

An Adaptive Model with Joint Chance Constraints for a Hybrid Wind-Conventional Generator System

Bismark Singh, University of Texas at Austin

David P. Morton, Northwestern University

Surya Santoso, University of Texas at Austin

Abstract:

We study the problem of scheduling a hybrid wind-conventional generator system to make it dispatchable, with the aim of profit maximization. Our models ensure that with high probability we satisfy the day-ahead energy promised by the model, using combined output of the conventional and wind generators. We consider two scenarios, which differ in whether the conventional generator must commit to its schedule prior to observing the wind-power realizations or has the flexibility to adapt in near real-time to these realizations. We investigate the relative synergy between the conventional generator and the wind farm in these two scenarios. From a computational perspective, the non-adaptive model is relatively tractable, benefiting from a strong extended-variable formulation as an integer program. The adaptive model is a two-stage stochastic integer program with joint chance constraints. Such models have seen limited attention in the literature because of the computational challenges they pose. However, we develop an iterative regularization scheme in which we solve a sequence of sample average approximations under a growing sample size. This reduces computational effort dramatically, and our empirical results suggest that it heuristically achieves high-quality solutions. Using data from a wind farm in Texas, we demonstrate that the adaptive model significantly outperforms the non-adaptive model in terms of synergy between the conventional generator and the wind farm, with expected profit more than doubled.