Wind-Diesel Hybrid Test Bed Emerging Energy Technology Fund Quarterly Report I (2012)

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Project Status

Research Overview

The defining theme for this research project is development of transformative and efficient energy technologies to address high penetration challenges in Alaska, with a focus on integration of intelligent control systems, power electronics, and advanced storage for overall power quality generation, with the added benefit of reduced diesel consumption. A test bed consisting of a wind-turbine simulator, power converter, battery bank, diesel gensets and load bank is the backbone of this project; control of these integrated systems is via a supervisory control and data acquisition (SCADA) system that acquires real time data from all parts of the system.

Preliminary research work has focused on modeling and simulation of distributed generation in high penetration systems, with the main objective being control performance. This forms the basis for the trials to be conducted on the physical system at the test bed facility. Overall, the project is on track and on schedule, and it is expected that once all the equipment is installed then testing will commence in accordance with the funding objectives, namely, diesel-off operation in high penetration systems.

Modeling and Simulation

The distributed power system models that were delivered by Sustainable Automation Inc. in 2011 continued to be used for simulation in anticipation of the test bed installation; these included the Matlab-SimPowerSystems models of gensets, inverter, battery, and primary load. Research work has involved use of wind speed data from select wind-diesel installations in Alaska to analyze various load-dispatch scenarios. Some of the objectives have been to test the power electronic components for voltage and frequency regulation, devise alternate and more robust control algorithms in lieu of those supplied with the equipment, and to investigate the capability of the system for diesel-off operation. ACEP has accessed wind speed data and other operational information from the Ugashik power system which is being used in the analysis of the models. The data primarily gives aspects of field performance including fuel consumption, generation levels for both diesel gen-sets and turbines, costs of installation and O&M, electrical data (voltage, current, power, power factor, etc), thermal and flow rate data (fuel flow rates, etc) have been obtained from village generation and load dynamics.

Equipment and Test Bed Status

Ongoing assembly at ACEP's ETF: the lead-acid battery bank, wind turbine simulator with grid form inverter, and CAT diesel engine.

Most of the equipment crucial in implementing the project has been received, and ACEP is in the process of assembling the test bed. The components on ground include the 100 kW Wind Turbine Simulator with induction generator, 3-phase 480 V output power; the lead-acid battery bank, 336 VDC, 896 Ah nominal capacity; the Grid-forming energy storage power converter; and transformer and isolation, 225 kVA, 480V Delta Primary, 480/277V Wye Secondary. ACEP is still exploring ways to acquire a diesel engine (150~350 Kw range) to complete the installation. Part of the research on the test bed will be devoted to energy storage systems. Initially the functional operation of the wind-diesel system will incorporate lead acid battery bank, and later the 20 kWh Prudent Energy Vanadium Redox (VRB) flow battery will be integrated in the test bed platform for further storage and ancillary services research.