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Stochastic power generation unit commitment in electricity markets: a novel formulation and comparison of solution methods

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Abstract-

We propose a stochastic unit commitment model for a power generation company that takes part in an electricity spot market. The relevant feature of this model is its detailed representation of the spot market during a whole week, including seven day-ahead market sessions and the corresponding adjustment market sessions. The adjustment market sessions can be seen as an hour-ahead market mechanism. This representation takes into account the influence that the company's decisions exert on the market-clearing price by means of a residual demand curve for each market session. We introduce uncertainty in the form of several possible spot market outcomes for each day, which leads to a weekly scenario tree. The model also represents in detail the operation of the company's generation units. The model leads to large-scale mixed linear-integer problems that are hard to solve with commercial optimizers. This suggests the use of alternative solution methods. We test four solution approaches with a realistic numerical example in the context of the Spanish electricity spot market. The first is a direct solution with a commercial optimizer, which illustrates the mentioned limitations. The second is a standard Lagrangean relaxation algorithm. The third and fourth methods are two original variants of Benders decomposition for multistage stochastic integer programs. The first Benders decomposition algorithm builds approximations for the recourse function relaxing the integrality constraints of the subproblems. The second variant strengthens these cuts by performing one iteration of the Lagrangean of each subproblem. We analyze the advantages of these four methods and compare the results.

Index Terms- Programming; stochastic; integer; Lagrangean relaxation; Benders decomposition; production/scheduling; planning

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