**Optimization Models and Algorithms for Infrastructure Planning**

**of Reliable and Resilient Power Systems**

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In this seminar we describe optimization models and algorithms for infrastructure planning of reliable and resilient power systems, motivated by the need for power systems to effectively meet growing electricity demand, and prepare for outages caused by increasing extreme weather events. We first consider an optimization model and algorithm for long-term capacity expansion planning of reliable power generation systems. The model optimizes both investment decisions (e.g., size, location, and time to install, retire and decommission facilities) and operation decisions (e.g., on/off status, operating capacity, and expected power output). It is also able to optimize reserve systems (or backup systems), as well as the main systems, to improve power systems reliability. An impact of operational strategies of generators (i.e., participating in electricity production vs. remaining as idle units during operation) on power systems reliability is considered. Probability of equipment failures and capacity failure states are used to rigorously estimate the power systems reliability depending on design and operation strategies. The optimization model is formulated as a Generalized Disjunctive Programming (GDP) problem, which is reformulated as a mixed-integer linear programming (MILP) model using the Hull relaxation for which a bilevel decomposition with tailored cuts is developed to reduce computational times of the multi-scale optimization model. We also show that the proposed bilevel decomposition is computationally efficient for solving large scale problems through 5-years and 10-years planning case studies, including a San Diego case study. Next, we describe a two-stage stochastic optimization model and solution strategy for proactive planning and reactive operations of resilient power systems under disruptions. The model optimizes both first-stage and second-stage decisions to satisfy the load demand while improving resilience. As first-stage decisions, three proactive investment strategies are included, such as line hardening, line addition, and distributed generator/battery installation. Reactive operation strategies are taken into account in the second stage for all uncertain scenarios, which includes line switching and re-dispatch of generators. The optimization model is formulated using Generalized Disjunctive Programming. The objective function is to minimize the total cost, including capital expenditures, operating expenses, and resilience-related penalties. To improve the computational performance of the proposed stochastic programming model, a simplification, which defines critical lines, and a decomposition algorithm based on scenario reduction are proposed. The effectiveness of the proposed model and solution strategy is shown by solving multiple cases with different numbers of nodes, lines, and scenarios.