The capabilities and characteristics of innovative supply-side and demand-side technologies in the electric power industry are advancing rapidly. The ability of the power system to integrate these technologies into system and market operations is moving more slowly. In order to integrate significant amounts of distributed, variable and uncertain technologies while continuing to utilize traditional resources efficiently, operating and control strategies, along with policies and market structures must continue to evolve. The papers in this minitrack discuss modeling, simulation and hardware developments relating to these issues, as well as system analyses and case studies.

With wind generation currently having the largest share of new capacity, and solar generation having the highest rate of growth, an increasing amount of variability and uncertainty will be present in system generation portfolios. A broad array of issues associated with the integration of large shares of variable generation into power system and market planning, design, and operation needs to be considered. The paper titled “Renewable Generation Forecasting: The Science, Applications and Outlook” presents the current state-of-the-art for forecasting and discusses prospects for future developments. Also addressing the wind resource, “Appreciating Wind Energy Probabilistic Nature within the Uncertainty of Electric Power Network Planning,” focuses on the impacts of wind integration on transmission system planning. Two papers examine the use of storage to mitigate wind variability. “Model Predictive Control-based Optimal Coordination of Distributed Energy Resources” presents an optimal control strategy for coordinating the use of storage, diesel and wind. In “The Effect of Stochastic Wind Generation on Ramping Costs and the System Benefits of Storage” the benefits to system performance from using storage to mitigate wind are compared to the affects of wind on the ultimate system benefits from including storage facilities.

Continuing with the examination of the system impacts of wind generation, the paper “Reliability Assessment at Day-ahead Operating Stage in Power Systems with Wind Generation” addresses the coupling of power system decision making across different time scales, for power systems with significant wind penetration. This paper examines, in particular, the effects of wind generation on reliability and operating reserves. “Dynamic Simulation Study of the Frequency Response of the Western Interconnection with Increased Wind Generation” presents findings on possible frequency response related impacts to the Western Interconnect of increased wind generation. Also investigating the frequency spectrum of wind power, “The Influence of Demand Resource Response Time in Balancing Wind and Load” analyzes the power spectrum density of the wind and load profiles in New England in order to optimize the use of demand response resources. The paper “A Historical Perspective and Business Model for Load Response Aggregation Based on Priority Service,” provides historical context on just how different our current demand response methods are from those promoted in the 1980s. The paper presents a priority service option that utilizes modern smart grid concepts and provides flexibility to the customer.

Successfully determining the impacts of large-scale wind or photovoltaic integration on a power system requires extensive simulation and analysis. The paper “Steps for a Complete Wind Integration Study” presents findings from an international collaboration under IEA WIND Task 25 to develop a set of recommended practices for wind integration studies. The paper “Impact of Photovoltaic Distributed Generation on Generation Resource Allocation,” examines the impacts of augmenting an existing power system with significant PV penetration.