Village DC Micro-grid/Storage/Renewable Energy Project

Volcano View Partnership
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Partners—Volcano View Partnership and Dr. Richard Wies, University of Alaska, Fairbanks

Total Project Cost: $540,000

Grant Funds Requested: $500,000
Matching funds: $40,000

Previous project submission- Village DC Micro-grid/Storage/Renewable Energy Project, submitted March 2011

Project Abstract-Village DC Micro-grid/Storage/Renewable Energy Project
Volcano View Partnership, Non-Confidential

Project Summary –
The Village DC Micro-grid/Storage/Renewable Energy Project is a demonstration project that will combine intelligent grid components, new flow battery storage technology, renewable energy and a more efficient use of wind 'dump loads'. This project will deploy existing technology not currently used in the State of Alaska to address a variety of issues currently faced by power providers.
We will use diesel generation, a small individual home windmill (5 kW) energy input, and will integrate them into a DC micro-grid with a new flow battery storage system. A larger windmill (11 kW) will be added to the grid to increase performance and decrease operating costs.
The new flow battery storage system and larger windmill will increase the lifespan of the power generation equipment by as much as 10 years, and with the added benefit of being environmentally friendly.
We will address the common issues all villages face: unbalanced power legs, brownouts due to large loads, and the growing demand for 'clean' power. The project will simplify the complex switching system normally needed to integrate renewable energy.
The project will demonstrate how this combination of technology, all off-the-shelf components, will put Alaska villages in the forefront of efficient power usage, getting the most from their diesel generator and renewable energy systems. We expect this small scale intelligent grid, as demonstrated in this project, to show savings by reducing diesel usage as much as 15% and upfront capitalization by as much as 15%.
Using a team of Alaska residents, businesses and a University of Alaska faculty member, we have designed a demonstration project that will connect four homes and two businesses in the village using proven components from a variety of industries in a new way. This will show how villages of various sizes and across the State can achieve savings on a variety of fronts including a reduction in energy conversion losses. Monitoring of the system at critical points will allow for tracking and recording of exactly what is happening in real time plus recording information to a permanent file. The monitoring data will be accessible in real time via the project's internet site.
Volcano View Partnership will work to either set up permanent power provider LLC or a utility co-op at the conclusion of the demonstration project. *See attachment A (Volcanic View Partnership AK Business Lic)*

Technology Validation and Research Methodology-
Objectives-
-The concept of a 'generator off' system will be shown to be a reliable option for those working to reduce diesel use through the use of renewable energy sources.
-This DC micro-grid will demonstrate the reliability of renewable power systems as it is reducing the complexity of all these systems coming together with conventional diesel generation.
-We will show that a DC system eliminates reactive power and requires only voltage matching, versus an AC grid that requires voltage, phase and cycle matching and which must have a technician and complex equipment to accomplish.
- We will demonstrate that DC micro-grids also help to address the issue of loss of power if run as distributive (bi-directional) power grids. Total loss of power to the entire grid can be avoided by having power input from various operations at various locations.
-Excessive winds can cause issues in a renewable system if there is not a way to 'dump' this load. We will make use of that 'dump' in a more efficient way to capture that energy.
- Through the use of mostly off the shelf components, the project will demonstrate the efficiency of DC versus AC systems. We expect the micro-grid to achieve less diesel consumption and will minimize the usual loss of energy that occurs in AC energy systems.

Methodology-
This demonstration project will make use of a diesel generator hooked up to a new zinc-bromide flow battery storage system that will send DC power via a dual transmission line out to four homes and two business in the village of Ugashik on the Alaska Peninsula. Additional power will be fed into the system from existing wind sources from two of the individual homes. A new 11 kW Danish manufactured windmill will be installed, further demonstrating how current village systems can be turned into renewable based distributive energy grids.
From the zinc-bromide flow battery system, a 5 kv DC grid will be set-up to run to the homes and businesses involved. A DC/DC high-power 600v to 5 kv bi-converter currently used in the military and in a National Science

Foundation Project and will be installed along the line to step-up the voltage to 5 kv. Then at each home we will use an inverter, used for years in the railroad industry, to take the voltage from 600 DC to 240 AC. For those home/businesses that are in need of DC, due to presently used alternative energy systems, we will use a converter to the appropriate DC voltage, which is from hybrid car industry.

Our traditional uni-directional electrical system in the US has been based on power produced as AC in a central location, and distributed out to homes and business for use. Homes and businesses ran, in the past, mostly incandescent lights, AC motors and other AC equipment.

We need to rethink this system, especially in Alaska, where more power is produced by various methods; diesel generators, solar, wind and hydro, scattered throughout a vast geographic region.

The efficiency in solid state DC/DC converters versus AC transformers can reduce the energy losses through a variety of ways. Fewer converters are needed than transformers, reducing the number of times of conversion and the energy losses seen in each of those conversions. DC/DC solid state conversion is also more efficient than AC/AC conversion at this time.

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Any excess power that is generated, by wind, will be diverted into the participating home boiler systems. We will monitor how much is diverted and will compare savings with historical heating fuel usage.

An electronic monitoring system will be designed and installed to monitor all critical points in the system. Individual home and business usage, diesel consumption, kW produced, and input from both the individual renewable energy units on homes and the 11 kW windmill will all be measured and analyzed . Analysis of the raw data will completed by Dr Richard Wies of UAF and the partnership to provide complete information on this technology for design engineers working with Alaskan village energy projects

See attachment B (Block Flow Diagram)

The project will be installed in the village of Ugashik on the Alaska Peninsula. Ugashik has no energy grid at this time. Ugashik is located on the Ugashik River, which is deep enough for large barge vessels to be loaded or unloaded at any stage of the tide. Ugashik also has a 5000’ airstrip so any of the supplies can also be brought via airplane. The climate of Ugashik ranges from temperatures in the negative mid-20’s to highs in the 80’s in the summer. High winds and rain are also common, allowing for most of the weather conditions the state of Alaska encounters being within the scope of what this project will encounter. Ugashik has done two wind studies over the past 40 years that show it to be an excellent source for wind power. Results of those studies can be provided. Ugashik has satellite internet access from two different companies which can allow for 24/7 electronic monitoring. An electronic monitoring system will be designed, installed and will be capable of monitoring all critical functions of the project.

The main building for the project will be located in the center of town on private land, owned by Briggs-Way Properties and leased at low cost to the project. This allows for the entire village to be served by the project in the future. Gravel is available on site. A surveyed gravel road that runs the length of the village is easily accessible to the project.

No specific permitting is required by the Lake & Peninsula Borough or the State for this project. Notification of which side of the road that needs to be declared by the project for the utility corridor will be decided and then notification sent to the borough planning committee. Preliminary notification of the project has already been sent to the borough. *See Attachment C (Site authorization- Briggs Way Properties)*

Project Schedule Summary–

The project is planned to be fully installed by early fall of 2013, with performance data beginning to be generated immediately upon full operation. Monitoring will be available 24/7 from this point forward, with data collection recorded, analyzed and reported on approximately a six month scheduled cycle for the next 12 months after that, ending Oct 1, 2014.

Project Summary Budget-
If funded this project will bring together both the talents and resources of Alaskan businesses through staff and matching resources, Alaskan residents, staff from the University of Alaska and grant funds in a demonstration **project estimated to cost a total of $540,000** The monies would be split out in approximately the following areas:

Equipment	$400,000
Salaried/UAF support	$ 76,000
Travel-UAF/crew	$ 8,500
Supplies/uncategorized	$ 55,500

Volcano View Partnership will use a combination of personal/partnership funds, equipment/services for in-kind matching and grant funds to complete the project. Briggs-Way Properties and Ugashik Wild Salmon Co and Roland Briggs Enterprises will contribute a portion of the matching via land rental, equipment use, building donation and housing/board for work crews. The match will come through a combination of in-kind and cash **matches in the amount of $40,000**, thus a grant **fund request of $500,000**.

Project Team Capabilities

Project team -
The project team will consist of, Roland Briggs, John Bragg, and John Ruhl of Volcano View Partnership, Dr Richard Wies of University of Alaska and the technical teams of the various suppliers. *See Attachments D&E (CVs for Wies, Briggs)*

- ***Dr. Richard Wies, Ph. D, P. E.*** is an Associate Professor of Electrical and Computer Engineering at the University of Alaska Fairbanks and a registered Electrical Engineer in the State of Alaska, with over 12 years of research experience focused on standalone hybrid electric microgrid systems. His main research contributions to date are the development of standalone hybrid wind-diesel-pv-battery electric power system performance and stability models to investigate techniques for reducing diesel fuel consumption and maintaining system stability with highly variable wind resources. *See Attachment F (Authorization from UAF for Wies participation)*

-**Roland Briggs, BS** in Mechanical & Electrical Engineering, has lived and worked in the rural villages of Alaska for 30+ years on a wide variety of power generation projects. He can draw on his experience of engineering complete power generation systems to run seafood processing plants, complete with renewable energy input, trouble shooting various village and school power issues for the Lake & Peninsula Borough School District, and designing/installing remote monitoring systems for school boiler/heating/cooling over a 350 mile long area in rural Alaska.

-**John Bragg** brings his over 25 years of commercial construction and mechanical projects experience to the project. John's experience has spanned various locations in the eastern US and Alaska. He has worked and lived in rural Alaska for close to 6 years working on projects from major airstrip construction to assisting village power generation operations for two different villages. He is the former mayor of Pilot Point, the recipient of a new large wind power project and continues to work with villages on power issues.

-**John Ruhl**, the four partner in Volcano View Partnership will work with the construction crew for laying the transmission line, setting up the building site and other project site/transmission needs. He brings over 20 years of construction and mechanical experience, working 100% in villages, to the project. He will also serve as a in-village back-up resource.

Commercialization of Funded Technology-
All of the components, zinc-bromide flow batteries, DC/DC converters and DC/AC inverters have been in commercial production for four years or more. To the best of our knowledge and in consultation with the various suppliers, none of this equipment is currently being used in Alaska, at least in the energy industry. (Consulting the TRL levels we see that all our components are at a TRL 9, but they are just not being used yet in Alaska)
The flow batteries are currently being used in various applications in the US and overseas.

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ZBB Energy Corporation, our chosen supplier, has systems in various locations across North America including at the Bella Coola Hydro Assisted Renewable Power project in Bella Coola, British Columbia and in Pennsylvania for a residential off-grid multi-sources renewable energy power system. They are also supplying systems overseas, such as powering an electronic system for Likusasa Engineering of South Africa.
The DC/DC converters are used extensively throughout the hybrid car industry, basically as the heart of the car's electric drive system. They are also used in the new undersea National Science Foundation Lab off the East Coast.
The DC/AC invertors have been used extensively in the railroad industry for many years as components for running the day-to-day operation of the railroad cars. They are also used in the US military and hybrid car industry.
We will be using one of two possible Danish windmills, a Aeolos or Gaia, both that have been used for a number of years in many areas of world. In comparing some of our various types of wind pattern in Alaska these appear to have some of the best outputs for those conditions. They have been shown to be very dependable and have a history of low maintenance requirements.
The project will be tracked and documented so that it may be replicated and scaled up. There are no plans to patent the project, but instead we will provide information, free of charge, for energy engineers to incorporate as they deem fit for their individual projects.
The state of Alaska has approximately 250 villages, with a total population of over 125,000 residents that have no link to a centralized power grid. The vast majority of these are served by diesel-driven generators. Most are also without a link to a road system making the subsidized (Power Cost Equalization) cost per kW from $0.45/kW-hr. to well over $1.00/kW-hr.The cost of fuel needed to run these villages in the next 20 years, at 2009 price levels, is estimated to be almost $9 billion. There is a strong effort now to make use of renewable energy, particularly wind, to help reduce those costs. Yet, even with the addition of renewable energy many villages/towns are still not seeing a reduction in their costs for a variety of reasons and in turn also are seeing new issues arising. For example, unbalanced power legs are causing problematic vibrations of the wind towers at the Kokhanok Wind Project. Also, such complex switching is needed that local workers can't trouble-shoot issues and sometimes by-pass the automatic switching to keep the system working, thus reducing possible savings.
The Village DC Micro-grid/Storage/Renewable Energy Project is designed to show savings to the upfront capital costs (as much as 15%) extend the longevity of the generation systems as much as 10 years, and finally allow for an overall reduction in the diesel used to operate the system by as much as 15%. We estimate that there are approximately 150 villages in Alaska that are using or planning renewable energy projects. These villages will benefit first from this project, especially where wind projects are marginal due to the sporadic nature of the wind resource. Secondary users will be those who are experiencing unbalanced power legs and those running larger capacity generators than the electric energy demand requires. Even the smallest of these villages, such as Ugashik, can enjoy part of this savings by incorporating even just a portion of the off-the-shelf technology proven through this project.
The project expects to also prove technology that other projects can use to enable the integration of a variable power source into a system built for a constant supply. All of this project's technology is already commercially available, making even preliminary results in the first year available and useful to the energy community.
We expect to show that economic benefits of this project can be realized throughout the State, in villages/towns of all sizes and locations. Fuel savings and reduced line energy losses will be monitored and demonstrated. Other benefits such as reduced costs on freight and the lack of generating toxic waste at the end of the projects life cycle will add to the total savings to Alaskans.

By signature on this application, I certify that we are complying and will comply with the amount of matching funds being offered.

Roland Briggs_____ Date: 3-7-2012