Alaska Energy Authority
Emerging Energy Technology Fund Application
September 5, 2013

Proposal Title: Improvements to 100 kW Wind Turbine for Village Power

Applicant
Contact Information: Intelligent Energy Systems, LLC
110 West 15th Ave
Anchorage, AK 99501
(907)770-6367
dennis@iesconnect.net
ona@iesconnect.net

Project Partners: Frontier Power Systems
Scientia Energy
James Tangler
Carl Andrew, TCSA Electrical Services
Albert Sakata, P.E., Sakata Engineering Services

Total Project Cost: $600,000

Grant Funds Requested	$580,000
Matching Funds	$20,000

Previous Grants: None

Previous Abstracts: None

1. Project Summary

a. Project Description

This project improves the already attractive economics of remanufactured wind turbines for the village power market. Thousands of proven wind turbines that have been operating in California for more than two decades will be available for remanufacturing over the next few years. Currently, over 25 remanufactured machines are operating successfully in wind diesel systems in Alaska.

With proper retrofitting, a number of key technological enhancements will convert these workhorses into state of the art, cost-effective 50 to 120 kW wind turbine platforms that can fill many markets. This project will improve the economics of village wind energy by increasing energy productivity per cost of installed capacity by 30% or more. The long-term objective of this project is to bring incremental improvements to proven turbine designs which will result in a new, lower cost, more reliable and more competitive wind turbine for village power systems in Alaska and around the world.

One of the key deficiencies of older turbines lies in the obsolete rotor design. Wind turbine airfoil aerodynamics has improved dramatically over the last 25 years, and funds are being requested to apply new, more efficient rotor designs to the 100 kW Danish wind turbine platform. These improvements will not only lead to significant economic improvements of village energy systems, but also expand the opportunities for low wind sites. This project is has a technology readiness level of 8 to 9.

b. Project Innovation

The development of special-purpose airfoils for horizontal-axis wind turbines (HAWTs) began in 1984 as a joint effort between the National Renewable Energy Laboratory (NREL), formerly the Solar Energy Research Institute (SERI), and Airfoils, Incorporated. These new airfoils exhibit improved lift coefficients (cl,max) and insensitivity to roughness effects. Families of airfoils were designed to provide better energy capture and peak-power control but were never commercially applied to the 100 kW Danish stall regulated machines. Annual energy capacity improvements from the NREL airfoil families over original blade sets are estimated to be between 23-35%. This level of performance improvement has been verified through field testing on larger turbines. This project proposes to test both the 8.2 meter rotor and 10.5 meter advanced airfoil design. The 8.2 meter blade is available, the 10.5 meter blade must undergo a manufacturing review prior to stretching of the 8.2 meter blade mould for fabrication.

The new rotor design will incorporate advanced low solidity airfoils that operate at higher tip speeds (nominally 70 m/s) with adequate structural capacity to operate in IEC Class 2 and Class 3 sites. It is anticipated that the blades will be fabricated as a tip extension design from existing 8.2 meter blade moulds and allow the blade to be fabricated in 10.5 meter and 11.5 meter blade lengths resulting in rotor diameters of 21.5 meters and 23.5 meters. Rotor power loadings of 275 W/m^2 and 230 W/m^2, suitable for service in lower wind environments common in many Alaskan villages are expected.

The project innovation is the application of new more efficient airfoil designs to proven wind turbine designs will create a more productive and cost effective wind turbine for off grid communities.

c. Project Site and Demonstration Environment

This project will involve side by side rotor tests on installed Windmatic 17s turbines in Tuntutuliak. The Tunt test bed has five 95 kW turbines installed. Two machines will be used as reference turbines and three machines will be used for testing purposes. Test machines will be equipped with the new 8.2 and 10.5 meter SERI advanced airfoils and performance verification testing will be conducted against reference turbines. A reference anemometer will be erected at the test site. Depending on wind class, the new rotors are expected to increase energy production by between 20 and 30% at this site. The 8.2 meter blade set is expected to increase annual energy production by 10-15%. The 10.5 meter blade set is expected to increase annual energy production by 25-35%.

TCSA already has the requisite infrastructure and trained wind technicians to accomplish the project goals and objectives. An uptower service crane will be fabricated so that local technicians can to raise and lower turbine rotors and replace blade sets without the use of a crane.

d. Priority

This application meets three of the stated priority considerations listed in AS 42.45.375(d) and the Alaska Energy Authority's Request for Application (RFA sec. 1.6).

1. This project is developed by Alaska residents and will serve many Alaskan community by increasing the productivity and economics of village wind systems.
2. This project is supported by matching funds and in-kind partnerships are committed by a number of companies.
3. This project has widespread potential to make wind energy more affordable, and create local business opportunities, promotes, improves, and expands the diversity of available energy supply.

2. Technology Validation and Data Collection

a. Objectives

The principals of IES and their partner, Frontier Power Systems, have been active in wind diesel system R&D for over 20 years. The principal of Scientia Energy has been active in operating Danish Wind Turbines in California since 1984. This project has engaged the leading blade design engineer as its project partner. IES will oversee the testing of the new airfoils, and the extension of the 8.2 meter airfoil to the 10.5 to 11 meter range.

Advanced blade designs are well understood. The advanced blade development program will be directed by James Tangler. Mr. Tangler was the lead NREL engineer who developed the advanced thin airfoil. Mr. Tangler will design the testing protocols, inspect the blades and their installation, as well as oversee the detailed aerodynamic design of the longer airfoils and their fabrication.

The technology for the 10.5 meter blade length is not currently commercially available, and will require the extension of the 8.2 meter mould to build the longer airfoil.

b. Data Collection

Data will be collected via existing supervisory control and data acquisition system in Tuntutuliak. Limited additional instrumentation and upgrades to the onsite data collection engine and analytical database will be required.

3. Project Schedule and Budget

Improvements to 100 kW wind turbine for village power systems					
Task	Task Description	Schedule	Projected Task Cost	Match	Grant Request
New Rotor design and testing					
1A	Install reference anemometry and data collection engine	May 14 – July 14	$40,000		$40,000
1A1	Procure and install improved 8.2 meter blade set and hub extension	Mar 13 – Jul 13	$55,000	$10,000	$45,000
1A2	Uptower service crane	Aug'13-Oct'13	$75,000		$75,000
1B	Advanced rotor aerodynamic and structural design	Jan'13 – Jun'13	$85,000	$5,000	$80,000
1B1	Advanced rotor blade fabrication and procurement	Mar'13 – Sep'13	$205,000	$5,000	$200,000
1C	Advanced airfoil field testing, project management and reporting	July'14 – Dec'15	$140,000		$140,000
		Task Total	$600,000	$20,000	$580,000

4. Project Team Qualifications

The lead investigator on this project will be Dennis Meiners, of IES, with the assistance of James Tangler, the lead engineer who supervised the development of the SERI thin airfoil while with SERI. Mr. Tangler, will be assisted by Peter Banner of Scientia Energy, Inc., and Carl Brothers of Frontier Power Systems. Each of these project partners have over 20 years experience in wind or wind diesel systems.

The project manager will be Patrick Boonstra of IES, who will be assisted at the village level by Carl Andrew, General Manager of TCSA Electrical Services, as well as the local wind technicians. The Chief Electrical Engineer will be Albert Sakata of Anchorage based Sakata Engineering.

5. Discussion of Commercialization of Funded Technology

Over the next 10 years, hundreds of these ruggedly built Windmatic 17s turbines will be retired. These machines will be available for remanufacture and redeployment. Improved blade sets will increase the energy production of these machines in Alaska and elsewhere. It is possible that these blades could be built in Alaska and many hundreds of sets sold around the world. There are currently 19 remanufactured machines operating in wind diesel systems in Alaska, that could benefit from these blades.

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
Prinicipal, Intelligent Energy System, LLC