Large power outages become more commonplace due to the increase in both frequency and strength of natural disasters and cyber-attacks. The outages and blackouts cost American industries and business billions of dollars and jeopardize the lives of hospital patients. The losses can be greatly reduced with a fast, reliable and flexible restoration tool. Fast recovery and successfully adapting to extreme events are critical to build a resilient, and ultimately self-healing power grid.

This dissertation is aimed to tackle the challenging task of developing an adaptive restoration decision support system (RDSS). The RDSS determines restoration actions both in planning and real-time phases and adapts to constantly changing system conditions. First, an efficient network partitioning approach is developed to provide initial conditions for RDSS by dividing large outage network into smaller islands. Then, the comprehensive formulation of RDSS integrates different recovery phases into one optimization problem, and encompasses practical constraints. Also, a frequency constrained load recovery module is proposed and integrated into the RDSS to determine the optimal location and amount of load pickup. Next, the proposed RDSS is applied to harness renewable energy sources and pumped-storage hydro (PSH) units by addressing the inherent variabilities and uncertainties of renewable and coordinating wind and PSH generators. A two-stage stochastic and robust optimization problem is formulated, and solved by the integer L-shaped and column-and-constraints generation decomposition algorithms.

The developed RDSS tool has been tested on the modified IEEE 39-bus and IEEE 57-bus systems under different scenarios. Numerical results demonstrate the effectiveness and efficiency of the proposed RDSS. In case of contingencies or unexpected outages during the restoration process, RDSS can quickly update the restoration plan.

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Approved for distribution by Wei Sun, Committee Chair, on August 26, 2017.

The public is welcome to attend.