Microgrid Testing Platforms in Oak Ridge National Laboratory

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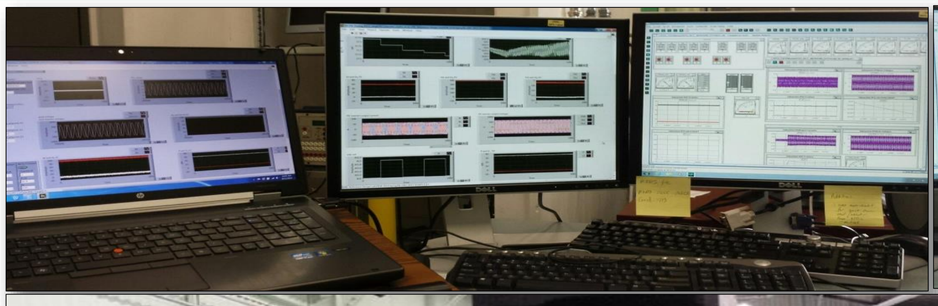
ABSTRACT

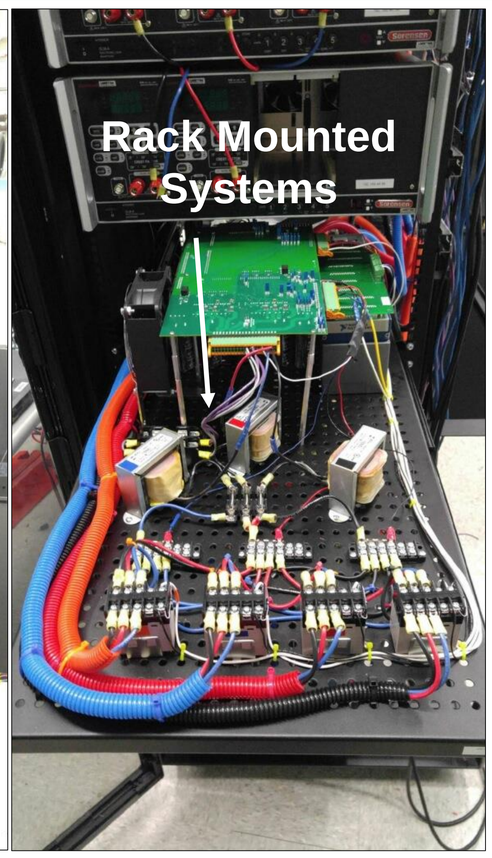
Oak Ridge National Laboratory has three unique testing platforms for device and microgrid controls. Each platform provides unique benefits to the development stages of both device controls and microgrid master controller. These platforms are the Distributed Energy Communication and Control (DECC) Lab, Real-Time Digital Simulator (RTDS) Hardware in the Loop (HIL) Testbed, and of Software-defined Intelligent Grid Research Integration and Development platform (SI-GRID). Each platform provides Ethernet communications interface for communications and controls testing. A ORNL developed Microgrid controller, the Complete System-Level Efficient and Interoperable Solution for Microgrid Integrated Controls (CSEISMIC), has been demonstrated and tested on each of these platforms.

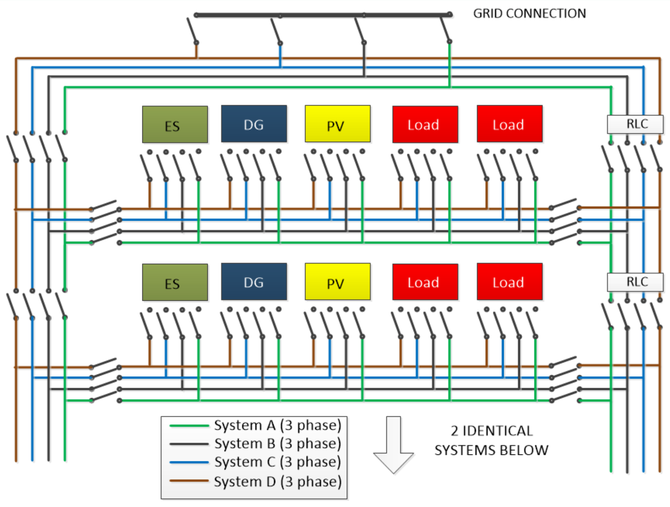
RTDS HIL MICROGRID TESTBED

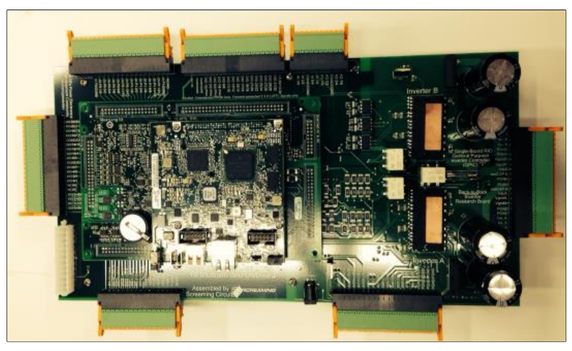
The RTDS-based microgrid testbed is a combination of software (virtual electrical network and inverter modeling in RSCAD deployed to the RTDS) and interconnected hardware (National Instruments FPGA-based device controllers and microgrid master controller). The virtual electrical model is based on the DECC microgrid and includes system topology, detailed dynamic and transient generation and load models, sensors, and protection relays.



SI - GRID TESTBED







The SI-GRID is network of reconfigurable low-voltage resources and loads which can be configured into multiple microgrids that act as a sandbox for testing of advanced microgrid controllers, device-specific controls, microgrid communication systems, and cyber security testing. SI-Grid utilizes low-voltage Inverter Research Boards and National Instruments FPGA-based hardware to operate the inverters at 24V AC. Programmable load banks are used to emulate electrical consumption on a microgrid.

DECC MICROGRID TESTBED

The DECC Lab consists of multiple voltage levels including 3-phase (480V and 208V) and single-phase (240V and 120V), real and reactive load banks, DC supplies for source emulation, 13kW rooftop PV, 50kW PV system and inverter, 65kW microturbine, 25kW and 50kWhr energy storage system, and controllable disconnect switch. This microgrid is able to operate both on and off grid to demonstrate islanding and resynchronization capabilities of microgrid controllers. Microgrid functions implemented on the controller perform energy management (including PV and load forecasting, multi-objective optimization, load shedding, etc.), protection, resiliency, and communications. Inverter controls and microgrid switch operations have been internally developed with National Instruments FPGA-based imbedded controls.