# Denali Commission
# Emerging Energy Technology Grant

*Final Project Descriptions*

## Alaska Sealife Center

*Seawater Heat Pump Demonstration Project*

The Alaska SeaLife Center proposes to employ a heat pump system that will "lift" latent heat from raw seawater at temperatures ranging from 35F to 55F, and transfer this heat energy into building heat at a temperature of 120F.

Seawater heat pumps are water-to-water heat pumps that operate by using electric compressors in combination with the physical properties of an evaporating and condensing fluid known as a refrigerant. The specific heat pump equipment required for this process is not an "off the shelf" or conventional heat pump; it must use a wider heat range to tap into colder temperatures. While conventional heat pumps are typically lifting heat from 45-55F water sources, seawater heat pumps are lifting heat from much lower temperatures, requiring more innovative compressor technology.

While this technology has been successfully deployed in Europe, this innovative process of removing latent heat from seawater and using it to heat buildings is an emerging technology in Alaska; there are no installations of this kind in the state.

## Cordova Electric Cooperative

*Psychrophiles for Generating Heating Gas*

This research and application project will deploy the use of psychrophiles (cold loving microbes) to improve efficiency in biogas digestors for generating cooking and heating gas for Alaskan households.

Biogas digestor technology is proven and in wide-spread implementation in India and China, with emerging efforts in Africa, California, and Europe. The technology is based on the biological production of methane by archeal microbes, namely methanogens, which naturally break down organic feedstock to produce methane. In Alaska, deployment of cold-region digestors can be used as a local, sustainable, alternative energy source for home cooking and heating.

Temperature range is a major restricting factor for most existing biogas digestors. Digestor microbial communities consist primarily of mesophilic, or warm-loving (15 to >80 C), bacteria, which typically shut down in colder winter months. This requires that the digestor be stored indoors, heated, or retired in the cold season. Researched will be the use of naturally-occurring, cold-loving (psychrophilic) methanogens ubiquitous in Alaskan lake bottom sediments.

## Kotzebue Electric Association

### *Feasibility of Solar Hot Water Systems*

KEA's goal for this project is to assess the feasibility of solar thermal hot water heating systems integrated into elder housing in the NANA region. Solar thermal systems are not a new technology. Using solar power to actively supplement other methods of water and space heating has many benefits. However, northern Alaska has not seen many installations for a variety of reasons, mostly economic. As fossil fuels continue to rise in price the benefit of solar thermal systems increase; modeling done on solar thermal systems, using RetScreen and other calculations, show that a payback on investment can be expected in less than 8 years. However, this technology first needs to be demonstrated in order to learn how to stream line off the shelf products for process for Alaska.

## Kotzebue Electric Association

### *Flow Battery Energy Storage Systems*

KEA's goal for this project is to analyze and demonstrate flow battery systems and their potential for energy storage in rural wind systems.

Energy storage can be considered a critical area of energy research, as storage remains one of the fundamental barriers to the feasible deployment of most renewable energy technology and the integration of multiple energy resources into energy generation. Large scale batteries for wind diesel systems that could provide village utility grid stabilization and load shifting are currently being developed by several suppliers. If these batteries become commercial products at the price points currently being anticipated, they could provide significant diesel fuel savings in communities with wind resources.

A battery is an electromechanical method of storing energy, meaning that energy is stored by chemical changes in a system, often between a metal and an oxidized state of that metal (which is why lead acid batteries have lead plates). Flow batteries use materials with multiple valence states so that electrons can be stored in an electrolyte solution which contains several ionic species. Since battery degradation often involves undesirable stray reactions that occur at the metal-electrolyte interface, these systems avoid those degradation mechanisms, and are projected to have very long lifetimes.

## Kotzebue Electric Association

### *Wales Diesel-Off High Penetration Wind System*

Kotzebue Electric Association's overall goal for this project is to demonstrate diesel-off configuration for a remote wind-diesel high penetration hybrid power system through the retrofit of existing equipment and controls.

A classification system is used when discussing the amount of wind that is being integrated onto the grid system. A system is considered to be a high penetration system when the amount of

wind produced at any time versus the total amount of energy produced is over 100%. Low penetration systems are those with less than 50% peak instantaneous penetration and medium penetration systems have between 50%-100% of their energy being produced from wind at any one time. Low and medium penetration systems are a mature technology. High penetration systems, however, still have many problems, especially when installed with that capacity to operate in a diesel-off mode.

The scope of work will for this project will include upgrading the controls and monitoring of the Wales system, as well as restoring the two Entegrity turbines. The Wales Wind-Diesel Hybrid Power System was intended to demonstrate the feasibility of retrofitting a village power plant with a high penetration wind-diesel system which allows the community to realize large reduction in diesel consumption. It is one of very few systems in the world which can operate with the diesels off for extended periods of time. The system needs to be upgraded so that research can continue.

## Ocean Renewable Power Corporation

### *Nenana Hydrokinetic Turbine*

ORPC proposes to build, install and test the RivGen™ Power System, a hydrokinetic energy unit, at the Nenana hydrokinetic test bed and analyze resource and technology results.

Hydrokinetic devices are powered by moving water, placed directly in a river, ocean or tidal current. They generate power only from the kinetic energy of moving water. Alaska has significant potential for hydrokinetic development in both rivers and tidal basins. Most inland communities in Alaska are situated along navigable waterways that could host hydrokinetic installations.

The RivGen™ Power System is a compact, standardize, stand-alone power generation system, consisting of two proprietary advanced design cross flow turbines directly connected to a proprietary underwater permanent magnet generator between them, all mounted to a structural support frame. This project will seek to collect data on many vital questions for all hydrokinetic projects, including environmental interaction, performance and efficiency, deployment challenges, support design, debris avoidance, and economics.

## Sealaska Corporation

### *Commercial Scale Wood Pellet Fired Boiler*

This project will convert Sealaska's corporate headquarters building from a diesel fired boiler to a wood pellet fired boiler. The overall goal of this project is to demonstrate that wood heat can be cost effective and feasible for larger commercial, industrial, and municipal buildings, and has the potential to affect demand for Southeast Alaska second growth wood fiber.

The proposed boil uses wood pellets as its heat source. Wood pellet fired heat systems do not have problems with combustion like other wood fired systems as pellets are dependable heat

sources that conform to industry standards of moisture content and size. To date there are not any large buildings within Alaska that use wood pellets as a heat source, and there are limited local markets and supply chains. Besides reducing fuel costs, the successful demonstration of a commercial scale application could greatly advance the development of a local market.

## Tanana Chiefs Conference

### *Organic Rankine Cycle Heat Recovery System*

Tanana Chiefs Conference's goal for this project is to demonstrate the potential improved fuel efficiency of the diesel power plant in a village in the TCC region through the use of an Organic Rankine Cycle (ORC) system for heat recovery from engine jacket water and exhaust.

An ORC power system employs the same principles as a steam Rankine cycle system. The difference between these two systems is the working fluid that is used in each (organic fluid in the case of ORC). ORC systems have been installed all over the world and applied to a variety of heat sources, such as geothermal energy, water energy of stripper wells, solar energy, and biomass energy. Existing ORC systems are usually industrial in scale, however, with ORC technology for mid-sized engines still in the R&D developments stages.

The proposal includes selection of an ORC unit and installation on a mid-sized, village diesel generator. A successful ORC application may result in a 10-15% reduction in fuel consumption for diesel power generation. Taking into account the high cost of fuel in rural Alaska, a system that improves the efficiency of village power plants represents a potentially economically viable option.

## University of Alaska Fairbanks, WiDAC

### *High Penetration Hybrid Power System*

The Wind Diesel Application Center will analyze state of the art power electronics to assess options for wind-diesel hybrid power systems to operate in a diesel-off mode.

Diesel-off hybrid power systems represent the next generation wind-diesel systems. In traditional systems, the diesel gen-set regulates both the voltage and frequency of the grid. In order to maximize fuel savings the diesels need to shut off when other renewable resources are available, but to do so the power electronics must be advanced enough to meet the needs of the grid.

To supply the required power quality without using diesel, other equipment is needed to provide volt-amperes reactive (VAR) support, such as a switchable capacitor bank, static converter or synchronous condenser. The system total reactive powers needs are balanced al all times with these devices to maintain voltage stability. This function can also be accomplished though power electronics such as inverters, which in fact could be the inverters already in use in modern wind turbines. The concept of using the inverter system built into the wind turbines themselves to provide voltage and VAR stability is the main thrust of this project.

# Emerging Energy Technology Program

*Project Descriptions*

## Polarconsult

### *High Voltage Direct Current Transmission*

The HVDC project's goal is to assess and demonstrate the technical and financial feasibility of low-cost small-scale HVDC interties for rural Alaska. The objective is to demonstrate that small-scale HVDC interties are technically viable and can achieve significant cost savings compared to the three-phase AC interties proposed between Alaskan villages. Because these AC interties are very costly to construct and maintain, very few have been built in Alaska. As a result, most villages remain electrically isolated from one another, which duplicates energy infrastructure and thereby contributes to the very high cost of electricity in most villages.

## Alaska Power Company

### *Yukon Hydrokinetic Project*

Alaska Power Company's goal for this project is the development and assessment of a hydrokinetic project in the Yukon River, near Eagle, Alaska. Originally, APC was working with UEK, a hydrokinetic turbine manufacturer, to develop site-appropriate technology. Recently APC has contracted with ABS Alaskan, Inc. who will, in a joint venture with New Energy Corp., provide the turbine equipment for the project. The New Energy Corp. technology is similar to the technology deployed at Ruby in 2008, but with a larger generation capacity. Due to the large potential and interest in hydrokinetic technology in Alaska, this project will seek to collect data on many vital questions for all hydrokinetic projects, including environmental interaction, performance and efficiency, deployment challenges, support design, debris avoidance, and economics.