"BRI Cyclo-Turbine™ for Energy Production"

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No Partners

Total Project Cost:	**$944,131**
Grant Funds Requested:	**$769,428**
Match Committed:	**$174,703**

No Previous Grants

Previous Project Title *"BRI Cyclo-Turbine™ Pilot Plant Demonstration"*
Abstract submitted in March 2011

BRI CYCLO-TURBINE™ FOR ENERGY PRODUCTION

GRANT APPLICATION ABSTRACT

Emerging Energy Technology Fund Grant Program

1. Project Summary – a. Project Description: Boschma Research, Inc. (BRI), and its team members including UAF, Clark-Wiltz Mining are pleased to have this opportunity to demonstrate the technical capabilities and commercial potential of the BRI Cyclo-Turbine™, a submerged river-in-stream energy-conversion (RISEC) system well suited for Alaskan rivers and streams. This 22-month, 3-Segment project includes pre-deployment movement of three Cyclo-Turbine generators to Alaska to conduct technology demonstrations at three diverse sites.

Segment 1 will be conducted at the well-characterized AHERC site on the Tanana River. The AHERC, Site 1, provides an abrasive, debris rich, fast-water environment typical of mid to large rivers in the state. Although all features of our 1.5kW system will be evaluated here, of special significance is the opportunity to fully test our new active debris guard and high molecular weight erosion resistant turbine blades.

Segment 2 will be conducted at a well-characterized site on the Kvichak River at Igiugig, Site 2. For this site, key features of our 5kW system, suspended from flotation gear, will be assessed - including energy extraction, fish safety, reliability, maintainability, Venturi functions, system handling and possibly under ice ops.

Segment 3 will entail operation of our 10kW system while bottom-mounted in a modest velocity, shallow creek at the Ganes Creek Mine near Takotna, Site 3. Clark-Wiltz Mining will operate the 10kW system throughout the 2013 and 2014 mining seasons. The goal is to demonstrate the technical and economic viability of the BRI system in continuous operations in a variable depth Creek (0.8 to 1.5m). This will validate BRI Cyclo-Turbine™ as a power production source for a wide range of Alaska's businesses, mining, oil and gas exploration, as well as other remote commercial and private venues. Comprehensive teardowns, power output, and O&M data will be analyzed. In the post-demonstration period, Clark-Wiltz may seek permits to continue power production utilizing the BRI Cyclo-Turbine™.

b. Project Eligibility: BRI plans to test an emerging energy technology.

c. Project Innovation: Four unique features make the BRI Cyclo-Turbine™ systems efficient and well suited for operations in Alaska: 1) Turbine blade angle of attack (AoA) changes during turbine rotation (Figure 1) to optimize lift and minimize drag, thus obtaining higher extraction efficiency than competing systems; 2) A Venturi flow accelerator increases available kinetic energy at the turbine resulting in substantially more energy extraction than possible without acceleration; 3) The above features facilitate small, compact systems able to extract substantial energy from shallow, slow moving waters; and 4) Simplicity of turbine, and installation by use of anchored cables, minimizes infrastructure, improves reliability, decreases costs, and facilitates integrated fish and debris guards to protect the submerged turbine, fish, mammals, and the curious.

Turbine blades are evenly spaced on a disk rotating about an axis that is normal to the direction of the flow. The AoA of the individual blades to the tangent of the orbit is varied resulting in lift and drag forces that are perpendicular and parallel to the flow, respectively. In Figure 1 the maximum AoA is shown at 90° and 270°, while Figure 2 shows power production locations and the impact of downstream turbulence on the blade at 270°. Nonetheless, the sum of forces results in high efficiency (~47%), well above fixed-pitch RISEC turbines.

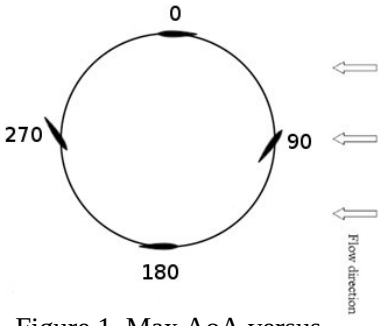


Figure 1. Max AoA versus Azimuth on Orbit

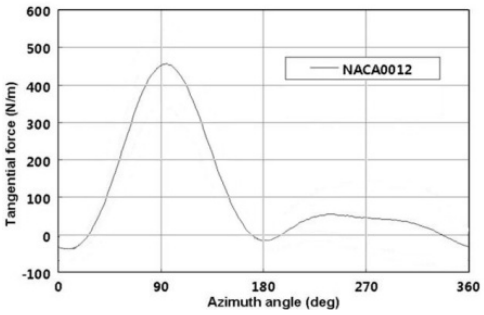


Figure 2. Tangential Forces versus Azimuth Angle

The turbine is installed in a Venturi (Figure 3) to take advantage of kinetic energy increase with the square of flow velocity ($E_k = ½ \rho_w V^2$). The 4-sided Venturi incorporates debris and fish guards and is supported to reduce silt transfer. Turbine energy is

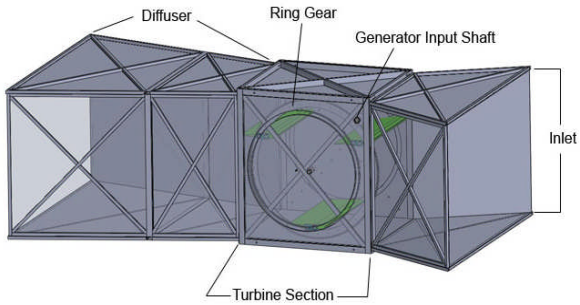


Figure 3. System Overview
(Turbine fits at Ring Gear)

transferred via drive shaft to a PM (permanent magnet) generator, then by marine conductor cable to an appropriate controller and grid tie inverter. The system life is projected to be 20 years or longer. Systems can be configured in multi-turbine arrays connected electrically or mechanically.

d. Priority: BRI has teamed with the University of Alaska-Fairbanks and on this project. This project will be supported by matching contributions from Igiugig and Ganes Creek, and has strong potential for widespread successful deployment in Alaska.

2. Technology Validation and Research Methodology – a) Objectives: 1) Demonstrate the systems energy extraction capability and system suitability for operations while suspended from floatation, bottom-mounted in deep and shallow Arctic river environments, and in under-ice operations; 2) Determine the maintainability, reliability, and operating costs of the installed system; 3) Evaluate the operational procedures and assess their compatibility with the Alaskan user; 4) Develop a detailed economic analysis based on deployment costs, operational and maintenance costs to include downtime "output lost" value, and projected system purchase price.

b) Methodology: The program will be accomplished at three sites: Site 1 - a 1.5kW system suspended from floatation in the Tanana River at Nenana; Site 2 - a 5kW system in the Kvichak River at Igiugig initially suspended from floatation, but later bottom mounted for under ice operations; and Site 3 - Ganes Creek to demonstrate the feasibility of a bottom-mounted 10kW generator operating at a remote, shallow-water site. We will install instrumentation on each system to collect appropriate data. At each site, stream flow velocity, power produced, debris stoppages, maintenance activities, downtime, material costs and any fish kills will be recorded and used in analysis of the system. UAF will participate in the instrumentation, data collection and analysis.

Project Location and Testing Environment: Location. The three segments of the program will be conducted sequentially: Segment 1 at the AHERC site in the fall of 2012; Segment 2 on the Kvichak River at Igiugig extending from May to November 2013; and Segment 3, at Ganes Creek extending from June to September 2013 and 2014. This schedule allows for demonstrations of bottom-mounted and suspended turbines, in shallow water, deep water, in high erosion and debris-heavy conditions and under ice. These sites offer diverse environments and are representative of many likely deployment sites in Alaska.

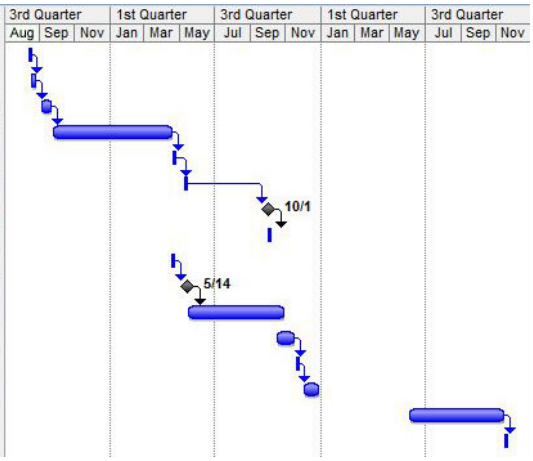
Technical Resources: Segment 1, Site 1, at Nenana was established specifically for the purpose of evaluating systems such as the cyclo-turbine and is close to Fairbanks, UAF, and mechanical and electrical resources needed. Segment 2, Site 2, at Igiugig is served by a 3,000 foot lighted runway with RNAV instrument approaches and barge service from Anchorage for shipping of materials to the site. Limited operator level mechanical maintenance support is available in Igiugig, any higher level maintenance may be accomplished at King Salmon, 48 air miles southwest. Flights to Anchorage are available daily. Spare components and tools will be shipped to Igiugig with the turbine systems. The system will moor to anchors in sites of known flow characteristics of favorable velocity, and within reasonable distance to the Igiugig Power House, where we intend to place the power conditioners. We believe that the site will easily support our technical needs. The community will provide equipment to extract the turbine when needed for inspection, maintenance, ice issues, etc. Igiugig Village Council has submitted applications to the AF&G for a "Fish Habitat Permit" and a "Fish Resource Permits" and to the Department of Natural Resources for a Land Use Permit. BRI and Igiugig will engage the highly qualified LGL Alaska Associates to perform the fish monitoring.

Segment 3, Site 3, at Ganes Creek is a remote location that can be reached by vehicle from Takotna on a 20-mile gravel road. A 5,000 foot private gravel airstrip is located at the mine, and it can accept relatively large cargo aircraft, i.e., a C-130 or DC-4. The mine is self sustaining with metal working, welding, and machining capability. There is an array of heavy lift and earth moving equipment available for system installation and extraction. McGrath is approximately 25 air miles away and offers limited additional technical support. Power at the site is diesel electric on a mine distribution grid. Lodging and meals for our R&D crew will be provided onsite by Clark-Wiltz Mining. BRI will provide a fully instrumented 10kW system. Insufficient data exists at Ganes Creek to make valid stream capacity estimates. Thus, we anticipate stream levels varying with rain and

snow melt on a frequent basis. This will result in variable production output; however, it is typical of many remote mining sites around the state. Necessary permits have been issued or renewal requested for operations at Ganes Creek. This site is on private property controlled by Clark-Wiltz Mining Company. Access is provided to research team members in accordance with BRI/Clark-Wiltz agreement. Clark-Wiltz will control the site throughout Segment 3 and ensure access to AEA and team members, and continue operations through 2014. All permits for Segment 3, Ganes Creek, has been previously issued and will be renewed with requests for extensions now being submitted.

3. Summary of Project Schedule and Summary of Project Budget: Schedule – 22 months

	Task Name	Duration	Start	Finish
1	Kickoff Fairbanks	1 day?	Wed 8/15/12	Wed 8/15/12
2	Site Surveys	7 days?	Thu 8/16/12	Fri 8/24/12
3	1.5kw Demo ACEP	14 days?	Tue 9/4/12	Fri 9/21/12
4	Systems Prep for 2013 Season	148 days?	Mon 9/24/12	Wed 4/17/13
5	Ganes System to Fairbanks	1 day	Sat 4/20/13	Sat 4/20/13
6	Ganes System to Mine Site	1 day?	Fri 5/10/13	Fri 5/10/13
7	Assemble/ Install/ Initiate	87 days?	Mon 6/3/13	Tue 10/1/13
8	Teardown/ Inspect	1 day?	Wed 10/2/13	Wed 10/2/13
9	Igiugig- System Arrive	1 day?	Thu 4/18/13	Thu 4/18/13
10	Install/ Initiate	2 wks	Wed 5/1/13	Tue 5/14/13
11	Operations	120 days	Wed 5/15/13	Tue 10/29/13
12	Under Ice operations	24 days?	Tue 10/15/13	Fri 11/15/13
13	Teardown/ Examine	1 day?	Wed 11/20/13	Wed 11/20/13
14	Report 1	1 mon	Mon 12/2/13	Fri 12/27/13
15	2014 Ganes Creek Operation	120 days	Mon 6/2/14	Fri 11/14/14
16	Project ends	1 day?	Mon 11/17/14	Mon 11/17/14



Summary Project Budget:		
	Labor Hours 4,719	$380,440
	Travel	$162,664
	Materials	$104,586
	Subcontractors	$169,575
	ODCs	$126,866
	TOTAL	$944,131
	Match Committed	-$174,703
	GRANT FUND REQUESTED	$769,428

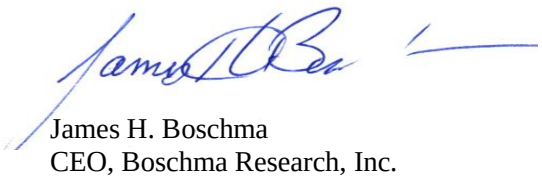
BRI, Clark-Wiltz, and Igiugig Village Council are providing the project match of 18.50% reflected in the Project Budget. 1,068 Labor hours are included as a matching contribution at a loaded rate of $123.26.

4. Project Team Qualifications: Program Manager – LTC(R) James H. Boschma, BRI CEO, has a BS in Aeronautical Sciences; and an MS in Engineering Management from UAF. He is a DOD qualified Program Manager and was Chief, General Equipment Test Division, U.S. Army Cold Region Test Center at Ft. Greely, AK (1979-1981). He is experienced in Arctic test planning, testing, data collection/analysis, instrumentation, and in under-ice tests. He is an experienced developer of Cycloidal Turbines and the author of several key Cycloidal Turbine patents. **Data Collection and Analysis Chief – Dr. Rorik Peterson,** Assistant Professor of Mechanical Engineering (UAF), is experienced in wind-diesel power integration/optimization technology, and in energy storage to increase renewable energy penetration in small power grids. Dr. Peterson will provide technical support and data reduction/analysis support during performance validation and commercial demonstration of the Cyclo-Turbine system throughout the projects life. **Electrical System Engineering – Mr. John Webster**, EE with 50 years experience, seven years as Chief Engineer of Chrysler Corporation Electronic Division (Huntsville), Engineering Manager, Electronic Engine Controller developer, served on National Academy of Scientist Panel as

expert on Power Semiconductor technology, Advanced Product Development Manager, and authored four patents. The effort will also be supported at Igiugig by **Alaska Energy & Engineering, Inc. (AE&E)**, an Alaska-owned firm providing design and project management services for rural energy projects. AE&E has built its reputation on the ability to provide practical design solutions and hands-on construction support to effectively meet the challenges of rural Alaska. Their primary field of expertise is electric power generation and distribution, rural fuel storage and handling facilities, and energy systems integration.

5. Discussion of Commercialization of Funded Technology: This project validates a versatile RISEC system that can be deployed on floatation or bottom mounted, is compact and guarded to keep debris and the curious out, and can serve remote villages, individual homes, mines, oil and gas explorations, businesses, commercial lodges, and research stations. Strong market potential includes 141-180 operating placer mines, exploration teams in search of new claims, 227 Native Villages, hundreds of commercial operations, homes and vacation sites around the state. The versatility of this project by demonstrating floatation deployed, bottom mounted, and under ice operating systems, should garner considerable industry attention. The three sites are diverse and representative of a majority of venues common in Alaska. Power production and system operations and maintenance data at these sites will be analyzed and will serve to refine and validate projected economic performance of the Cyclo-Turbine in Alaska operations. System performance measurements in these real-world sites provide operational, as well as economic, data for high-resolution analysis. These data support development of logistics requirements necessary for high utility systems and support development of a thorough life cycle cost assessment. Ultimately, commercialization of this technology will advance as a result of knowledge gained in this program and similar operations in the Arctic environment.

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



James H. Boschma
CEO, Boschma Research, Inc.

Proof of Eligibility: BRI's Alaska Business License and Certificate of Authority are provided.