Value of Flexible Resources, Virtual Bidding, and Self-Scheduling in Two-Settlement Electricity Markets With Wind Generation

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This work presents new models for evaluating flexible resources in two-settlement electricity markets (day-ahead and real-time) with uncertain net loads (demand minus wind). Physical resources include wind together with fast- and slow-start demand response and thermal generators. We also model financial participants (virtual bidders). Wind is stochastic, represented by a set of scenarios. The two-settlement system is modeled as a two-stage process in which the first stage involves unit commitment and tentative scheduling, while the second stage adjusts flexible resources to resolve imbalances. The value of various flexible resources is evaluated through four two-settlement models:

i) an equilibrium model in which each player independently schedules its generation or purchases to maximize expected profit;
ii) ii) a benchmark (expected system cost minimization);
iii) iii) a sequential equilibrium model in which the independent system operator (ISO) first optimizes against a deterministic wind power forecast;
iv) iv) an extended sequential equilibrium model with self-scheduling by profit-maximizing slow-start generators.

A tight convexified unit commitment allows for demonstration of certain equivalencies of the four models. We show how virtual bidding enhances market performance, since, together with self-scheduling by slow-start generators, it can help a deterministic day-ahead market to choose the most efficient unit commitment.