GE 1.5 ESS Wind Turbine Retrofit Controller Development

Cooperative Research and Development Final Report

CRADA Number: CRD-17-00680

NREL Technical Contact: Jeroen van Dam

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Technical Report
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Cooperative Research and Development Final Report

Report Date: February 14, 2025

In accordance with requirements set forth in the terms of the CRADA agreement, this document is the CRADA final report, including a list of subject inventions, to be forwarded to the DOE Office of Scientific and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: Bachmann electronic Corp.

CRADA Number: CRD-17-00680

CRADA Title: GE 1.5 ESS Wind Turbine Retrofit Controller Development

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Sponsoring DOE Program Office(s):

Office of Energy Efficiency and Renewable Energy (EERE), Wind Energy Technologies Office

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind
Year 1	$75,000
Year 2, Modification #1	$75,000
Year 3, Modification #2	$.00
Year 4, Modification #3	$.00
TOTALS	$150,000.00

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Executive Summary of CRADA Work:

National Renewable Energy Laboratory (NREL) and Bachmann electronic corp. will collaborate on the development of a software application to be used on an existing aftermarket Bachmann controller, utilizing and existing Bachmann software platform, which will be used on the General Electric (GE) 1.5 ESS wind turbine. This retrofit will significantly enhance NREL's ability to control experiments it is planning to conduct on the GE 1.5 wind turbine as part of the Gearbox Reliability Collaborative, Atmosphere to Electrons and other future R&D. The proposed work is leveraging ongoing Department of Energy (DOE) Annual Operating Plan activities on the GE 1.5 ESS wind turbine at the National Wind Technology Center.

CRADA benefit to DOE, Participant, and US Taxpayer:

- Assists laboratory in achieving programmatic scope, and/or
- Enhances the laboratory's core competencies.

Summary of Research Results:

Task 1: Gathering of background information

The objective of this task is to identify the safety limits currently implemented in the controller. This will be mostly based on the current owners manuals which contain set points, temperature limits etc. To confirm those limits a monitoring device will be installed in the turbine to gather additional data.

NREL will:

- Provide documentation it has available
- Support installation of monitoring device

Partner will:

- Provide monitoring device
- Install monitoring device
- Analyze data gathered by monitoring device

NREL and Bachmann reviewed non proprietary data related to the turbine. Bachmann installed hardware in the turbine in July 2019 (Figure 1). NREL provided remote access to this hardware for Bachmann. The hardware was removed in March 2024 and returned to Bachmann.

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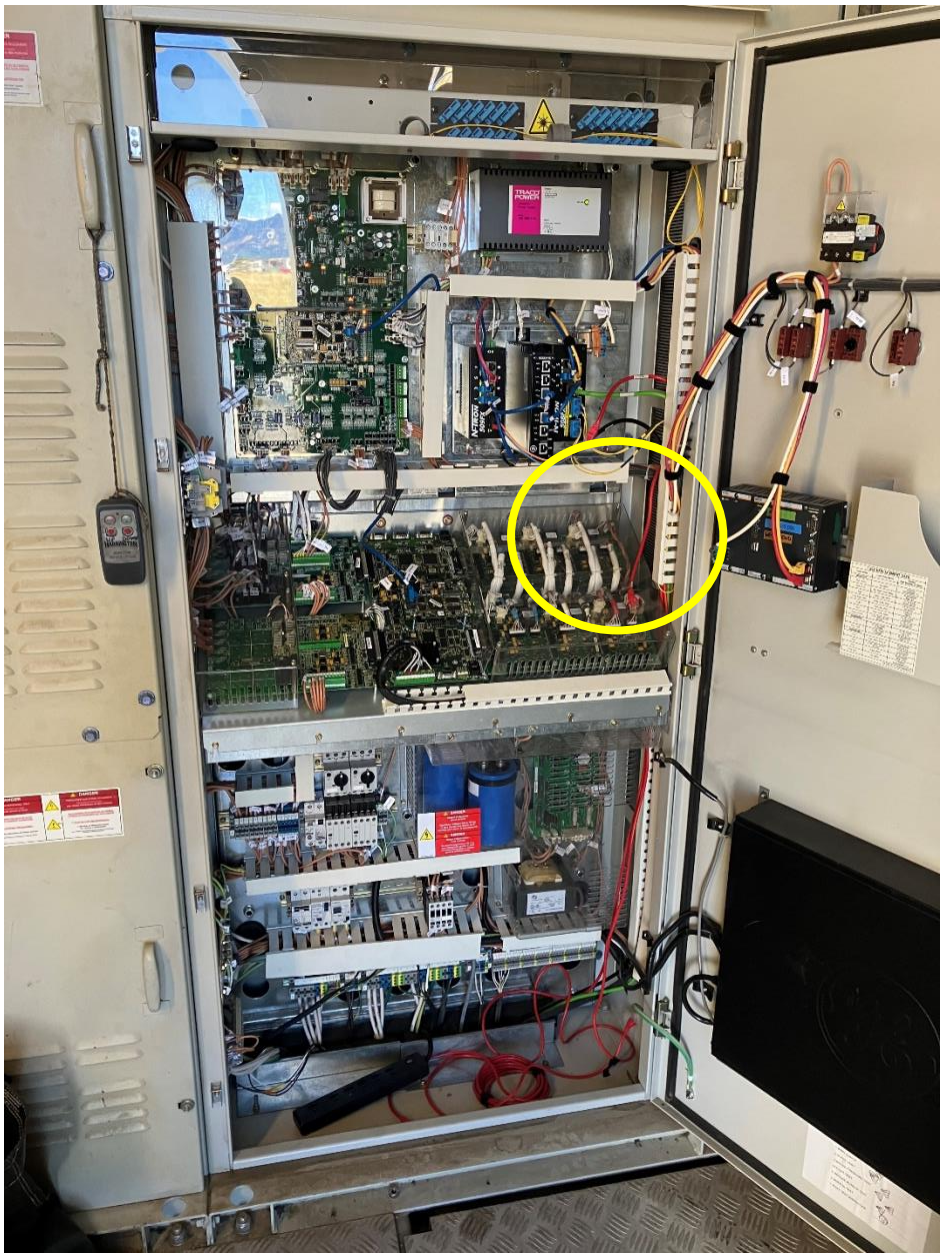

Figure 1. Bachmann device installed in GE 1.5 wind turbine at NREL Flatirons Campus

Task 2: Perform baseline turbine characterization

The objective is to characterize the baseline power performance and mechanical loads. This data will be used later in the project to confirm the retrofit solution matches the current controller. Operational modal testing will be performed to confirm the dynamic properties of the GE 1.5 FAST (Fatigue Aerodynamics Structures and Turbulence) model.

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NREL will:

- Perform power performance test per IEC 61400-12-1 ed.1
- Collect mechanical loads data on the GE 1.5 turbine
- Perform operational modal test

As Bachmann was not able to make progress towards development of the aftermarket controller, NREL did not expend resources on base line characterization beyond the baseline tests previously performed and documented.

- Power Performance Test Report for the U.S. Department of Energy 1.5-Megawatt Wind
- Turbine: https://www.nrel.gov/docs/fy15osti/63684.pdf
- Mechanical Loads Test Report for the U.S. Department of Energy 1.5-Megawatt Wind
- Turbine: https://www.nrel.gov/docs/fy15osti/63679.pdf
- Acoustic Noise Test Report for the U.S. Department of Energy 1.5-Megawatt Wind Turbine: https://www.nrel.gov/docs/fy15osti/63681.pdf
- Power Quality Test Report for the U.S. Department of Energy 1.5-Megawatt Wind Turbine: https://www.nrel.gov/docs/fy15osti/63686.pdf

Task 3: Develop retrofit controller

The partner will use their standard in house processes to develop the retrofit controller solution. NREL will support this task by performing aero-elastic simulations.

BACHMANN was unable to develop a retrofit controller solution so NREL did not provide any aero-elastic simulations. Task 3 was not completed.

Task 4: Implementation

Once the controller has been developed and tested in the laboratory environment it will be implemented in the GE 1.5 wind turbine at the NWTC. This requires installation of new hardware and commissioning of the new controller.

NREL will:

- Provide required permits to allow implementation and testing of new controller
- Support the implementation of the new controller hardware and software
- Assist in commissioning per plan specified by the Partner

Partner will:

- Install new controller hardware and software
- Provide written commissioning plan to allow development of a Safe Work Permit

As task 3 was not performed, this task was also not performed

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Task 5: Controller validation

Once the new controller has been installed and commissioned, testing will be conducted to verify the performance of the controller.

As Task 3 and 4 were not performed this task could also not be performed.

Task 6: Documentation and training

Once the controller has been shown to be functioning documentation needs to be developed to allow use of the controller for research and development. Training should focus on how to safely implement controller changes but also cover normal operation and maintenance of the turbine.

This task was not performed as prior tasks were not executed.

References: None

Subject Inventions Listing: None

ROI#: None

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