its community-centric coordination. However, equity analysis indicates widening profit disparities in competitive markets (UPDA and HAC) at high adoption levels, while ICBM maintains stable fairness. These findings highlight that MO-TDO deployment delivers broad cost savings, efficiency gains, and demand-side management benefits, but the choice of market design should align with stakeholders' priorities—whether maximizing cost reduction, enhancing grid stability, or ensuring equitable benefit distribution.

Key words: *Peer-to-peer trading, optimization, prosumer decision tool, renewable integration*

Biography of presenting author

Amin Zakhirekar is a PhD candidate at the University of New South Wales Canberra, where his research focuses on decentralized energy markets and blockchain-enabled peer-to-peer trading mechanisms. Drawing on a bachelor's degree in industrial engineering and a master's in project management, Amin develops multi-objective optimization models, leveraging genetic algorithms such as NSGA-II, to design prosumer and retailer strategies that balance cost, reliability, and equity among local energy communities.
Amin has co-authored articles in leading journals on energy such as Journal of Cleaner Production and presented at international conferences.
In addition to his research, Amin serves as a teaching assistant in courses on optimization and energy systems, and as a sessional academic, where he has designed coursework on software quality assurance for engineering students. He is a committee member of the Australian Institute of Project Management's Canberra chapter and holds industry experience in heavy-construction and IT project delivery for power-plant developments. Amin combines rigorous computational methods with practical insights to advance sustainable, decentralized energy solutions.

Presenter picture:

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