

A DSO-Driven Privacy-Preserving Mechanism for Managing Power Exchanges in Australian Networks

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Abstract-

This article presents a four-level hierarchical model to incorporate decentralized energy communities (ECs) into local electricity markets. The model utilizes an innovative distribution system operator (DSO)-driven algorithm to maximize grid services from ECs, monetize their energy surplus, and adapt market exchanges to network security constraints. In level 1, EC members determine their internal scheduling and power exchanges. A decentralized peer-to-peer (P2P) structure embedded in level 1 enables power sharing with dynamic pricing and limited data sharing among EC members. Levels 2 and 3 involve the EC operators and the retailer company determining their market strategies. In level 4, a DSO-driven algorithm is deployed to evaluate security constraints and the feasibility of exchanges between market players. Implemented on a modified 594-node distribution network in Victoria, Australia, the model optimally integrates ECs with local electricity markets. By preserving agents' privacy and keeping exchange details confidential, the proposed model ensures next-day contracts adhere to network security restrictions, maximizes grid services from ECs, and reduces members' electricity bills by 7.5%.

Index Terms- Decentralized optimization, electric vehicles (EVs), energy community (EC), peer-to-peer (P2P) power sharing, smart grids.

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