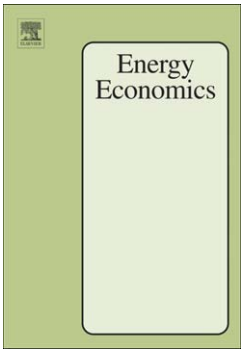

Towards More Resilient Integrated Power Grid Capacity Expansion: A Robust Optimization Approach with Operational Flexibility

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PII: S0140-9883(18)30095-1
DOI: doi:10.1016/j.eneco.2018.03.014
Reference: ENEECO 3946

To appear in: *Energy Economics*

Received date: 21 March 2017
Revised date: 1 March 2018
Accepted date: 6 March 2018

Please cite this article as: Caunhye, Aakil Mohammad, Cardin, Michel-Alexandre, Towards More Resilient Integrated Power Grid Capacity Expansion: A Robust Optimization Approach with Operational Flexibility, *Energy Economics* (2018), doi:10.1016/j.eneco.2018.03.014

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Abstract

This paper proposes a multi-period two-stage adaptive robust optimization model for long term power grid capacity expansion in an environmentally conscious way under generator output uncertainties due to natural variations and generator disruptions. In the first stage, the model plans generator addition and transmission line setup prior to, and robust to, uncertainty realization. In the second stage, it plans power generation and dispatch after, and flexible to, uncertainty realization. The model exploits the idea of strategic robustness and operational flexibility as a way to improve performance in the face of uncertainty. The robust optimization framework uses deterministic uncertainty sets, with parameters that permit control over the level of conservatism of the solution. Because the resulting two-stage model is semi-infinite and, therefore, intractable, it is reformulated as an affinely adjustable counterpart. The reformulation uses affine decision rules on second-stage variables and converts, after constraint processing, the semi-infinite model into a finite single-stage mixed integer programming model. The resulting model is tested on the IEEE 30-bus system and value gains are shown by comparing the performance of the model with a deterministic model and a stochastic programming model with varying risk aversions.

Keywords

Adaptive Robust Optimization; Power grid capacity expansion; Supply Uncertainties; Disruptions; Flexibility