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Alaska Energy Authority
Emerging Energy Technology Grant Fund Application
March 9, 2012

Project Title:	True Community Wind-Diesel Hybrid Using Smart Inverters and Fast Charging Batteries for Kwigillingok
Applicant:	Intelligent Energy Systems, LLC
Contact Information:	Intelligent Energy Systems, LLC Dennis Meiners Tel: 1-907-770-6367 dennis@iesconnect.net
Partners:	ABB, Chuck Huntley, ABB Alaska Pat Hayes, Energy Storage Systems, ABB Sakata Engineering Kwigillingok Power Company Dennis Witmer, P.hd, Energy Efficiency Evaluations Ginny Faye, ISER/UAA Carl Brothers, Frontier Power Systems
Total Project Cost:	$1,055,750 Grant Funds Requested: $1,025,750 Match Committed: $30,000
Previous Grants:	Kwigillingok Wind Farm Construction – REF #2195410
Previous Abstracts:	Kwigillingok Wind Energy Battery Storage – AEA EETF

Abstract

1. Project Summary

a. Project Description

Village power systems suffer from high costs, small markets and limited access to technology and skilled technicians. These factors are exacerbated by recent spikes in diesel fuel costs. To help minimize diesel fuel usage, a simple to deploy, easy to operate and maintain, high performance energy storage system that can maximize the use of wind and solar energy is needed.

This is a technology validation project, applying the ABB Distributed Energy Storage (DES) system using Samsung Bosch high performance vehicle-format batteries to provide short term (< ½ hour) of energy storage to create a true wind-diesel hybrid power system for the village of Kwigillingok. The DES with fast rechargeable, high cycle, low maintenance energy storage is the key building block for village power systems incorporating wind or solar with diesel. The high conversion efficiency and control features of the DES coupled with the batteries will provide both passive and dynamic wind-diesel operating modes. The system will enable high penetration of fluctuating wind, with long periods of diesel off and small generator set operation. Inclusion of the battery energy storage simplifies higher wind penetration while significantly improving fuel savings. Fuel savings are expected to exceed 50% for wind-diesel systems and 10 to 15% for diesel battery operations.

Lithium ion battery technology was selected by automobile manufactures as the battery of choice for transportation and fast charge applications. This and future projects will benefit from the huge investments in this technology by the automobile industry, which is driving down costs while steadily increasing performance. More importantly, battery replacements will be available through automobile dealerships, as well as village power systems will provide a secondary market for used batteries.

The ABB/DES is a fully engineered, packaged energy storage system designed for direct attachment to a medium voltage distribution system, requiring little to no modification of the diesel power plant. The DES can be adapted to various energy storage mediums. In this application, Samsung Bosch lithium ion vehicle-format, fast rechargeable batteries are used to provide up to 15 minutes of continuous output of 250 kW. The DES is a state of the art, tested system designed to provide a broad range of grid stabilization services such as peak shaving, load shifting, voltage and frequency regulation, renewable capacity firming, and outage management.

As a result of significant investments by the automotive industry in pursuit of rechargeable batteries for the plug in and hybrid vehicles, large format lithium-ion rechargeable batteries are beginning to be commercially deployed by utilities in bulk energy storage, distributed system, residential security, and off-grid and micro-grid system applications. The DES modules include inverters, batteries, switchgear and transformers to connect to low or medium voltage systems, housed in a shippable building. The DES is a serial production product from ABB. The only differences are in capacity and selection of energy storage type. The DES unit is being used by utilities for capacity firming, time of use management, peak shaving, voltage support, frequency regulation, and backup power.

The DES raises the efficiency of village wind diesel system in the following ways:

- Provides a modular tested system for uniformity and efficiency of application.
- Improves power quality on wind-diesel grids to increase wind penetration
- Provides energy storage for extended diesel-off operations
- Provides reliable back-up power
- Reduces/eliminates diesel power house modifications necessary for many other energy storage systems

b. Project Eligibility

1. This project meets the requirements of AS 42.45.375(c), which includes deployment of existing technologies that has not previously been demonstrated in state.

c. **Project Innovation**

Preliminary modeling studies indicate that 15 minutes of rapid rechargeable energy storage in most wind diesel systems, such as the Kwigillingok High Penetration wind system, will enable diesel-off operations up to 30% of the year and the potential for small diesel generator set operation for over half of the year. Fuel savings of 50% are expected and significantly reduced diesel maintenance costs.

There are three primary innovations in this project. These are:

1. The demonstration modular uniform integration and grid support system for simplifying wind-diesel and grid support applications.
2. Adaptation of off the shelf commercial energy storage technology which uses fast-recharge high cycle lithium ion batteries for dynamic and passive wind diesel and diesel battery control modes. This includes diesel off operation. Four Samsung/Bosch LiB lithium ion vehicle battery modules will enable over 2500 hours of annual diesel off operation in the Kwigillingok wind diesel system.
3. The project will evaluate the control, efficiency and cycling performance of advanced inverters and vehicle format advance lithium ion batteries to achieve high fuel displacements and high power quality in wind diesel grids.

It is necessary to adapt wind diesel control and integration methods for use with fast rechargeable energy storage, and to field validate this application. This method of simplified high penetration integration of wind offers the greatest potential for broad application across rural communities. The project will evaluate the cost and performance characteristics of the energy storage system, as well as determine effective operating strategies and optimal energy storage requirements. Estimated, potential and actual fuel savings will be measured. Field validation is required to understand the value of energy storage, in various modes of operation, including frequency and voltage control, peak shaving, load following and grid stabilization. This demonstration is required to understand system capacity requirements, validate cycle efficiency, determine appropriate sizing, and assess the durability of vehicle format lithium ion batteries and this solution for expanded grid stabilization applications. The fuel savings resulting from the ability to store excess wind power when it is available and deliver to the load as needed, as well as the value of diesel off operation, expanded use of smaller generator sets and the reduction or elimination of diesel spinning reserve requirements are important performance parameters.

It is anticipated that this battery system will not need to be replaced for 10 to 15 years. The use of vehicle battery modules will insure best service, price and support in Alaska. This project will validate performance, and determine the optimal capacity, rating, type, size, efficiency and cycling performance capabilities of lithium ion vehicle type batteries for integrating wind into smart grids to manage and store power.

d. **Priority**

This application meets all four of the stated priority considerations outlined in AS 42.45.375(d) and the Alaska Energy Authority's Request for Applications (RFA sec. 4.3):

- **Alaska residents, associations, organizations, or institutions** – This project will benefit rural communities where power costs are high, such as the community of Kwigillingok. This project is supported by a number of Alaskan, businesses, Intelligent Energy Systems, Llc, Sakata Engineering, and Energy Efficiency Evaluations. These are three Alaskan businesses engaged in the renewable energy sector.
- **Partnership with the University of Alaska** – IES has been working with the University of Alaska Anchorage (UAA), Institute of Social and Economic Research (ISER) to model the economic value of wind diesel systems and determine optimal economically and financially viable operational models. ISER will study the value of energy storage in this application.
- **Projects supported by matching funds or in-kind partnerships** – IES commits to support this project with $30,000 in in-kind services.
- **Projects with potential for widespread deployment in the state** – This project will provide a uniform highly functional, simple to deploy, and cost effective method of increasing wind penetration and improving diesel efficiency for any isolated grid or substation.

2. Technology Validation and Research Methodology

Validation of the application of the ABB/DES using plug in vehicle batteries for high penetration wind diesel applications will accomplished by collection of baseline and performance data, compared with design tools. Performance measures will include: System configuration reports, documentation, system specifications. Design tool analysis of estimated annual performance, and economic modeling of operating scenarios, related to depth of discharge, cycle life, round trip efficiency, diesel operating hours, fuel displacement and wind power availability. The DES packaged unit will be instrumented and factory tested, prior to shipment. High speed data will be logged to the SCADA master control. Parameters including load, power quality, diesel engine, wind and battery energy storage contributions and state of charge will be monitored, logged and reported. Fuel usage will be logged on a daily basis with logging through engine generator controllers. UAA, Institute of Social and Economic Research and Dennis Witmer will provide third party independent performance evaluation and design tool validation.

3. Summary of Project Schedule and Summary of Project Budget

a. **Project Schedule:**

- Phase I (Pre-Deployment Activities): Performance objectives and final design August/Dec 2012
- Phase II : Order placement and fabrication: October/Dec 2012
- Phase III. Factory acceptance testing, April 2013
- Phase IV: (Deployment) Installation, integration and commissioning in Kwigillingok. Summer 2013
- Phase V: Testing and evaluation: October 2013-October 2014, yearly test reports years 1 through 3.

b. **Project Budget:** The projected budget allocated by expenditure type is listed below:

Hardware/equipment/software	$645,750
Contractual Services	$410,000
Total Project Cost	$ 1,055,750

4. Project Team Qualifications

The Project Manager will be Dennis Meiners, CEO of Anchorage-based Intelligent Energy Systems (IES), assisted at the village level by William Igkurak, General Manager of Kwigillingok Power Co. IES has been responsible for the design and deployment of three high penetration wind diesel systems for the Chaninik Wind Group. Albert Sakata, is the Chief Electrical Engineer and Electrical Administrator and Chief Mechanical Engineer will be Carl Brothers of Frontier Power Systems; both Mr. Sakata and Mr. Brothers have specialized in energy technology for 30 years. System analysis will be conducted by Dennis Witmer, Ginny Fay (ISER), and Tobias Schwörer (ISER). ABB team members are Project Manager Patrick Hayes, Application Engineer Gary Morris, and Alaska Representative Chuck Huntley. Ben May, Project Manager for IES, will be coordinating installation. Dennis Witmer, PhD, (EEE) has been involved in the evaluation of energy technologies, including utility battery energy storage systems for the last 10 years, and will evaluate technical and commercial viability. Local on site operators for the Kwigillingok Power Company include: Sam Atti, and John Paul. The utility manager is William Igkurak.

5. Discussion of Commercialization of Funded Technology

a. **Potential Market:** ABB has more than 100 years of power expertise and specializes in the highest quality power electronics and energy storage solutions. This is a broadly applicable energy storage solution, which can be used in a variety of roles both on grid and off-grid applications. The most attractive feature for rural communities is minimizing the requirements for onsite construction and virtual elimination of the need to modify the existing diesel power system. These two features represent significant cost saving in installation, outages and commissioning. The amount of fuel and cost savings will vary according to application, but the diesel battery application will extend the life of an existing diesel plant, and increase diesel efficiency by reducing spinning reserve and paralleling diesel requirements. This is a product with worldwide applications.

b. **Potential Public Benefit:** The initial beneficiaries of this technology will be the residents of Kwigillingok, who will experience fuel savings and reduce diesel plant maintenance. The Kwigillingok project benefits from world-wide investments in advanced IGBT inverters and advanced lithium ion battery technologies.

This project will assess the range of applications and demonstrate the substantial potential improvements offered by the new inverter and lithium ion technology for energy density, high performance, battery life and cost. This project will eliminate risk with respect to usage and spur demand for the technology. Suppliers indicate that as demand for these products grows and production volumes increase, the suppliers anticipate cost reductions in the range of 25-30%, accompanied by continuing quality and performance improvements.

The value of Emerging Energy Technology Fund investments should be measured not only by their conventional economic value, but also by how these investments address the longstanding technical, geographical, and societal impediments presented by Alaska's small population, distance from markets, and project remoteness. These impediments make it difficult to get the attention of leading companies. ABB and Samsung are both strong suppliers that can bring considerable resources to solving rural energy problems. ABB is in a unique position with their able to partner with many battery suppliers to insure the proper battery cell technology for the application.

This project provides public benefits on multiple levels:

- adapting power electronics solutions to rural Alaska energy problems,
- leveraging relationships with strong stable manufacturers such as ABB and automobile battery manufacturers to adapt off-the-shelf products to rural Alaska needs,
- demonstrating the value of high penetration wind-diesel systems for rural Alaska, and
- reducing the risk of future investments in battery storage systems.

Encouraging partnerships with strong businesses will provide Alaskans with ongoing access to a stream of more efficient, more competitive and higher quality products to address our energy challenges.

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

_____Dennis Meiners, Intelligent Energy Systems, LLC

Proof of Eligibility: Intelligent Energy Systems, LLC meets the eligibility requirement as a business holding an Alaska business license. Please see Attachment 1 (Alaska Business License – Intelligent Energy Systems, LLC).