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Title:
Energy Imbalance Settlements for Renewable Resources: Efficiency and Risk Implications

Abstract:
This research examines the welfare implications of the bidding behavior of energy market participants when energy imbalance payments are determined endogenously from market clearing conditions. In some markets, wind producers are required to settle their day-ahead electricity offers based on their actual production in real-time. This is usually justified by economic and cost-causation principles, without considering the effects of these policies on curtailment and system risk. With real-time settlement requirements, the price that players pay or receive when their actual energy production deviates from the day-ahead offer is based on the realized errors in wind and demand, so it is affected by the strategies of all wind producers in the market. This paper formulates a two-stage game where players place ex-ante bids for energy production and then may curtail their realized output in real-time, and finds the symmetric subgame perfect equilibrium strategy for producer bidding and curtailment. The convexity of price sensitivity leads to conservative bidding strategies even when producers are not risk averse. The results show that the market-based pricing mechanism leads to better tradeoffs of system efficiency and risk compared to the case where penalties are exogenous, suggesting additional benefits of market-based penalty prices beyond those previously studied.