Minitrack on Integrating Distributed and Renewable Resources

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The capabilities and characteristics of innovative supply-side and demand-side technologies in the electric power industry are advancing rapidly, while enabling innovations to power system operations, planning and markets have moved more slowly. Efficient integration of distributed, variable and uncertain system resources with portfolios of existing resources requires evolution in planning, operational and control strategies. Policies and market structures must also continue to evolve. This mini-track features six papers across two sessions that address issues in system integration of distributed resources and variable generation (primarily wind and solar).

The first paper session focuses on the integration of distributed resources into large-scale electric power systems, and the challenges and benefits that can go along with increased distributed resources. Distributed energy resources, defined broadly as customer-side generation; energy storage and demand response (load curtailment), can play an important role in providing services to transmission operators. They must be considered in planning studies when they become a critical element in providing reliability and security, particularly in the presence of large-scale variable generation resources in interconnected systems. Integration of distributed energy resources requires continuing innovation in technology to enable the participation of distributed energy resource in regulation and balancing services, ancillary service markets and distribution system management.

The three papers in this session encompass several aspects of distributed energy system design including architecture, communications, planning and operations. While the first paper in the session, "Self-Balancing Distributed Energy in Power Grids: an Architecture based on Autonomic Computing" focuses on the architecture that links the energy demand and supply systems with the communications system, the other two papers ("Storage Sizing and Placement through Operational and Uncertainty-Aware Simulations" and Fast Regulation Service Provision via Aggregation of Thermostatically Controlled Loads") focus on two of the most interesting and challenging areas where distributed resources could offer some benefit to the larger system.

The second session focuses on the integration of renewable generation resources into larger-scale electric power systems. Electricity market restructuring, advances in energy generation technology and agreements on the reduction of global greenhouse gas emissions have paved the way for a large increase in the use of renewable generation connected at both the transmission and distribution level. With wind generation currently having the largest share of the new capacity, and solar generation having the highest rate of growth, this trend is expected to continue to produce an increasing amount of variability and uncertainty in system generation portfolios. A broad array of issues associated with the incorporation of large shares of variable generation (VG) into power system planning, design, and operation, including market operation, needs to be considered.

The three papers in this session each cover a unique aspect of the renewable integration problem. The first paper, "Effect of PV Generation on Conventional Generation," models the response of other generators in the system to an increase in solar energy generation in particular. The second paper, "The Impact of Variable Market Price on Optimal Control of Wind-Hydro Storage System in Kenya," is unique not only it its application to a less-developed economy but also its focus on renewables that are variable over much different time scales (minutes for wind energy and months to years for hydro). The final paper, "Variable Generation, Reserves, Flexibility and Policy Interactions," offers a synthesis of the system of policy initiatives that have been introduced in various parts of the world to address the challenges of renewables integration.

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