High Penetration Photovoltaic Power Electronics and Energy Management Technology Research, Development and Demonstration

Cooperative Research and Development Final Report

CRADA Number: CRD-13-517

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Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI. Reports and Abstracts A.(3), of the CRADA agreement, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the U.S. Department of Energy (DOE) Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: Advanced Energy Industries. Inc./ Solar Energy (AE)

CRADA number: CRD-13-517

CRADA Title: High Penetration Photovoltaic Power Electronics and Energy Management Technology Research, Development and Demonstration

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind
Year 1	$279,999.00
Modification #1	$243,000.00
Modification #2	$163,750.00
Modification #3	$22,054.00
Modification #5	$62,000.00
Modification #6	$125,691.00
TOTALS	$772,494.00

Abstract of CRADA Work:

Advanced Energy Industries, Inc., will partner with DOE's National Renewable Energy Laboratory (NREL) to conduct research and development to demonstrate technologies that will increase the penetration of photovoltaic (PV) technologies for commercial and utility applications. Standard PV power control systems use simple control techniques that only provide real power to the grid. A focus of this partnership is to demonstrate how state of the art control and power electronic technologies can be combined to create a utility interactive control platform.

Summary of Research Results:

Initial CRADA tasks demonstrated how advanced, megawatt scale PV inverters perform at power by using equipment at the NREL Energy System Integration Facility. AE's advanced inverter technology was demonstrated by connecting them to NREL's Power in the Loop test

equipment that included: Megawatt scale Grid Simulators (AC), megawatt scale PV simulators (DC), megawatt scale Load Banks and real-time electric distribution feeder models.

Performance Testing of Utility Interactive AE 500 kW PV Inverter

The primary objective of this task was to demonstrate the performance of an AE 500 kW inverter with advanced functionality, according to Advanced Energy's SEGIS-AC program objectives. AE provided NREL an inverter with utility interactive controls (including LVRT). NREL tested the inverter at full power at the Energy Systems Integration Facility. Equipment that will be used for this task includes: AC grid simulator, PV simulator and Hardware-In-The-Loop (PHIL) Control System. Inverter performance was evaluated at power to predict how it will perform when connected to the grid through the use of AE-provided feeder simulation models that are interfaced to the grid simulator. AE provided on-site engineering support to promote close collaboration and improve probability of successfully accomplishing the testing within the desired time and budget. AE provided inverter control interfaces, which facilitated reduced testing time.

Advanced Inverter Test Plans

NREL jointly developed test plans with AE which outlined specific test procedures and test sequences to evaluate inverter functions such as: Volt/VAr, Watt/Frequency, and Volt/Watt including the inverter's response under grid sags, swells, and abnormal events.

Evaluation of New-Technology IGBT

NREL tested the performance of the new-technology IGBT model in the existing 1kV-500NX inverter design. Determine power, waveform, and thermal data for multiple points in the 1kV-500NX envelope. The focus of this investigation was to evaluate new-technology IGBT devices packaged in existing outlines with novel interconnection methods.

This testing was performed at the ESIF test facility and consisted of operating the inverter at several different operating conditions. These included:

- AC Voltage
- DC Voltage
- Power Level
- Reactive Power Level
- Ambient Temperature

Power data and thermal data was logged and voltage and current waveforms were monitored at the IGBTs. Turn-on, turn-off, and conduction losses were calculated from waveform data.

Subject Inventions Listing:

N/A

ROI #:

N/A

Report Date:

December 6, 2017

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