Strategic Generation Investment in an Electricity Pool: an MPEC Approach

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Investment decisions to be made by producers within a market framework are complex and risky decisions. This is particularly so in imperfect markets, which is the case of electricity markets. Investment decisions are complex because they require modeling the market functioning leading to complementarity models. They also require taking into account the uncertainty plaguing markets, which leads to stochastic complementarity models. Finally, investment decisions are complex because the behavior of rival producers has to be properly represented.

In addition to the need for such a complex model, investment decision making is risky due to the long-term consequences of the involved decisions. We consider in this paper a strategic producer trading in a pool-based market through supply function strategies. This producer seeks to derive its investment strategy for a future target period spanning one year, for which the demand is modeled through a piecewise constant curve approximating the load duration curve in that target year. The strategies of rival producers in the pool and their investment decisions are uncertain parameters represented in this paper through scenarios. In other words, we use scenarios to describe uncertainty pertaining to 1) rival offers and 2) rival investments.

This paper provides a methodology to assist a strategic producer in making informed decisions on generation investment. The strategic behavior of the producer is represented through a bilevel model: the upper-level considers both investment decisions and strategic production actions and the lower-level corresponds to market clearing. Prices are obtained as dual variables of power balance equations. This model is able to optimally locate throughout the network generation investments and to select the best production technologies. The resulting model is a mathematical program with equilibrium constraints (MPEC), which recasts into a large-scale mixed-integer LP problem solvable using currently available branch-and-cut techniques. Results pertaining to an illustrative example and a case study are reported and discussed.