Power-based generation expansion planning for flexibility requirements

D.A. Tejada, G. Morales-España, S. Wogrin, E. Centeno

Abstract— Flexibility requirements are becoming more relevant in power system planning due to the integration of variable Renewable Energy Sources (vRES). In order to consider these requirements Generation Expansion Planning (GEP) models have recently incorporated Unit Commitment (UC) constraints, using traditional energy-based formulations. However, recent studies have shown that energy-based UC formulations overestimate the actual flexibility of the system. Instead, power-based UC models overcome these problems by correctly modeling ramping constraints and operating reserves. This paper proposes a power-based GEP-UC model that improves the existing models. The proposed model optimizes investment decisions on vRES, Energy Storage Systems (ESS), and thermal technologies. In addition, it includes real-time flexibility requirements, and the flexibility provided by ESS, as well as other UC constraints, e.g., minimum up/down times, startup and shutdown power trajectories, network constraints. The results show that power-based model uses the installed investments more effectively than the energy-based models because it more accurately represents flexibility capabilities and system requirements. For instance, the power-based model obtains less investment (6-12%) and yet it uses more efficiently this investment because operating cost is also lower (2-8%) in a real-time validation. We also propose a semi-relaxed power-based GEP-UC model, which is at least 10 times faster than its full-integer version and without significantly losing accuracy in the results (less than 0.2% error).

Index Terms— generation expansion planning, unit commitment, energy storage systems, capacity expansion planning, power system planning, power generation planning.

Citation:
Tejada, D.A.; Morales-España, G.; Wogrin, S.; Centeno, E. "Power-based generation expansion planning for flexibility requirements", IEEE Transactions on Power

Systems. December, 2019.