Price-Taker Offering Strategy in Electricity Pay-as-Bid Markets

The recent increase in the deployment of renewable energy sources may affect the offering strategy of conventional producers, mainly in the balancing market. The topics of optimal offering strategy and self-scheduling of thermal units have been extensively addressed in the literature. The feasible operating region of such units can be modeled using a mixed-integer linear programming approach, and the trading problem as a linear programming problem. However, the existing models mostly assume a uniform pricing scheme in all market stages, while several European balancing markets (e.g., in Germany and Italy) are settled under a pay-as-bid pricing scheme. The existing tools for solving the trading problem in pay-as-bid electricity markets rely on non-linear optimization models, which, combined with the unit commitment constraints, result in a mixed-integer non-linear programming problem. In contrast, we provide a linear formulation for that trading problem. Then, we extend the proposed approach by formulating a two-stage stochastic problem for optimal offering in a two-settlement electricity market with a pay-as-bid pricing scheme at the balancing stage. The resulting model is mixed-integer and linear. The proposed model is tested on a realistic case study against a sequential offering approach, showing the capability of increasing profits in expectation.