

## **North Dakota Renewable Energy Program Status Report**

Contract Number: R-048-060

Report for time period of: June 1, 2023 to December 31, 2023

### **Description of Project**

Please provide a brief description of the project:

BWR Innovations is developing a green energy generator system, capturing the excess energies of solar panels and wind turbines to create and store hydrogen. The compressed hydrogen is used by fuel cell modules to create electricity on-demand, producing energy without pollution, carbon emission, noise, or maintenance.

In the first period of the project, BWR Innovations has purchased equipment to create our clean energy generation. In the second period of the project, BWR innovations purchased additional components, specifically carbon fiber hydrogen tanks, an electrolyzer, and telemetry components for remote monitoring and management. In the third period, BWR Innovations has demonstrated integration of embedded controls and all portions of fuel cell electrical production, creating electricity in scalable power productions, selectable phases, and multiple possible voltages tailored to the needs of the application. In fourth reporting period, BWR Innovations has integrated controls with renewable energy capture for a complete installation. The system was first demonstrated at Grand Farms Autonomous Nation in August, with a second demonstration at Big Iron Farm Show in September. This project has completed with all technical tasks completed, successful demonstrations at multiple events, and the launch of a zero-emission portable generator that is the first in the industry in 25kWe range.

All technical tasks proposed by BWR Innovations in this research have been demonstrated. AC power may be delivered using grid power, fuel cell generators, or renewable energy from solar panels or wind turbines. A scalable fuel cell generator design may be implemented, with multiple fuel cell modules integrated on a 48VDC power bus. Electrolyzers, powered either by renewable energy or grid power, may produce hydrogen from deionized water and compressed to 5000 PSI. The final set of tasks were to integrate into a portable/transportable system, with a plan to demonstrate the scalable/modular architecture to larger components, applications, and installations.

At the onset of the project, Grand Farms occupied a forty (40) acre site outside Horace, North Dakota using temporary facilities. Shortly after BWR Innovations was awarded the grant by the Renewable Energy Council, Grand Farms announced the selection of Casselton, North Dakota as the permanent home for the Grand Farm operation. Additional land has been purchased by Grand Farms and the scope of the Grand Farm permanent facilities have expanded since September 2021, delaying the construction of the buildings and sliding the schedule for the installation of the solar panels and wind turbines outlined in this research proposal. To accelerate the use of the hydrogen generator for Grand Farm activities, Grand Farm and BWR Innovations have chosen a portable system for using and demonstrating a clean energy hydrogen generator. This portable system has been demonstrated at Grand Farms at Autonomous Nation, and the remaining work of this grant is to provide a scaled system that would power the Grand Farm facilities by using a modular clean energy design using 100kWe fuel cell modules as the electrical generating component.

BWR Innovations, collaborating with Grand Farms, has purchased a 12-foot trailer for transporting a hydrogen generator complete with tanks, fuel cell modules, batteries, and inverters. Based on our interaction with Intertek ([www.intertek.com](http://www.intertek.com)), an nationally recognized testing laboratory (NRTL), the trailer needs to have the ability to be completely immobilized during operation, although Grand Farms and BWR Innovations ideally wants a system that is easily portable and can be set up with minimal to no tools, training, or special equipment. To balance these requirements, BWR Innovations has chosen a trailer using an icehouse suspension and axle system. During transportation, the trailer has the tires lowered and is easily moved to any location. Once the location is reached, hand cranks on the hitch and on each tire lowers the frame to the ground, providing a solid, stable platform that is unable to be moved.

In October 2023, BWR Innovations demonstrated the design of the trailer-based zero-emission electrical generator to the California Air Resources Board (CARB). CARB is the policy-making entity that assisted the State of California to enact legislation to require lawn mowers, chain saws, string trimmers, and other small tools to be zero emission. For the smaller tools, zero emission may be achieved by using battery powered systems. However, generators of 4kWe to 25kWe cannot be practically powered by batteries, since the batteries needed to sufficiently power a generator for a reasonable amount of time is excessive in space and weight. A much more efficient approach is to power the zero-emission generator with hydrogen using fuel cell modules, which BWR Innovations demonstrated to CARB.

### **Project Tasks**

Please describe the progress on all project tasks achieved during the reporting period:

During this phase of the research project, BWR Innovations has successfully demonstrated electrolysis of deionized water to create hydrogen, compression of hydrogen to store 3kg at 350 bar (approximately 5000 PSI), the use of hydrogen in fuel cell modules to create DC electricity, adaption of DC electricity to AC electricity using inverters (for single phase, split phase, or three phase), the edge based control and monitoring of all functions, and the ability to remote monitor and manage the system via cloud-based telemetry.

### **Project Plan**

BWR Innovations has been working with Grand Farm for their “Energy and Agriculture” initiatives. As part of the collaboration, BWR Innovations has previously been invited to provide a fuel cell generator to the Grand Farm site for the Autonomous Nation Conference (<https://grandfarm.com/autonomous-nation/>). As part of the Autonomous Nation program, BWR Innovations has previously partnered with Boson Motors to provide electrical recharge of the Boson Electric Tractor using a zero-carbon emission hydrogen fuel cell generator.

The portable generator system, using installation as part of the new trailer design, can be stationed at Grand Farms for events such as Cultivate and Autonomous Nation, as well as be mobile to be used as part of the advertising for Grand Farms at the Fargo Street Fair and Big Iron. The tanks, batteries, fuel cell modules, and inverters may be assembled in a modular fashion that can be removed from the trailer and/or affixed to the trailer interior. In either configuration, the hydrogen generator trailer will provide single phase or split phase electricity without noise, maintenance, or carbon emissions.

The portable generator fully proved all objectives of this research project, and the ability to create larger generators (portable or stationary)



Figure 1. BWR Innovations Portable Zero-Emission Generator at California Air Resources Board



Figure 2. BWR Innovations Zero-Emission Generator during demonstration at CARB



Figure 3. Spectator at CARB Demonstration, examining BWR Innovations zero-emissions generator

**Deliverables**

Please describe the progress on project deliverables, as stated in your contract, achieved during the reporting period:

BWR Innovations has demonstrated at multiple venues a hydrogen microgrid generator capable of powering vehicles, stationary, and portable electrical loads. The intent of the collaboration with Grand Farms is to create the nexus between energy and agriculture, where the 21<sup>st</sup> Century farmer may sell energy (electricity and/or hydrogen) as a cash crop.

BWR Innovations has completed mechanical, electronic hardware, and software design of the scalable system. Additionally, BWR Innovations has been aggressively working with third party laboratories and experts for safety analysis and regulatory certifications. The scalable, modular, and reconfigurable design produces single phase, split phase, and three phase power through software selections, and Grand Farms may be able to be completely self-sufficient and resilient with their energy consumption with the BWR Innovations generator.

The deployed system is meeting the needs for Grand Farm, and we are working with the Grand Farm administration for a fixed location as Grand Farms is groundbreaking for their new facility near Casselton. The portable system may be used in promotions and field meetings, demonstrations and to assist with equipment maintenance and repairs, or to provide temporary power in any location for a finite period of time.

**Expenditures**

Please provide a breakdown of expenditures. Include all sources of match. Provide supporting documentation as a separate attachment.

The expenditures during this phase were specific to the purchase of a 100kWe fuel cell module from Intelligent Energy in England. The entire quotation totaled \$415,000, with BWR Innovations requesting \$147,802.93 from the NDIC. A wire transfer of \$170,000.00 for fuel cell modules was submitted to Intelligent Energy by BWR Innovations on February 17, 2013