ALASKA ENERGY AUTHORITY RFA 2014-007: EMERGING ENERGY TECHNOLOGY FUND

PROJECT TITLE:

HIGH VOLTAGE DIRECT CURRENT TRANSMISSION SYSTEM FOR RURAL ALASKA APPLICATIONS

PHASE III – CONVERTER STANDARDS AND INDUSTRY SOLICITATION

SUBMITTED SEPTEMBER 5, 2013

APPLICANT ORGANIZATION & CONTACT:

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APPLICANT PARTNERS:

UNIVERSITY OF ALASKA FAIRBANKS

MANITOBA-HVDC RESEARCH CENTRE

NRECA CRN COOPERATIVE RESEARCH NETWORK

TOTAL PROJECT COST: $ 245,000

EETF Grant:	$ 235,000
Applicant/Partner Match:	$ 10,000

PREVIOUS PROJECT PHASES:

HVDC Transmission System For Rural Alaska Applications
Phase I – Preliminary Design and Feasibility Analysis
Funded by: Denali Commission, Project #356-07
Completed: August 2009

HVDC Transmission System For Rural Alaska Applications
Phase II: Prototyping and Testing
Funded by: Denali Commission, Award #01201-00
Completion Date: May 2012

PREVIOUS EETF APPLICATION TITLE: SAME AS CURRENT APPLICATION

PROJECT ABSTRACT

1.0 PROJECT SUMMARY

1.1 PROJECT DESCRIPTION

Background

High voltage direct current (HVDC) power transmission is a proven commercial technology with dozens of installations in service world-wide. HVDC is recognized as superior to alternating current (AC) power transmission in certain applications, for the following reasons:

- Ability to use long distance submarine or buried overland cables,
- Superior long distance electrical efficiency and capital cost,
- Superior reliability and flexibility – HVDC provides an asynchronous intertie connection, and
- Fewer wires are needed and simpler, less costly structures are possible.

Interties between Alaska's rural villages would benefit from many of these attributes of HVDC transmission. Unfortunately, existing HVDC systems are designed to move 50 to 1,000s of megawatts (MW), which is far more than Alaska's villages need. Several proposed interties have considered HVDC, but available HVDC converters are too large and costly to be practical for these applications.

Polarconsult Alaska, Inc. (Polarconsult) has been working with Alaska's rural utilities and industry stakeholders since 2005 to develop a small-scale HVDC transmission system that is 'right-sized' for Alaska village interties. With funding from the Denali Commission, this HVDC concept has been advanced from idea to functional prototype. Polarconsult completed Phase II of the project (prototyping and testing) in 2011, with a final report issued in May 2012.

The Alaska Center for Energy and Power (ACEP) recently conducted a technical review of the low-power HVDC concept generally and more specifically of development efforts funded by the Denali Commission. ACEP published a report of its findings in May 2013. ACEP found that the general concept has considerable merit for Alaska applications, and made a number of specific recommendations for future development efforts to increase the likelihood of technical success and industry acceptance of this new transmission technology. ACEP's recommendations include:

- Past development efforts bundled several related but separate technologies: the HVDC converters, innovative overhead intertie designs, and use of earth return circuits. ACEP concluded that each technology has merits and warrants further development, but they are independent of each other and should proceed separately to simplify management and increase the likelihood of success.
- The power electronics industry has evolved considerably since 2005, and alternate developers/suppliers of suitable voltage source converter (VSC) systems may now exist that were not previously available. Accordingly, future converter development efforts should use an open solicitation process.
- Final standards and specifications for the converter and overall HVDC system should be developed in close coordination with utilities and appropriate industry entities (such as EPRI, IEEE, CIGRE) to ensure that the resultant technology can be readily deployed by utilities in a manner that is manufacturer-independent, compatible with traditional utility financing avenues, and conventional operating protocols.

Polarconsult agrees with ACEP's recommendations and this proposed work plan incorporates all of the above recommendations. This project will refine converter standards and protocols and complete an open RFQ solicitation of the industry for qualified prospective converter developers. Detailed development proposals will be solicited from the top respondents to the RFQ to provide comprehensive development proposals. These will be reviewed and used to form a recommended development plan for future technology development.

This HVDC system was recently presented at an EPRI conference by Mr. Randy Wachal, P.Eng. of the Manitoba HVDC Research Centre (MHRC).[i] The concept was well-received, and shows increasing industry interest.

Proposed Scope of Work

Task 1: Advance Converter Standards and Specifications

Task 1a: Update Converter Specification

Polarconsult and its partners (the 'project team') will update the converter specification developed in Phase II to reflect lessons-learned from the Phase II prototypes and create a specification that is technology-independent, so that converters from different manufacturers can function together on a single HVDC grid. The deliverable will be an updated comprehensive specification for a bi-directional, 500 kW, 50 kV DC, voltage-source converter suitable for rural Alaska applications.

Task 1b: Prepare Operating Protocol Template

The project team will prepare an operating protocol template containing:

- Operating protocols for a rural point-to-point HVDC intertie.
- Operating protocols for a rural multi-terminal HVDC intertie.
- Minimum SCADA requirements / specifications for point-to-point and multi-terminal HVDC interties.
- A list of typical fault modes and control system / operator responses.

Task 1c: Stakeholder Review, Submittal to Industry Organizations

Once drafts of both documents are complete, they will be forwarded to stakeholders for review and comment. Stakeholders will include the members of the Stakeholder Advisory Group formed in Phase II of this project, and other entities as may be identified by the project team.[ii] Comments received will be incorporated into the documents as appropriate.

These two documents will then be submitted to applicable industry organizations (IEEE, EPRI, etc.) to advance the adoption of formal standards for this emerging class of HVDC VSC system.

Task 2: RFQ Solicitation for Converter Development

Task 2a: RFQ Open Solicitation

Task 1 documents will be incorporated into an open request for qualifications (RFQ) solicitation for qualified converter developers. The RFQ will serve to identify as many qualified developers as possible, and gauge the level of interest in developing this class of converter.

Task 2b: Phase IV Scope of Work Development

The project team will review responses to the RFQ and identify the top qualified firms. The team would engage in discussions with these firms to prepare an estimated budget and schedule required to advance converter technology to a point where it is ready to ship to Fairbanks for independent testing by UAF. The deliverable from these discussions would be a recommended scope of work, budget, and schedule for Phase IV of this project.

Task 3: Reporting

Polarconsult and its partners would prepare a final report detailing the achievements of the project. The report would provide a recommended schedule, scope and budget for further development of this technology, and would include the deliverables of Tasks 1a, 1b, 2a, and 2b as appendices.

1.2 PROJECT INNOVATION

Small-scale HVDC transmission can dramatically reduce the capital cost of interties in rural Alaska. The capital cost of building a remote one MW AC overhead intertie in rural Alaska is $200,000 to $600,000 per mile.[iii] Comparable HVDC interties can be built at as little as half this cost. Including the cost of the HVDC converters, significant savings are realized on interties longer than 8 to 10 miles. Cost estimates prepared by Polarconsult indicate capital savings of $2 to $4 million are achievable on a single 25-mile intertie by using HVDC vs. AC. These savings are possible for the reasons articulated in Section 1.1 of this abstract.

1.3 PROJECT SITE AND DEMONSTRATION ENVIRONMENT

This phase of development does not directly involve physical testing or a physical demonstration site. The project team includes professionals that are well versed and highly experienced in both HVDC-specific and Alaska-specific design issues. This team is well-positioned to successfully complete the proposed scope of work.

1.4 PRIORITY

This project meets all of the priority criteria set forth in AS 42.45.375(d)(1) through (4) as follows:

(1). Polarconsult is an Alaska business owned by and employing Alaska residents.

(2). Polarconsult has partnered with the University of Alaska Fairbanks (UAF)'s Alaska Center for Energy and Power (ACEP) to complete the proposed project.

(3). The application includes applicant matching funds.

(4). Commercialization of this technology will have an immediate potential for widespread Alaska deployment. Phase II of this project investigated a dozen interties around Alaska that could save costs by using HVDC. In recent years, HVDC has been investigated for interties between Hoonah and Juneau, Kake and Petersburg, Bethel and Chikuminuk Lake, Dillingham and Grant Lake, and Barrow and Atqusuk.

(5). Heating Efficiency. By lowering the capital cost of rural power interties, this project can foster the conversion of high-energy-cost villages to electric heat by connecting them with comparatively low-cost power, for example from the railbelt grid.

2.0 TECHNOLOGY VALIDATION AND DATA COLLECTION

This project will provide current information on the number and qualifications of prospective suppliers for this class of HVDC converters, and current information on the expected development costs and schedules for the converters. This information will better define the commercial viability of this system and guide future development efforts.

The primary data collected in this project will be the SOQs submitted in Task 2a and the development proposals submitted in Task 2b. This information will be summarized and included in the final report.

3.0 PROJECT SCHEDULE AND BUDGET

The proposed budget for this project is $245,000. This includes $10,000 as in-kind labor from Polarconsult and $235,000 in grant funds. Polarconsult's hourly labor rates will range from $53 to $143 depending on the employees tasked to the project and specific hours used as in-kind match.

Tasks 1a and 1b (Specs and protocols):	January 2014 to August 2014	$ 135,000.
Task 2a and 2b (RFQ Solicitation and scoping):	Sept. 2014 to March 2015	$ 75,000.
Task 3 (Reporting):	June 2015	$ 35,000.
TOTAL		**$ 245,000.**

4.0 PROJECT TEAM QUALIFICATIONS

The project team includes Polarconsult, UAF/Dr. Wies, ACEP, MHRC, and the National Rural Electric Cooperative Association (NRECA)'s Cooperative Research Network (CRN). Core members of this team have worked successfully over the past five years advancing this HVDC system.

Polarconsult is a professional engineering consulting firm headquartered in Anchorage since 1978. Polarconsult specializes in innovative, affordable and robust engineering solutions tailored for Alaska conditions. Polarconsult has successfully served over 200 municipal, public, and private-sector clients throughout Alaska. Polarconsult will manage this project, with Joel Groves, P.E. acting as project manager. Mr. Groves has managed Phases I and II of the HVDC system development efforts.

Dr. Richard Wies, Ph. D, P. E., an Associate Professor of Electrical and Computer Engineering at UAF and a registered Electrical Engineer in the State of Alaska, has over 14 years of research experience focused on stand-

alone hybrid electric micro-grid systems. His current research interests include developing smart grid controls for the stable and efficient operation of stand-alone hybrid wind-diesel-battery-thermal storage micro-grid systems in Alaska villages. He also has an interest in developing HVDC transmission systems to connect villages and export Alaska's stranded energy resources. Dr. Wies will contribute to development of specifications and protocols, and will assist in overseeing converter design, assembly, and testing activities.

ACEP is an applied energy research program at UAF. Dr. Wies' efforts will be coordinated through ACEP. ACEP will also be involved in document review, development proposal review, and reporting.

MHRC is a division of Manitoba Hydro International (MHI). MHI is wholly owned subsidiary of Manitoba Hydro (MH), the crown electricity provider for the Canadian province of Manitoba. MH is owner and operator the Nelson River HVDC systems for the past 30+ years. Nelson River HVDC system consists of two 2000 MW 1000 km HVDC Bipoles, and is in the process of adding a 3rd Bipole. MHRC is an internationally recognized leader in research and development of power systems technologies, manufacturers of PSCAD simulation software used by virtually every HVDC project worldwide, and provides international engineering consulting services including HVDC, AC, power electronics, and related technologies. MHRC efforts on this project will be led by Randy Wachal, MHRC's Engineering Systems Manager. MHRC will contribute to development of specifications and protocols for the HVDC system, and review of converter development proposals.

CRN is the research arm of the NRECA. For over a decade, CRN has provided pertinent, timely research to assist electric cooperative utilities in addressing a wide array of technology and operational challenges, including integration issues for small distributed generation sources similar to this project. CRN efforts include investigative reporting, in-depth analysis, the production of guides and handbooks, product evaluations and technology demonstrations. CRN personnel on this project will include Tom Lovas in Alaska, as well as Doug Danley and Bob Saint, PE. CRN will contribute to development of specifications and protocols for the HVDC system, and review of converter development proposals.

5.0 COMMERCIALIZATION OF FUNDED TECHNOLOGY

This phase of the project is intended to advance converter technology through an additional design/build/test iteration, promote diversity of converter suppliers through an open solicitation process, and promote awareness and standardization of this class of HVDC transmission by submitting converter specifications and system operating protocols to industry organizations. These actions will help to ready the technology and commercial environment (financial, regulatory, etc.) necessary for successful commercial adoption of this technology.

6.0 SIGNED APPLICATION CERTIFICATION

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

Michael D. Dahl, Secretary / Treasurer Polarconsult Alaska, Inc.

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i The 2013 EPRI HVDC and Flexible AC Systems Conference (August 28-29). MHRC and Mr. Wachal are partners on this proposal, and were also contributors to the Phase II HVDC project.

ii The Phase II Stakeholder Advisory Group consisted of over 30 urban and rural Alaska electric utilities and other entities associated with Alaska's electric industry.

iii See Appendix B, Table B-14 of ***HVDC Transmission Systems for Rural Alaska Applications Phase II Prototyping and Testing*** (Polarconsult, 2012) for per-mile costs of recent rural Alaska interties. See also Table 3 ***of Small-Scale High Voltage Direct Current – A Lessons Learned Review of the Polarconsult HVDC Phase II Project with Recommendations for Future Research and Alaskan Application*** (ACEP, 2013).