In this dissertation, various optimization problems from the area of transportation and power systems will be respectively investigated and the uncertainty will be considered in each problem. Specifically, a long-term problem of electricity infrastructure investment is studied to address the planning for capacity expansion in electrical power systems with the integration of short-term operations. The future investment costs and real-time customer demands cannot be perfectly forecasted and thus are considered to be random. Another maintenance scheduling problem is studied for power systems, particularly for natural gas fueled power plants, taking into account gas contracting and the opportunity of purchasing and selling gas in the spot market as well as the maintenance scheduling considering the uncertainty of electricity and gas prices in the spot market. In addition, different vehicle routing problems are researched seeking the route for each vehicle so that the total traveling cost is minimized subject to the constraints and different uncertain parameters in corresponding transportation systems.

The investigation of each problem in this dissertation mainly consists of two parts, i.e., the formulation of its mathematical model and the development of solution algorithm for solving the model. The stochastic programming is applied as the framework to model each problem and address the uncertainty, while the approach of dealing with the randomness varies in terms of the relationships between the uncertain elements and objective functions or constraints. All the problems will be modeled as stochastic mixed-integer programs, and the huge numbers of involved decision variables and constraints make each problem large-scale and very difficult to manage. In this dissertation, efficient algorithms are developed for these problems in the context of advanced methodologies of optimization and operations research, such as branch and cut, benders decomposition, column generation, and Lagrangian method. Computational experiments are implemented for each problem and the results will be present and discussed. The research carried out in this dissertation would be beneficial to both researchers and practitioners seeking to model and solve similar optimization problems in transportation and power systems when uncertainty is involved.

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The public is welcome to attend.