Generation Expansion Planning with Chance-Constrained Optimization

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Power systems are expected to grow over time, mainly due to population and industrial growth. System expansion plans are often based on forecasted load growth over a multi-year horizon. Similarly, system operators use a short-term forecast of the system to help determine which units should be utilized in meeting load demands while ensure reliability constraints are met. However, for both of these problems uncertainty is present. This has motivated recent interests in expansion and operations problems using stochastic programming to incorporate this uncertainty or risk.

In this work, the overall goal is to apply chance constrained programming to power system planning and operation. The motivation for this approach is that using stochastic tools allows for the operation and planning of the system taking into account uncertainty in loading while ensuring reliability measures are satisfied.

The generation expansion and system operation problem consists of either determining new generation capacity and location to be added or determining the amount of power that should be dispatched from difference sources in the system. A Mixed Integer Linear Programming (MILP) approach addressing the generation expansion-planning problem is utilized in this work. In order to incorporate load demand uncertainty in this study, a form of chance-constrained optimization is utilized in an Optimal Power Flow (OPF) program that includes system operating constraints and power loss. In this approach, the loading level in the expansion problem is adjusted iteratively until the prescribed confidence level is met in the OPF problem. The effectiveness and illustration of the generation planning method is tested using standard benchmark systems.