Renewable Energy Program

North Dakota Industrial Commission

Application

Project Title: Renewable Hydrogen Microgrid

Applicant: BWR Innovations LLC

Principal Investigator: Joel Jorgenson, Ph.D., PE

Date of Application: July 30, 2021

Amount of Request: $332,159

Total Amount of Proposed Project: $665,909

Duration of Project: 24 months

Point of Contact (POC): Joel Jorgenson

POC Telephone: (701) 205-3103

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POC Address:

Joel Jorgenson
BWR Innovations LLC
3471 South University Drive
Fargo, ND 58104

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ABSTRACT

Objective:
BWR Innovations proposes a turn-key sustainable electrical generation system, integrating renewable energy resources (wind and solar) with an electrolyzer (that produces hydrogen) and a hydrogen fuel cell system accompanied with a hydrogen storage system. This will provide the first industrial level "closed loop" microgrid, fully powered by renewable energy. BWR's design is a scalable and modular design that will demonstrate the production and storage of energy efficiently, with zero carbon emissions, minimal maintenance, and no operating expense.

Expected Results:
At the conclusion of the project, the installation will be able to produce electricity for a farm, industrial setting or retail/industrial facility and provide the economic validation to replicate this model across North Dakota. The project will store excess energy by producing hydrogen and storing in a local tank. We are estimating this will provide "stand by" energy for up to 1 week. Above the standby hydrogen level, excess energy (electricity or hydrogen) can be sold back to utility companies or third parties, creating a new market of income for North Dakota farmers.

This project has the potential to validate the scope of this microgrid to provide the electricity used in a farm or industrial application at $0 variable cost and potentially replace standby generators for industrial applications, agricultural energy needs and the creation of hydrogen as a portable energy source in a cost effective, environmentally sound and economically viable method.

The success of this project will lead to manufacturing of fuel cell systems in North Dakota, economic diversification within North Dakota, commercialization of intellectual property developed in North Dakota, creation of new science in mechanical engineering, electrical engineering, and finance, and the capability for North Dakota individuals and businesses to generate, store, and sell energy in new and reliable ways.

The commercialization of this hydrogen fuel cell micro-grid is substantial. The 8-year potential for this is in excess of 5,000 individual installations, working with solar/wind installers and with utility companies. To support the growth, BWR has the manufacturing commitments to quickly ramp up production with contract manufacturers in North Dakota.

Duration:
BWR Innovation proposes this project to be completed in twenty-four months.

Total Project Cost:
Our estimated cost for this project is estimated at $665,909. This will include a 40kW solar panel, a 10kW wind turbine, an electrolysis unit, 20 kW fuel cell, compressor, hydrogen storage tanks and all connected telemetry equipment to monitor and manage the complete system. The cost will include all equipment, installation and ongoing maintenance and management of the project.

Participants:
Participants for this project include (but are not limited to): BWR Innovations (Fargo, ND), Intelligent Energy (Loungborough, England, UK), Assembly Systems (West Fargo, ND), Network Center (Fargo, ND), Newava (Watertown SD), Digikey (Fargo, ND), North Dakota State University (Fargo, ND), Grand Farms (Fargo), and Trison (Hibbing, MN).

BWR Innovations is the lead institution, leading the research and design efforts of the electrical generation system. Grand Farm is providing a site for the installation as well as assists in creating the use models for a sustainable agriculturally based electrical system. North Dakota State University is assisting with specific engineering design, as well as economic models for the sale of distributed energy of electricity and hydrogen.

Newava, Assembly Systems and Trison provide contract manufacturing services for components of the microgrid system. Digikey is a key supplier of components. Intelligent Energy provides fuel cell modules to be used in the hydrogen-powered generator. Network Center provides services for web-based data analysis used in the telemetry.

PROJECT DESCRIPTION

Objectives:
This project has the following objectives:

- On-site electrical production through the capture of renewable energy,
- On-site energy storage, providing one week's worth of energy in reserve for use when solar/wind is not able to provide adequate energy. Excess hydrogen can be sold for energy applications.
- Zero operating cost,
- Zero carbon emissions,
- Minimal noise,
- Minimal footprint,
- A scalable design that will help put North Dakota as the lead in the nation's energy production.

Methodology:
BWR Innovations is a partner in the Sothern California Gas Home Hydrogen demonstration, a novel approach for creating and storing renewable energy in hydrogen tanks. This Home Hydrogen demonstration uses solar panels only (no wind energy) as its renewable energy source, with the stored hydrogen feeding fuel cell systems provided by BWR Innovations to provide electricity during evening and nighttime hours. Fast Company magazine has recognized the Home Hydrogen demonstration as a "World-Changing Idea".

This project builds on the design of the "World-Changing Idea", by addressing the unique aspects of renewable resources in North Dakota, specifically solar energy and wind energy. The efficiencies of renewable energy systems have increased dramatically over the years, and subsequent costs have decreased as economies of scale develop. To power a standard site demand, 40 kW is a targeted value

for a solar energy installation. This value is based on the maximum power demand of a 200 Amp 208 Volt installation.

While the production of electricity is well known, there is to date an inability to effectively store excess energy. While batteries are often proposed, using batteries for electrical storage is not practical, due to the cost, size requirements, and availability of the number of batteries needed for large scale energy storage.

BWR Innovations proposes a unique energy storage methodology, using compressed hydrogen as a means to efficiently and cost-effectively store energy. The compressed hydrogen is created by an electrolyzer, which is powered by the excess electricity from the renewable energy sources. The electrolyzer takes inlet potable water, and splits the hydrogen-oxygen mixture into hydrogen gas and oxygen. The hydrogen is then compressed and stored, in tanks similar to propane tanks found throughout North Dakota.

When the sun stops shining and the wind stops blowing, the compressed hydrogen is used to create electricity through the use of fuel cells. The fuel cells create electricity from compressed hydrogen, and the electricity produced can power the installation. Excess energy from the fuel cells can be sold back to utility companies on demand, as a form of distributed electrical generation to supply electricity to the grid in times of excess demand.

Another option is to sell any excess hydrogen into a rapidly growing market as a portable energy source. This can be sold in a pressurized container or potentially commingled in a natural gas pipeline.

The proposed installation will be the largest demonstration of a complete “green hydrogen” system in North America, and is a model that can be implemented throughout North Dakota, the United States, and worldwide. The only inputs to the system are sun, wind, and water, and the output is clean energy (electricity and compressed hydrogen). Figure 1 shows the installation and the major components.

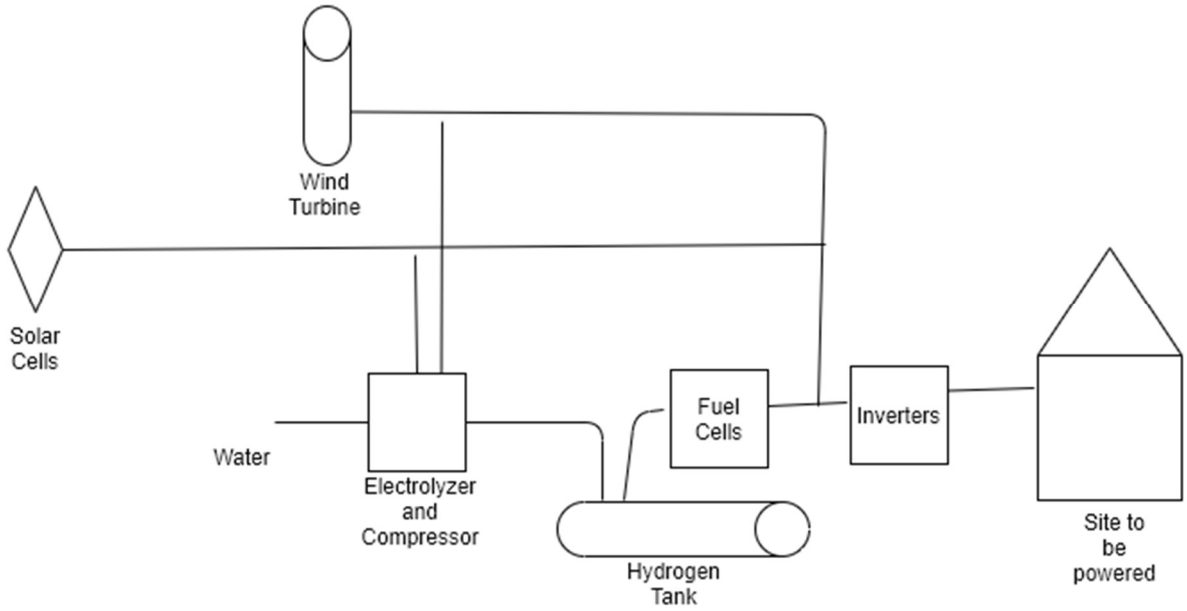


Figure 1. Block Diagram of the Renewable Hydrogen Microgrid

BWR Innovations uses design methodologies similar to those created for mission-critical electronics, specifically DO-254 design methods. The first major subtask is Design Capture, where the requirements, design environment, test plan, and preliminary vendor list is documented. These documents are critical, to accurately capture all of the performance, size, weight, cost, and environmental constraints of the microgrid design. Once all of the documents are complete, a review for all stakeholders occurs where the requirements are refined and ultimately approved. The approved requirements serve as a template for the conceptual and physical design reviews that will follow.

After the design requirements are documented, the conceptual design tasks follow. These tasks are using computer aided design to create computer-based models to implement the microgrid requirements. For electrical engineers, the conceptual design tasks are harness designs and printed circuit board designs. Software engineers will create software code, and mechanical engineers will make layouts of chassis, enclosures, and fasteners. At the completion of the conceptual design, a complete set of drawings are available for review. The review verifies that the concept drawings will meet the requirements from the Design Capture phase, but also that the concept drawings have considerations for manufacturing, test, field support, procurement, and marketing.

The third stage is the physical design. The items from the conceptual design are prototyped and combined with procured items for the first integrated working model of the system. With all the pieces assembled and integrated, the working prototype is debugged, tuned, and performance tested against the Design Requirements from the first stage. The physical design may also then be stress tested, to verify reliability and stability, as well as to create procedures for installation, field use, troubleshooting, and customer service support.

The last stage is the design assurance. During this stage, the field-tested design is operated for extended durations to fully understand the issues that would be seen by end customers. Does the microgrid have long startup times, and does the startup time vary from winter to summer? Does humidity affect the energy capture of renewables? Is the pressure level of hydrogen affected by temperature? This stage uses the comprehensive telemetry expertise of BWR Innovations to accumulate the data available from the microgrid system, analyze for changes over time, and then start predictive analysis to be able to treat changes in performance or reliability before the system performance degrades or failures occur. A natural outcome of the design assurance stage is cost modeling and analysis. The cost analysis, combined with the performance data, sets the stage for future recommendations and proposed installations. This stage is data and computation extensive, and BWR Innovations is uniquely poised for a successful design assurance completion.

Anticipated Results:
BWR expects to demonstrate an electrical system capable of providing the entire electrical demands for a site, store sufficient energy to provide a buffer during periods of time when the sun isn't shining and the wind isn't blowing, and the capability for providing energy as a revenue source. Electricity sold back to the electrical grid and compressed hydrogen made available for consumer use may generate $15,000[1] annually from this installation.

The demonstration of the renewable energy storage system will provide energy independence and resiliency, ensuring electricity to the site independent of rolling blackouts or weather-related electrical gird interruptions. In addition, the ability to store and sell electricity to the electrical grid at any point in time, not limited to only when the renewable energy source is producing electricity, allows the site owner to sell electricity as a commodity, garnering the best prices instead of at spot prices when demand is lowest.

Facilities:
BWR Innovations and Grand Farm are planning for the installation at the new (yet to be announced) Grand Farm facility. A public announcement for the location of the new facility is scheduled for September 16, 2021. While the installation is at Grand Farm, BWR Innovations will retain ownership, provide service and upkeep, record all performance and service information. Potential revenue, from the sale of electricity to the grid or hydrogen sold will support research projects by BWR Innovations at Grand Farm. The facility demands are minimal. The solar panels may be installed on the ground, or as the roof panels for a building. The size of the solar panels is approximately 2200 square feet. All fuel cell components, with the exception of the tank for the pressurized hydrogen and the solar cells, can fit within a footprint of ten feet by ten feet, which is proposed to be provided by BWR Innovations.

Resources:
No unique or rare resources will be needed for this project. All of the energy is developed from solar and wind, and a small amount of potable water would be needed (not to exceed 0.5 gallons per hour.)

Techniques to Be Used, Their Availability and Capability:
The solar energy is captured by stationary solar cells, using photovoltaic cells to create DC voltage that

powers the site through inverters (converting DC voltages to AC voltages). The excess energy from the solar cells powers the electrolyzer and compressor, converting solar energy to compressed hydrogen. Similarly, the renewable energy from wind is captured by a wind turbine, also powering the site through the inverters and powering the electrolyzer and compressor.

The electrolyzer is a rack mounted unit that may be stacked in a modular design, to create the required amount of hydrogen production. Each electrolyzer is capable of producing 1 kg of hydrogen per day. For this research, BWR Innovations is proposing an installation with five electrolyzers, for a combined production rate of 5 kg of hydrogen per day.

The compressor and storage tank are common gaseous components, similar to tanks used to store propane. The valves, regulators, lines, and fittings are all commercially available at gas suppliers such as Airgas or Praxair.

The fuel cell modules are available from Intelligent Energy. The fuel cell modules, models FCM804s, are units that BWR Innovations has used for years in various products, and are scalable in units for 4kW per module. For this installation, BWR innovations is proposing an installation of five FCM804s, for a combined electrical production of 20kW.

The inverters proposed in this installation are modular components that provide 208VAC from 48VDC. These units are capable of providing the complete needs of the site, whether the source of the energy is wind, solar, fuel cells, or any combination of the three sources.

All of the components of the system are connected to BWR Innovations telemetry system. The power produced by the solar cells and the wind turbine are recorded. The hydrogen production from the electrolyzer is monitored, as are other parameters within the design. The hydrogen level in the storage tank is monitored, and the fuel cells are controlled by the BWR telemetry system.

All of the components are commercially available. BWR Innovations has partnership with the suppliers for the compressors, storage tanks, fuel cells, inverters, and the site for a target installation. The telemetry system is available from BWR Innovations, and is similar to the telemetry system that BWR offers throughout the United States and Canada via distribution.

An optional synchronization system is available for direct connection to the electrical grid, for future capabilities of selling excess electricity to the electrical grid. The synchronization system is also connected to the BWR Innovations telemetry system for monitoring, and has connections for utility level control.

This combined system will be the largest planned installation in North America. BWR Innovations is a partner in the Home Hydrogen Demonstration of Southern California Gas, which is based on a 4kW fuel cell installation. BWR innovation is providing the turnkey fuel cell system, inverters, and telemetry control for Southern California Gas.

Environmental and Economic Impacts while Project is Underway:
Once operational, the site will produce all of the energy needed by the site, capturing renewable energy

from wind and solar sources. The unique aspect of the project is to capture excess energy and store in the form of compressed hydrogen gas. Hydrogen gas is the most abundant element in the world and is an extremely clean, safe, and efficient form of storing energy.

When the hydrogen is consumed by fuel cells to produce electricity when the solar energy and wind energy is not available, the fuel cells convert compressed hydrogen to electricity. The byproduct of the fuel cells is water vapor, which has zero environmental impact. At no point of the operation is any carbon produced or any harmful emission present.

Regarding the economic impact, the site will be able to produce all of the electricity needed with zero operational costs, virtually zero maintenance, minimal noise, and may be able to sell excess energy. Excess electricity may be sold to the electrical grid with an optional synchronizer, and excess hydrogen may be sold using portable storage tanks that are filled from the compressor and the hydrogen storage tank on the site. The electricity is likely to be sold at wholesale prices, and compressed hydrogen of 99.9% purity may be sold at a commercial price of $16 per kg.

Ultimate Technological and Economic Impacts:
BWR Innovations is proposing an installation that is scalable, modular, and reconfigurable in creating electricity and storing energy with zero carbon footprint. The system has telemetry monitoring that allows anywhere, anytime, any platform access of authorized users, and has the ability for utility company control. The ultimate goal of the system is to replicate to any site that desires to have energy as a revenue stream for their operation, where the excess is available as a shared resource in distributed generation.

Having the controls available at the utility level produces a robust distribution network. As the future moves towards microgrids and distributed generation of energy, BWR Innovations' concept is a solid basis that can be replicated anywhere in North Dakota, the United States, or the in the world.

With the transformation in the US electrical grid as the nation moves from large power plants to distributed clean energy sources, there is a gap that BWR is addressing. In the near term, BWR expects demand for medium sized (5-20kW) fuel cells to exceed 5,000 units over the next 8 years. BWR is working with residential/commercial solar/wind installers and with electric utility companies to purchase and install these units.

Why the Project is Needed:
This project is critically needed to demonstrate the capability of energy storage via compressed hydrogen, to demonstrate the green energy approach of using renewable energy to produce compressed hydrogen, and to demonstrate a standalone microgrid capable of meeting its own energy demand and providing the excess energy as a revenue stream. North Dakota has immense potential with wind and solar energy, but finding the most economical method of selling this energy is not a clear path. The storage of energy via compressed hydrogen and then the sale of this compressed hydrogen into the rapidly growing market for hydrogen could be significant for existing and new wind/solar production capacity.

The enclosed micro grid, that this will demonstrate could also be a prototype for energy savings/production in existing agricultural facilities, industrial and retail facilities. The compact footprint and sizeable energy production could be a model for use across the state and as a replacement for the many "stand by" power generation assets.

This capability will produce a whole new market for North Dakota farmers with the sale of energy through electricity and hydrogen.

1. https://electrek.co/2019/09/13/tesla-launches-commercial-solar-online-ordering-transparent-pricing/

STANDARDS OF SUCCESS

Standards of Success should include: The measurable deliverables of the project that will determine whether it is a success; The value to North Dakota; An explanation of what parts of the public and private sector will likely make use of the project's results, and when and in what way; The potential that commercial use will be made of the project's results; How the project will enhance the education, research, development and marketing of North Dakota's renewable energy resources; How it will preserve existing jobs and create new ones; How it will otherwise satisfy the purposes established in the mission of the Program.

The standards of success are straightforward, based on the objectives proposed by BWR Innovations:

- The demonstration of a site producing sufficient electricity via renewable energy to completely meets its own electricity needs, with excess energy creating stored energy,
- A robust, reliable microgrid that is demonstrated to operate year-round, being impervious to temperature and wind conditions of the North Dakota weather,
- The capability to sell excess energy, either through the sale of electricity to utility companies or the sale of compressed hydrogen gas, ultimately in tanks or diverted to a natural gas pipeline.
- The demonstration of a reasonable return on investment, where future installations can expect to generate revenue and create cost savings to offset any investments for their microgrid system.

If these standards are satisfied, North Dakota would see a new era of energy, energy production, and the sales of systems that would make North Dakota the world's leader in energy systems:

- Fuel cell systems, provided by Intelligent Energy and assembled at Assembly Systems,
- Telemetry systems, designed by BWR Innovations, assembled at Trison, with components from Newava and Digikey,
- Cloud based monitoring, developed by BWR Innovations and the Network Center,
- Further research, design, teaching, and extension services through North Dakota State University,
- A new market for energy, which North Dakota can utilize in state or to sell/distribute to customers throughout North America.

BACKGROUND/QUALIFICATIONS

Please provide a summary of prior work related to the project conducted by the applicant and other participants as well as by other organizations. ***This should also include a summary of the experience and qualifications pertinent to the project of the applicant, principal investigator, and other participants in the project.***

BWR Innovations is uniquely capable for this project due to our products, partnerships, and intellectual property. Our module fuel cell system, scalable from 4kW to 20kW, is unique in the fuel cell marketplace. Currently, most fuel cells are either targeting mobility and material handling (greater than 50kW) or drones (less than 1200 Watts.) The collaborative partnership between BWR Innovations and Intelligent Energy (see attached letter of support) outlines BWR's role as Intelligent Energy integration partner for turnkey fuel cell systems in the United States. Finally, our issued patent in distributed electrical generation (US 11,08,508) along with patents pending in distributed hydrogen generation and utility level control of fuel cell systems is a barrier to entry to any other entity considering this space.

The technical components of this project are led by Dr. Joel Jorgenson, CEO and President of BWR Innovations. Dr. Jorgenson has earned electrical engineering degrees from North Dakota State University (BSEE, 1987), the University of Iowa (MSEE, 1993), and Iowa State University (Ph.D., 1998), and is currently completing his Masters of Business Administration degree at the University of Illinois. Dr. Jorgenson holds patents in fuel cell systems, power management, and telemetry, and is an adjunct professor at North Dakota State University's Electrical and Computer Engineering Department. Dr. Jorgenson has been awarded Entrepreneur of the Year by the Fargo-Moorhead Chamber of Commerce, the Architect of Defense by the Minnesota Defense Alliance, and has numerous accolades, publications, and positions.

The program management components of this project are led by Thomas Nelson, Fuel Cell Systems Program Manager of BWR Innovations. Mr. Nelson is a serial entrepreneur and successful business owner, with decades of experience in small and medium businesses throughout Minnesota. Mr. Nelson is leading the business development and advanced partnership at BWR Innovations, and holds a Bachelors and a Masters of Business Administration from the Carlson School of Business at the University of Minnesota.

BWR Innovations was founded in 2018 by Dr. Jorgenson as a *Blue-Water* innovator for telemetry and fuel cell systems. The concept of the Blue Water innovation is based on the business concept by Mauborgne and Kim (*Blue Ocean Strategy, https://www.blueoceanstrategy.com/what-is-blue-ocean-strategy/*)where companies produce novel, unique value-added designs that are not commodity and are not directly available from competition. BWR Innovations was founded on this premise, and has been developing unique designs in fuel cell systems and telemetry that meet an unmet need and are creating new markets. The acronym *BWR* stands for Blue Water Resolute, which means that as we are creating new markets in Blue Oceans, the problems we are tackling are challenging and require resolute focus.

MANAGEMENT

*A description of **how** the applicant will manage and oversee the project to ensure it is being carried out on schedule and in a manner that best ensures its objectives will be met, **and a description of the evaluation points to be used** during the course of the project.*

Projects managed at BWR Innovations use a combination of time-tested project management tools coupled with new technology for a distributed workforce. The online capability of the project management tools allows all users (and project stakeholders) to access project information, view status and progress, and to provide feedback and input.

The overall methodology of the program management is based on DO-254, a set of standards developed for the design of systems used in airborne systems. The Federal Aviation Administration has mandated the adoption of design assurances to be used in the design of electronics and mechanical systems that are integrated into aircraft systems, to assure that structured design methods are created, followed, and documented.

The first step of the project is the Design Capture phase, where each critical part of the design is documented and the interfaces between all parts are defined. For example, in this phase, the complete characteristics of the major components are defined, such as the solar cells, the wind turbine, the electrolyzer and compressor, the hydrogen storage tanks, the fuel cell modules, the inverters, and the telemetry system. Each system will have its performance characteristics established, and a defined means to test, troubleshoot, and repair each component.

The second step of the project is the Conceptual Design phase. During this phase, the architectures of the software, electronics, and mechanical components are defined. Software will be developed using Python, C, and Powervision; Electronic components will be designed using schematic capture, wire harness design, and printed circuit board design software; and mechanical design will use Solidworks for design and manufacturing. At the end of this phase, the projected performance of each component will be compared against the requirements of the first phase.

The third step of the project is the Physical Design, where components are purchased, assembled, integrated, and tested. At the completion of this stage, the hydrogen microgrid system will be operational, and the performance metrics will be compared against the predicted performance of the Conceptual Design.

The final step of the project is the Design Assurance stage, where components are analyzed for performance within the design limits and for any potential failure points. The stage also allows for Lessons Learned to be documented, to allow for future improvements within this project and for future similar projects.

Dr. Jorgenson has used methods of DO-254 for decades. He was first introduced to this methodology while employed at Rockwell Collins (Cedar Rapids, IA) as a design engineer, and taught methods from DO-254 to engineering students at North Dakota State University. This methodology is robust and easy to learn and understand. To track progress, Gantt charts and Trello software are available to all team members and stakeholders.

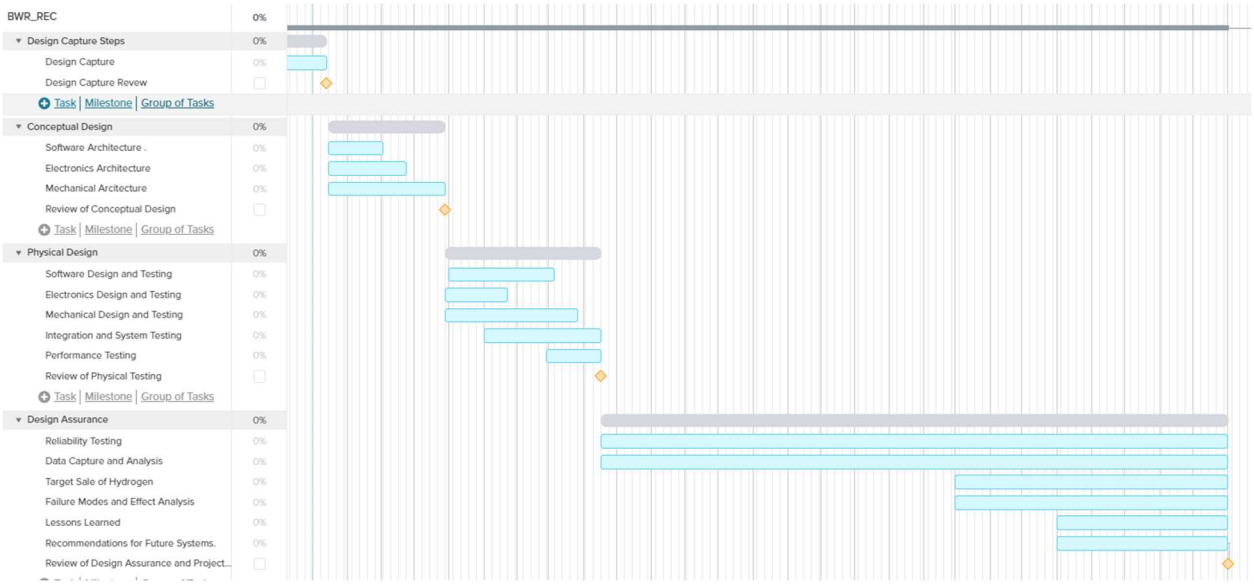
BWR Innovations is partnering in this microgrid research with Grand Farm and North Dakota State University. Critical partners at Grand Farm include Dr. William Aderholdt, Gran Farm Program Manager, and Brian Carroll, Grand Farm Chief Operating Officer. Dr. Jorgenson will coordinate directly with Grand Farm for the design and integration, as well as to investigate where a successful implementation of a green hydrogen microgrid can foster new research ideas and create opportunities for the twenty-first century farm. Dr. Aderholdt's letter of support is part of the BWR Innovations application package to the Renewable Energy Council.

BWR Innovations is also partnering with North Dakota State University. The specific point of contact at NDSU is Dr. Jane Schuh, Vice-President of Research and Creative Activity. Dr. Schuh is instrumental in identifying faculty wishing to collaborate on research and publication of new discoveries in engineering, agricultural extension, and agricultural financial modeling.

TIMETABLE

Please provide a project schedule setting forth the starting and completion dates, dates for completing major project activities, and proposed dates upon which the interim reports will be submitted.

BWR has developed a preliminary Gantt chart based on a twenty-four-month schedule. Figure 2 shows the Gantt chart, with each of the four steps of the project management, and critical milestones at the end of each stage.



Interim progress reports are available at any time, as BWR can access design and program progress at any point. BWR Innovations proposes interim reports based on the milestone completions of each stage. Assuming a start of November 1, 2021, those dates are approximately:

- Completion of Design Capture: Approximately December 15, 2021,
- Completion of Conceptual Design: Approximately January 26, 2022,
- Completion of Physical Design: Approximately April 16, 2022,

- Completion of Design Assurance: Approximately October 31,2023.

Additional reports from BWR's telemetry will be available on a monthly basis during the Design Assurance phase, starting approximately on September 30,2022.

BUDGET

*Please use the table below to provide an **itemized list** of the project's capital costs; direct operating costs, including salaries; and indirect costs; and an explanation of which of these costs will be supported by the grant and in what amount. The budget should identify all other committed and prospective funding sources and the amount of funding from each source. **Please feel free to add columns and rows as needed.** Higher priority will be given to those projects that have matching private industry investment equal to at least 50% or more of total cost.*

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Salary	$0	$225,000	$0	$0
Fringe	$0	$33,750	$0	$0
Equipment	$332,159	$0	$0	$0
Site Lease	$0	$0	$0	$50,000
Installation Costs	$0	$0	$25,000	$0
Total	$332,159	$258,750	$25,000	$50,0000

An itemized list of the equipment is shown below:

Equipment	
Wind Turbine	$ 10,000.00
Solar Panels	$ 32,500.00
Fuel Cells	$ 88,500.00
Electrolyzer	$ 53,991.00
Mechanical Cabinet	$ 6,000.00
Hydrogen tank and compressor	$ 66,568.00
Inverter	$ 54,600.00
Mounting	$ 20,000.00
Total	$ 332,159.00

Please use the space below to justify project associated expenses, and discuss if less funding is available than that requested, whether the project's objectives will be unattainable or delayed.

All components are commercially available, either at BWR Innovations or through our partnership with key suppliers. If less funding is available than requested, BWR is able to scale the size of the project to

demonstrate the unique capabilities of the project, albeit at a lower electrical and hydrogen production level.

Salaries listed in the proposal are for BWR Innovations personnel to design, document, debug, install, and monitor the microgrid system over the period of the design project. Fringe benefits are calculated at 15% of the salaries. Site lease costs are in-kind support from Grand Farm for the installation of the microgrid on their facility.

Installation costs include, but are not limited to, permitting, excavation at site for concrete footings and pads, trenching for underground wiring from external mechanical cabinets to buildings, electrical work by master electricians to connect microgrid controller to buildings and facilities, and outside services for the permitting and verification of federal, state, and county regulatory requirements.

CONFIDENTIAL INFORMATION

Any information in the application that is entitled to confidentiality and which the applicant wants to be kept confidential should be placed in an appendix to allow for administrative ease in protecting the information from public disclosure while allowing public access to the rest of the application. The appendix must be clearly labeled as confidential and must include the following information: (a.) a general description of the nature of the information sought to be protected, (b.) an explanation of why the information derives independent economic value, actual or potential, from not being generally known to other persons, (c.) an explanation of why the information is not readily ascertainable by proper means by other persons, (d.) a general description of any person or entity that may obtain economic value from disclosure or use of the information, and how the person or entity may obtain this value, and (e.) a description of the efforts used to maintain the secrecy of the information.

If there is no confidential information, please note that below. If you plan to request confidentiality for ***reports*** *if the proposal is successful, this section must still be completed.*

At this time, BWR Innovations is not aware of any data or project information that must be kept confidential. Key attributes for this project have already been protected by BWR Innovations, through patent applications, trade secrets, copyrights, trademarks, and an issued United States patent. If future research creates new intellectual property that BWR requests to protect, BWR Innovations will work with the Renewable Energy Program for considerations.

PATENTS/RIGHTS TO TECHNICAL DATA

Any patents or rights that the applicant wishes to reserve must be identified in the application. If this does not apply to your proposal, please note that below.

In May 2021, BWR Innovations was issued US Patent 11, 018, 508 *Electrical Power Generating System,* describing the invention of a fuel cell generator with telemetry and synchronization. BWR Innovations has filed patent applications on fuel cell systems, including (but not limited to):

- A Means to Control Distributed Generation Through Telemetry

- A Software Means to Select Protocols,
- Distributed Generation and Storage of Renewable Energy, and
- A Fuel Cell Based Auxiliary Power Unit.

The listed intellectual property will remain in the ownership of BWR Innovations.

STATE PROGRAMS AND INCENTIVES

Any programs or incentives from the State that the applicant has participated in within the last five years should be listed below, along with the timeframe and value.

BWR Innovations has not received any state funding or support.

GRANDFARM

July 26, 2021

Renewable Energy Council
State Capitol, 14th Floor, 600 E Boulevard Ave. Dept. 405
Bismarck, ND 58505-0840

Re: BWR Innovations

Renewable Energy Council,

Grand Farm is excited to support the submission by BWR Innovations to the Renewable Energy Council. Grand Farm energizes a global ecosystem of industry, government, and higher education to solve modern and future challenges within the agriculture industry. Over the past several months, it has become deeply apparent that the energy and agriculture sectors are intertwined, and very reliant on each other. As farm operations drive towards the future with agriculture technology, renewable energy solutions (including microgrids and hydrogen energy) will be necessary to maintain reliable farm operations. With North Dakota's recent commitment to becoming carbon-neutral by 2030 through innovation (rather than regulation). BWR Innovation is leading the way in thinking about hydrogen energy applications in powering the farm of the future.

It is for these reasons we strongly support BWR Innovation's application to the Renewable Energy Council

Sincerely,

Wm. David Aderholdt

Dr. William Aderholdt
Director, Program Management Office
Grand Farm

Intelligent Energy

May 10, 2021

To Whomsoever It May Concern:

Intelligent Energy Limited ("IE") is pleased to support BWR Innovation Inc.'s ("BWR") proposal for building and demonstrating a 20kWe fuel cell power system using our IE-Lift™ 804 fuel cell power modules at a microgrid project at Grand Farm, North Dakota. IE understands that the proposed project intends to demonstrate carbon free and noise-free power production in mid-2021.

Intelligent Energy is a fuel cell engineering company focused on the development and commercialization of its PEM fuel cell products for a range of markets including automotive, stationary power, and UAVs. We are headquartered in the UK, with additional operations in the US, Japan, South Korea, and China.

Running on hydrogen and oxygen from the air, the IE-Lift™ 804 is designed as a self-contained power module with all requisite balance-of-plant components to produce clean DC power in a power-dense and convenient package. The compact and modular unit can be deployed to deliver power for a wide range of applications.

IE and BWR have been mutually exploring a number of commercial opportunities for fuel cell power systems in the US since late 2018. IE has previously supplied its fuel cell power modules to BWR and looks forward to supplying its fuel cell power modules to BWR for this project. This project, and successful demonstration of the microgrid to stakeholders, would support the commercialization of fuel cell power systems in the US. IE wishes BWR the very best in this endeavour.

Yours sincerely,

Katie Russell
Commercial Operations and Business Development Director
Intelligent Energy Limited

Intelligent Energy Limited

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July 30. 2021

Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue, Department 405
Bismarck, North Dakota 58505-0840

Re: BWR Innovations, LLC. Proposal

Greetings Ms. Fine,

On behalf of BWR Innovations LLC, I am pleased to submit our application to the Renewal Energy Grant. We hope that you find our proposal worthy of support, as we believe that this project has the potential to be a substantial success technically and generate tremendous opportunities for North Dakota's economy.

We are thankful to the opportunity for you to review our ideas, and we look forward to your feedback.

With regards,

Joel Jorgenson, Ph.D.
President, CEO
BWR Innovations, LLC
3471 South University Drive
Fargo, North Dakota 58104

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Karlene Fine
Executive Director
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600 East Boulevard Avenue, Department 405
Bismarck, North Dakota 58505-0840

Re: BWR Innovations, LLC. Tax Liability Statement

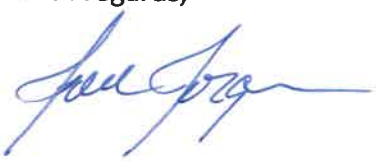
Greetings Ms. Fine,

Fulfilling a requirement of the Renewable Energy Grant Application process, BWR Innovations, LLC would like to provide the following statement:

I, Joel Jorgenson, as President and CEO of BWR Innovations, a current and properly registered company with the North Dakota Secretary of State Office, hereby state that BWR Innovations, LLC does not have a tax liability to the state of North Dakota, Cass County, the City of Fargo, or other known jurisdictions in the state of North Dakota.

To the best of my knowledge, that statement is accurate and true and I hereby provide my signature to that statement.

With regards,



Joel Jorgenson
President, CEO
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