COVER PAGE

Project Title:

Demonstration of Aqua Flux™, a Distributed Hydrokinetic Generation System, at Olive Creek Mine

Applicant contact information:

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Partners:

- University of Alaska – Fairbanks
- Olive Creek Ventures

Total project cost; Grant funds requested; Match committed:

- Total project cost: $748,788
- Grant funds requested: $559,650
- Match committed: $189,138

Previous project/application title(s) and/or number(s) for grants from the Renewable Energy Fund or Denali Commission Emerging Energy Technology Grant program:

None

Previous Project title(s) for abstracts submitted to the Emerging Energy Technology Fund, if applicable:

None

ABSTRACT

PROJECT SUMMARY

Project Description: Distributed Generation Technologies LLC (DGT) is leading a diverse development team to commercialize an innovative hydrokinetic power generation solution, Aqua Flux™, to provide clean, point-of-use renewable power to meet the energy demands of remote Alaskan communities. DGT's initial goal is to demonstrate technology that economically meets sub-250kWe needs, but which can subsequently be scaled to address larger power needs, including mines, factories, rural communities and/or cities. Along with key partners, like the University of Alaska – Fairbanks (UAF) and Olive Creek Ventures LLC, DGT will initially implement and demonstrate Aqua Flux™ at a remotely located placer gold mining operation with an aggregate energy demand of approximately 100kWe at full operating capacity.

Project Eligibility: As designed, our system has the potential to propel adoption of an emerging technology – hydrokinetic turbines – and to greatly expand the availability of economical, locally produced, hydrokinetic power for our target consumers: remotely located energy users. An important commercialization focus for our company is a large-scale mining project being developed in central Alaska. In addition to the projected energy needs of the mine, the remote location of the find is expected to create an additional energy consumption need in a nearby – yet to be established – community numbering at least 500. The mine, which is currently scheduled to begin producing in five years, offers an opportunity for DGT to leverage existing partnerships to displace a portion of conventional energy sources with clean, on-site hydrokinetic power. While developing partnerships with Alaska's already existing remotely located coastal and interior communities to efficiently capture locally produced hydrokinetic energy is not only a natural strategic hedge against the risk of the mine failing to reach a production stage, but also could provide a pathway to more rapid commercialization. In order to meet our development goals we expect to reach a Technology Readiness Level (TRL) 8 by the end of 2013. During the upcoming months we will leverage the scientific knowledge of our partners to thoroughly analyze key environmental, economic and technical factors. Concurrently, we are testing and refining our system's design, as well as defining the engineering and permitting effort required to demonstrate our system under conditions that align with our evolving commercialization plan.

Project Innovation: The Aqua Flux™ units and financial model are unique and innovative. Rather than concentrating on a centralized power generation system whereby heat and electricity via transmissions losses are wasted, and costly feedstock transportation and cultivation infrastructures are required (e.g., for distributed gasification technologies), a series of Aqua Flux™ units will be located both near where the power is needed and where it is sourced, thus minimizing transmission and installation costs and losses. This reduces costs by reducing the need for extensive power transmission lines, minimizes greenhouse gas (GHG) footprints from now, reduced installation footprints, and eliminates the need for dedicated energy production crops/feedstocks required by distributed gasification solutions that would pose the only real competition to the Aqua Flux™ for such remote sustainable power needs in the northern hemisphere. Furthermore, Aqua Flux™ units are readily deployable, have a minimal environment impact on waterways, are visually non obtrusive (they lie submersed below the water line), and produce more than double the energy density of competing hydrokinetic solutions, such as C2, C3 hydro turbines (www.hydrovolts.com), and the Lucid Power Pipe™(www.lucidenergy.com), in a highly scalable footprint. DGT's technology is based on established, but more optimized and efficient gas turbine technologies with substantially less aerodynamic losses than similar product offerings. In addition to optimizing traditional components, such as power electronics, DGT introduces a completely novel engineering

element. The heart lies in the power density improvement by systematic optimization and adaption of traditional *multi-stage*, gas turbine, axial flow turbine technologies as applied to the higher density fluid (water) versus the traditional fluids of turbines (combustion products). Furthermore, the disruptive design takes further advantage of the expansion (static pressure loss) along the accelerating water's path as it enters the turbine section by combining this pressure effect (suction) with an external, air driven turbine in a surrogate, "combined cycle" fashion. The net result is an easily deployable, scalable and clean point-of-use power generation solution that has no GHG footprint and/or environmentally unfriendly byproducts.

Priority: DGT's proposed demonstration project meets each prioritization criterion: Distributed Generation Technologies LLC is an Alaska and Tribal owned, domestic LLC with a primary business office in Fairbanks, and is formed with an Alaska resident as a member. From a partnership perspective, DGT is partnering with UAF's Alaska Hydrokinetic Energy Research Center (AHERC) in order to leverage their breadth of hydrodynamic and environmental scientific knowledge. Additionally, DGT's project is supported by in-kind contributions that equal more than 25% of the total cost of the project. Finally, most inland communities in Alaska are located along waterways that could host hydrokinetic installations. Some estimates put Alaska's river energy resource potential at about 40% of the U.S. total. Alaska, with 90% of the total U.S. tidal energy resource, has some of the best tidal energy resources in the world. In short, Aqua Flux™ units hold the potential for widespread deployment throughout Alaska.

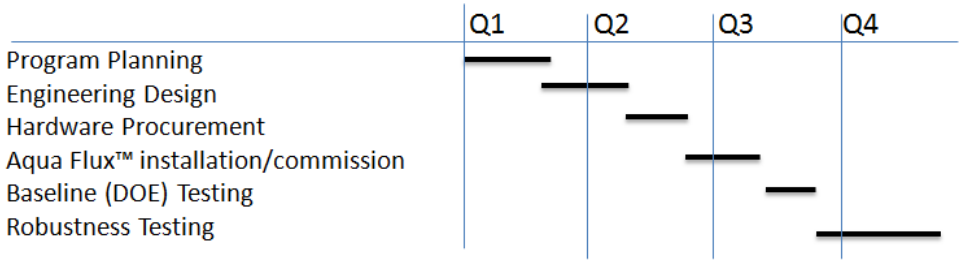
TECHNOLOGY VALIDATION AND RESEARCH METHODOLOGY

Objectives: The goals of the program are as follows: (1) design, develop and deploy a distributed, commercial scale (~100kWe), Aqua Flux™ turbine to generate clean, point-of-use electrical power for the placer mine host test-site at Livengood, AK; (2) demonstrate the technical viability of the unit through a rigorous experimentation data gathering phase, corroborated by a companion analytic performance model; (3) predict the economic viability of a distributed network of units applied initially to meet the energy needs of a rural community; (4) confirm the versatility of the device regarding location and scalability; and, (5) quantify and confirm the technology's positive impact on sustainability and the environment through development of a techno-economic model that incorporates all measureable effects including environmental, social and economic implications.

Methodology: The above goals will be achieved through (1) deployment of a heavily instrumented Aqua Flux™ turbine system (generator module and associated power electronics) directly in the nearby Tolovana River and connected to the host-site's loads (electric pumps, system heaters, pneumatic devices and general site lighting); (2) generation of the two aforementioned models that will be continuously calibrated/tuned with the recorded performance data; and, (3) execution of a series of locally and remotely monitored tests at the host-site. Specifically, the turbo-machinery components of the power generating module (similar to an axial turbine stage) will be outfitted with a combination of static pressure and temperature transducers, and flow meters (for turbine inlet water velocity measurements). The accompanying power module (comprising the AC generator and inverter) will be equally instrumented, but for overall electric performance and power measurements. Two distinct test series are envisioned: a systematic "Design of Experiments" (DoE) approach, and a protracted robustness/endurance test series. The DoE tests – a systematic matrix of controlled tests – will quantify system performance (turbine and overall system efficiency and generated power) versus inlet flow velocity (controlled/adjusted via an inlet guide vanes system) and electric load requirements for both turbine and genset optimization, as well as control system definition and procure key life-cycle and performance model calibration data. The outcome of the initial test series will be a calibrated performance model for future scale-up and

performance predictions. Secondly, robustness testing (continuous system operation and monitoring under full/actual river conditions) will ensue to document overall performance, system reliability and life-cycle analyses (LCA) over an extended four month test regime. The turbine will be monitored periodically and locally by the commissioning team (DGT) and continuously via a web interface by researchers at UAF. This will be used to understand turbine corrosion (key to system "life-ing"/maintenance data) and waterway debris effects on the turbo-machinery components as they also relate to variations in system efficiencies and/or secondary corrosion mechanisms. Further, continuous water sampling and native fish and wildlife monitoring will garner further calibration data for companion techno-environmental and LCA modeling efforts to confirm the system's positive environmental impact. Through these efforts, the analytic team may make recommendation in a variety of areas, including optimizations in Aqua Flux™ system components, cost reductions, subsystem design, energy conversion efficiencies and environmental effects. The DGT team will continue to monitor the overall system performance, operating variables and their effect on ancillary components (rotating components, seal, bearings, etc.), and will furnish the academic team members and Hydrokinetic Industry as a whole with key data for their companion analytic efforts and databases. The instrumentation and data collection/management plan, therefore, will be integral to the project's success.

PROJECT SCHEDULE AND BUDGET SUMMARY



TOTAL BUDGET	**$ 748,788**	**100%**			**RATES**	Technical Lead	$ 150.00
MATCH/IN KIND	**$ 189,138**	**25%**				Project Manager	$ 125.00
GRANT REQUEST	**$ 559,650**	**75%**				Engineer	$ 100.00
						Technician	$ 60.00
PROGRAM DURATION	**12**	**months**				O/H	15%
						G/A	10%

BREAKDOWN	**Q1**	**Q2**	**Q3**	**Q4**	**In Kind**	**Subtotal**
LABOUR	$ 53,250	$ 86,750	$ 136,750	$ 85,500	$ 148,638	$ 362,250
HARDWARE	$ -	$ 80,000.00	$ 40,000	$ 5,000	0	$ 125,000
SUBCONTRACTS	$ 55,000	$ 24,000	$ 17,500	$ 45,000	$ 35,000	$ 141,500
TRAVEL	$ 2,250	$ 7,000	$ 21,750	$ 4,500	$ 5,500	$ 35,500
OVERHEAD (O/h)	$ 7,988	$ 13,013	$ 20,513	$ 12,825	0	$ 54,338
GODDS & ADMIN. (G/A)	$ 5,725	$ 11,100	$ 7,925	$ 5,450	0	$ 30,200
TOTAL	**$ 124,213**	**$ 221,863**	**$ 244,438**	**$ 158,275**	**$ 189,138**	**$ 748,788**

PROJECT TEAM QUALIFICATIONS

DGT's managing members have brought together a technical team, which will build/develop/optimize the hydrokinetic solution at the host-site, while academic partners at the AHERC will leverage their techno-enviro-

economic modeling skill-sets, calibrated by concurrent experimental data from the turbine commissioning team, to validate the project's positive impact on sustainability and on the environment, thereby aligning and ensuring commercial and environmental goals are met. Dr. Donald Kendrick has over 20 years of experience in the power generation, renewable energy and product development/commercialization fields in the roles of manager, director and C-level executive. He thrives on bringing disruptive and innovative technologies – such as Aqua Flux™ – to market and fostering business around them. He has extensive technical experience working with combustion, ultra-low emissions, gas turbines (land based, APU, Main Propulsion), biofuels, and bioenergy. Donald has a Ph.D. in Mechanical Engineering from the California Institute of Technology, holds eight patents, and has been published in scientific journals on seven different occasions. His role for this project will be "Technical Lead." Shawn Gahr has over five years of business development, project management, strategic and financial analysis experience in the renewable energy space. Having spent his summers at a family gold mine near Fairbanks as a youth, he is highly motivated to bring affordable, locally produced energy solutions to remote Alaskan communities through technological innovation. His specific energy technology experience includes biofuels, energy storage, and hydrogen. Shawn holds an M.P.I.A. with a specialization in International Economics from the University of California, San Diego, and a B.S. (magna cum laude) in Business-Economics from Willamette University. His role for this project will be "Project Manager."

COMMERCIALIZATION OF THE FUNDED TECHNOLOGY

The Aqua Flux™ system project team will leverage technology-specific expertise throughout in order to develop a thorough understanding of the proper economic and environmental factors that will guide a rapid and successful deployment trajectory. The novelty in the approach lies in each expert's contribution to data and modeling issues related to geographic specificity, the use and effects on the sustainable feedstocks (rivers and/or streams), reductions in transmission needs and losses, material handling, and the consideration of economic and environmental changes in energy and materials markets caused by eventual widespread Aqua Flux™ deployment. In short, the Aqua Flux™ system provides a clear example of the applicability of consequential hybrid economic and environmental life-cycle modeling for distributed energy systems based on sustainable sources, with a variety of impacted markets to be considered at a variety of production scales. A 1986 study by New York University of free-flow river power in the USA estimated conservatively that there is 12,500 MW of undeveloped such hydro capacity for energy. This equates to about $10 billion in electricity sales in today's dollars. The study did not consider smaller rivers and canals where DGT's turbines can also generate renewable energy. The market just in the USA is thus orders of magnitude larger that the NYU estimate. Aqua Flux™ turbines will expand the diversity of available energy supplies, increase overall energy generation efficiency and reduce adverse and traditional energy generation effects, in complete alignment with the Alaskan Energy Authority.

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

_____, Shawn Gahr