Heila Microgrid Controller Validation Using CUBE

Cooperative Research and Development Final Report

CRADA Number: CRD-17-663

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In accordance with Requirements set forth in the terms of the CRADA agreement, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the 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: Heila Technologies LLC

CRADA number: CRD-17-663

CRADA Title: Heila Microgrid Controller Validation Using CUBE

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind
Year 1	\$ 50,000.00
TOTALS	\$ 50,000.00

Abstract of CRADA Work:

This CRADA facilitates validation of the Heila IQ controller (microgrid controller) using NREL's Consolidated Utility Base Energy (CUBE) hardware platform. The CUBE microgrid platform includes power electronics and controls to integrate PV, battery, and diesel generator assets to serve a common load. The Heila IQ controller includes algorithms to manage and optimize these assets and will be used as the dispatch-level controller for the CUBE. Heila will use the CUBE platform in a number of use cases that will benefit commercialization of the Heila IQ controller.

Summary of Research Results:

The project with Heila Technologies consisted of five subtasks which are listed below. The research results from each subtask are included below the subtask description.

Task 1.1: Make CUBE ready for Heila testing (2 months after initiation)

This task will include (a) initial troubleshooting to address operational anomalies observed the last time CUBE was operated, (b) incorporation of actual battery energy storage vs. the programmable DC power supply previously used to emulate the battery energy storage, and (c) modification of the CUBE SUPER control algorithms to allow dispatch control by the Heila IQ Controller. The task will be performed solely by NREL.

Task 1.1 Research Results: CUBE was installed in NREL's Power System Integration Lab (PSIL) and initial troubleshooting was completed. Battery storage elements, consisting of large

battery packs previously used on a medium-duty electric vehicle for defense applications was configured and integrated to power one of CUBE's DC input ports. The CUBE's supervisory control system was modified to accept dispatch commands via a communications port from the Heila IQ Controller. Overall, at the end of this subtask the CUBE was ready to be used as a deployment and test platform of the Heila IQ Controller.

Task 1.2: Develop detailed test plan including load and solar profiles (2 months after initiation)

A detailed test plan must be developed prior to commencement of the actual testing exercises. The test plan should specify (a) number of one or two hour tests, (b) the actual load and solar irradiance profiles to be used for each test and (c) DAQ requirements. The time steps for the solar and load profiles can range from seconds to minutes. This work will be led by Heila with NREL input.

Task 1.2 Research Results: Multiple telephone calls were held with Heila Technology staff to develop the test plan. Due to funding limitations the focus of testing was on relatively short time period tests which would include a number of dynamic changes in load and resource as to test the capability of the Heila IQ Controller's ability to maintain reliable grid operation during such events. It was decided to simulate load with NREL's load banks and change the load via a time profile with 1-second temporal resolution.

Task 1.3: Develop communication interface between the Heila IQ Controller and the CUBE SUPER (2 months after initiation)

This task involves (a) specifying the information which must be communicated between the Heila IQ Controller and the CUBE SUPER, (b) specifying the physical communication interface and protocol, and (c) developing additional communication interface algorithms on the CUBE SUPER as necessary. Information which must be sent from the Heila IQ Controller to the CUBE SUPER includes operating mode requests and asset set points. Information to be sent by the CUBE SUPER to the Heila IQ Controller is TBD but may include power flows, AC voltage and frequency, and battery status such as SOC, maximum charge power, maximum discharge power, etc. This task will be performed jointly by NREL and Heila.

Task 1.3 Research Results: Along with subtask 1.2 related phone calls more discussion was undertaken to fully define the communications needs between the Heila IQ Controller and CUBE. A protocol using MODBUS over TCP was chosen as it allowed fast enough, low-latency communication and was easily integrated into both the Heila IQ Controller and CUBE. A table of data being provided to and supplied from the CUBE was developed.

Task 1.4: Validate Heila IQ dispatch algorithms using the CUBE hardware platform (5 months after initiation)

The testing will be performed at NREL and will require on-site participation by Heila. Heila and NREL will jointly execute the test plan as described in Task 1.2. The effort is currently scoped at two weeks.

Task 1.4 Research Results: Over the period of two weeks, with members of Helia staff on-site for one week, the previously prepared test plan was executed. Multiple tests of 1 and 2 hour duration were completed to test the capability of the Helia IQ Controller. Data was collected during the test for post-processing.

Task 1.5: Analyze data and write report (5 ½ months after initiation)

Data collected from the tests will be analyzed to determine effectiveness of the Heila IQ Controller. The results will be documented in an NREL technical report, fact sheet/white paper, and/or conference paper. This work will be led by Heila with NREL input.

Task 1.5 Research Results: The data from the tests completed during subtask 1.4 was analyzed and plots and graphs were developed. These plots and graphs were integrated into a DOE report Helia Technologies was preparing as part of their required reporting under their CleanTech Challenge award. Note: further dissemination of the performance of the Helia IQ Controller was not desired by Helia Technologies due to business concerns and thus an NREL Technical Report and or conference paper was not developed as originally envisioned in subtask 1.5.

Subject Inventions Listing:

None

ROI #:

None

Report Date:

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