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Production efficiency of nodal and zonal pricing in imperfectly competitive electricity markets

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Abstract Electricity markets employ different congestion management methods to handle the limited transmission capacity of the power system. This paper compares production efficiency and other aspects of nodal and zonal pricing. We consider two types of zonal pricing: zonal pricing with Available Transmission Capacity (ATC) and zonal pricing with Flow-Based Market Coupling (FBMC).We develop a mathematical model to study the imperfect competition under zonal pricing with FBMC. Zonal pricing with FBMC is employed in two stages, a day-ahead market stage and a re-dispatch stage. We show that the optimality conditions and market clearing conditions can be reformulated as a mixed integer linear program (MILP), which is straightforward to implement. Zonal pricing with ATC and nodal pricing is used as our benchmarks. The imperfect competition under zonal pricing with ATC and nodal pricing are also formulated as MILP models. All MILP models are demonstrated on 6-node and the modified IEEE 24-node systems. Our numerical results show that the zonal pricing with ATC results in large production inefficiencies due to the inc-dec game. Improving the representation of the transmission network as in the zonal pricing with FBMC mitigates the inc-dec game.

Keywords Congestion management, Zonal pricing, Flow-based market coupling

JEL Classification C61, C72, D43, L13, L94

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