

Expansion planning of the transmission network with high penetration of renewable generation: a multi-year two-stage adaptive robust optimization approach

A. García Cerezo; L. Baringo Morales; R. Garcia Bertrand

Abstract-

This paper addresses the multi-year two-stage expansion planning of the power system with high penetration of power consumption of loads, along with the capacity and marginal production cost of generating units. Unlike previous works, we model certain features of the operation that are typically ignored in multi-year robust transmission network expansion planning problems, namely, the operational variability of renewable generating units, the operational flexibility of conventional generating units, and the non-convex operational feasibility sets of storage facilities. The solution procedure employed for this multi-year two-stage robust problem, which is formulated as a three-level problem, is based on the combination of the nested column-and-constraint generation algorithm with two exact acceleration techniques. We analyze the performance of the proposed model through the use of the IEEE 24-bus Reliability Test System and the IEEE 118-bus Test System. Numerical results show that the use of the multi-year approach leads to reductions in the total worst-case cost of up to 7% in comparison with the static and sequential static procedures. Moreover, an underestimation of the total worst-case cost of more than 8% is attained when ignoring certain operational constraints of conventional generating units and storage facilities. Lastly, a sensitivity analysis is presented in order to illustrate the impact of the maximum deviations of the uncertain parameters on the total worst-case cost.

Index Terms- Adaptive robust optimization; Multi-year approach; Operational flexibility; Renewable generation; Storage facilities; Transmission network expansion planning

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