

Introduction to Integrating Distributed or Renewable Generation Minitrack

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The electric power industry is experiencing exciting growth in the integration of intermittent renewable energy technologies, responsive load resources, storage technologies, microgrids and intelligent devices. This evolution requires continued development of tools for system planning and operations, control strategies, and the ability to facilitate market integration for all participants.

This mini-track has evolved from previous HICSS meetings in the early 2000s which included individual papers that analyzed renewable and distributed technologies, but not a full mini-track devoted to this topic. HICSS-43 in 2010 included a mini-track on the integration of “non-conventional” resources. During the current decade these resources are increasingly accepted as integral components of the electric power system as reflected in dropping the term “non-conventional” and devoting a full mini-track to distributed energy resources and microgrids.

Technological barriers from previous decades, to more widespread integration of variable and distributed resources, are increasingly overcome by improved computing power and analytic capabilities, access to micro-controllers, and advanced control and communication technologies. In the coming years, research and development projects are anticipated to continue embracing microgrid analyses and implementation along with both high- and low-voltage integration of variable renewable energy technologies. Demand resources are expected to play a more prominent role in the power system through their ability to balance the variable generation from wind and solar technologies as well as lower consumer costs. The industry continues to pursue breakthroughs in the economic barriers to the broader of storage technologies. Overarching all these advances is the need for continued progress in protecting and maintaining the privacy of data and information, as well as the security of individual devices and the system as a whole.

These technologies and trends are discussed in this mini-track. The papers address modeling, simulation and hardware developments relating to planning, operations and control, as well as economic

and market issues, and include system analyses and case studies.

In the first session, focusing on Renewables and Distributed Energy Resources, the first paper discusses the *Optimal Electricity Pricing for Societal Infrastructure Systems* which incorporates awareness of infrastructure systems that rely upon electricity, such as electric vehicle charging stations, communication systems and data centers, in proposing an electricity pricing framework. In *Learning to Shift Thermostatically Controlled Loads (TCL)*, the authors propose a learning algorithm in order to better model TCLs, which in turn will facilitate integration of renewable energy. Continuing with distributed energy resource modeling, *Coordinating Heterogeneous Distributed Energy Resources for Provision of Frequency Regulation Services* frames an optimal control problem with an aggregator for coordinating DER participation in real-time energy and ancillary services markets. Closing this session, *Distributed Energy Resources: New Markets and New Products* proposes a new market paradigm that allows for three products only: real power, reactive power and reserves.

The second session titled: Integrating Distributed or Renewable Resources, begins with a paper on the *Impact of Short-Term Variations in the Generation Output of Geographically Dispersed PV Systems* that analyzes the transient behavior of PV systems at shorter than hourly time steps. With binding renewable energy output targets for countries in the EU coming in 2020, the paper *Impact of Uncertainty on Wind Power Curtailment Estimation* presents results on the impact of uncertainty in forecasting and curtailment. *The Impact of Distributed Energy Resources on the Bulk Power System: A Deeper Dive* analyzes the price impacts of widespread implementation of distributed resources. The final paper discusses a proposal for *A Vision for Co-optimized T&D System Interaction with Renewables and Demand Response* that emphasizes the increasing role of both variable resources and microgrids in the power system, and seeks to minimize negative impacts while maximizing the benefits of microgrids.