The 14th IERE General Meeting and
the IERE-EPRI North American Forum
Abstract Format

Reducing Grid Integration Risks and Demonstrating Smart Inverter Technologies through Advanced, Full-Scale Testing with the Duke Energy EGRID at Clemson University

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Keywords:

Abstract
Central to updating the nation's aging transmission grid is the development of new smart-grid and energy storage technologies that integrate successfully with emerging clean energy resources and the existing grid. The rapid growth of the renewable energy, energy efficiency and smart grid markets has opened up opportunities for innovations that require rapid development, testing and certification prior to market introduction. Powerful grid simulation capabilities that mimic real-world circumstances (such as wide-area power disruption from natural disasters, cascading accidents, and cyber or physical attacks) without real-world risk is needed to test and validate models, advance smart-grid technology, energy storage and smart inverters, and integrate distributed renewable energy resources more efficiently into the transmission and distribution infrastructure.
To serve as a platform for testing and certifying new technology that supports the country's smart grid and renewable energy goals, Clemson University has invested in the Duke Energy eGRID – Electrical Grid Research, Innovation and Development – center at the Clemson University Restoration Institute (CURI) in North Charleston, SC. The cornerstone of the eGRID Center is a 15 megawatt grid simulator with hardware-in-the-loop testing capabilities, which is one of only a few facilities world-wide that can perform full scale, grid integration evaluations on medium voltage, multi-megawatt devices.
This presentation will explore the suite of grid integration evaluations that is possible at these advanced testing facilities beyond today's standards testing, including: voltage and frequency variations, harmonics, voltage flicker, frequency response, reactive power control, frequency regulation, fault ride-through evaluations and even hardware-in-the-loop evaluations. By performing these types of grid integration evaluations at full scale in a laboratory, a complete energy storage system can be characterized against field conditions in a controlled and calibrated environment in less time and with fewer restrictions when compared to field demonstrations.
The inclusion of Hardware-In-the-Loop testing capabilities provides a platform above and beyond present standards for compliance testing by simulating a detailed dynamic power system model in real-time where the device under test actually interacts with the simulated power system. One area in which Hardware-In-the-Loop testing could be beneficial is in performing parallel model verification, in which the differences between the actual device behavior and the detailed dynamic model of the device can be reconciled to provide a more robust and accurate model. This type of testing can identify and prevent costly and dangerous failures upon deployment and allows the

customer to demonstrate their product in a safe and controlled environment, accelerate its introduction into the market and reduce the risk of new market introductions.
Clemson University has teamed with key partners including utilities, certification bodies, technology innovators, industry leaders and research centers to bring a diverse background and knowledge base to design, construct and commission the facility. The facility under the guidance of the founding members will focus on certification of new technology leading to rapid market introduction, provide state of the art grid simulation capability and lead initiatives in energy storage, smart grid, grid security and compatibility testing.