

Closeout Report for USDOE Office of Indian Energy award DE-IE0000035  
Project: St. Mary's/Pitka's Point Wind Construction  
Submitted by Alaska Village Electric Cooperative, Inc. (AVEC)  
March 30, 2020

This grant award DE-IE0000035 is being closed because the project it funded is complete and is in full operation, and the grant expired December 31, 2019; this report represents the project status as of that date. The grant funds were fully expended. Grantee is Alaska Village Electric Cooperative, Inc. (AVEC).

**Background** – AVEC's prime power plant located in Saint (St.) Mary's, Alaska (pop. 683) provides power to that community and to nearby Pitka's Point, Alaska (5 miles SW of St. Mary's; pop. 117). St. Mary's is located in western Alaska about 450 air miles WNW of Anchorage, and is situated on the north bank of the Andreafsky River about 5 miles upriver from its confluence with the Yukon River. A road and electrical intertie connect the two communities. A third community – Mountain (Mt.) Village, Alaska (pop. 860) is located further down the Yukon River, about 18 miles WNW of St. Mary's; a seasonal road connects St. Mary's to Mt. Village, and an electrical intertie has just recently been completed along that road, creating a local electrical grid serving the three communities with the prime power plant in St. Mary's. All three communities – St. Mary's, Pitka's Point and Mt. Village – are served their electric power by AVEC, a member-owned rural electric cooperative.

St. Mary's falls within the transitional climate zone, characterized by tundra interspersed with boreal forests, and weather patterns of long, cold winters and shorter, warmer summers. Energy prices - for electric power, gasoline and diesel/heating fuel - are among the highest in the nation. St. Mary's is served by barge and aircraft. The state-owned gravel runway with a crosswind strip provides year-round access, and the airfield is capable of receiving large jet aircraft. The Yukon River is typically ice-free and open to barge traffic from June through October; the Andreafsky River provides the only deep-water dock in the area. A 22-mile seasonal-use road links St. Mary's to Pitka's Point and Mountain Village. St. Mary's incorporated in 1967 under state law as a first class city; it is a traditional Yup'ik village with a fishing and subsistence economy and lifestyle.

**Activities** – Project scope included planning, permitting, design, construction and commissioning of 1 new 900 kW-capacity wind turbine at a site in Pitka's Point about 4 miles from the diesel-fired prime power plant in St. Mary's. The main objective of this project is to generate electric power from a renewable resource in an effort to reduce the local dependency on fuel oil as the sole source of electric power generation. The wind generator's output will augment the prime source generation provided by the diesel-powered generators.

AVEC developed a strategic plan to complete several major community energy infrastructure projects in St. Mary's, Mountain Village and Pitka's Point concurrently. Major projects include the subject utility-scale wind turbine, a new diesel-fired power plant, a new bulk fuel tank farm to store and supply power plant fuel, an electric intertie to Mountain Village, and a new backup power plant in Mountain Village. At the time of this report, the wind turbine and intertie are completed, the bulk fuel tank farm is under construction, and the power plant is designed and out to bid.

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Select 2019 power data for the three subject AVEC communities are as follows:

<i>Year ended 12/31/2019</i>	Generation (kWh) by source			Load (kW)	
	Diesel	Wind	Total	Peak	Average
St. Mary's (incl. Pitka's Point)	1,891,432	1,342,374	3,233,806	702	370
Mountain Village	2,644,906		2,644,906	522	302
Total	4,536,338	1,342,374	5,878,712		

In 2019, AVEC's new wind turbine generated a total gross 1,342,374 kWh; this represents 41.5% of the total 2019 gross kWh AVEC generated from all sources in St. Mary's (diesel) and Pitka's Point (wind).

AVEC's wind turbine selection policy, in part, prefers turbine models which are direct-drive, have multiple I/O controls, and are built to withstand the severe operating environments found in the arctic. During the selection process for this project, AVEC partly expanded this policy to also consider simplified induction turbine models with limited I/O controls. Another major factor in turbine selection and overall wind-diesel system design in this particular case is the new transmission intertie between St. Mary's and Mt. Village, coupled with a planned retirement of the Mt. Village power plant and its replacement with backup-only generation. Together these upgrades will almost double the size of the local grid and the consequent demand from the St. Mary's prime power plant; this created the opportunity to install substantially larger wind generation capacity than the prior St. Mary's/Pitka's Point grid alone could absorb without frequent need to curtail wind turbine(s). Ultimately the wind turbine selected and procured for this application was an Emergya Wind Technologies (EWT) 900-kW generator placed atop a 50-meter tubular steel tower, with blades that sweep a circular area 52 meters in diameter. AVEC constructed a nearly-identical turbine in Bethel less than a year prior, and together these two wind turbines are AVEC's largest; the remainder of AVEC's 30 wind turbines are Northwind 100kW models.

New technologies offering storage and integration of renewably-generated power continue to emerge and advance towards reliability and usefulness in electric utility applications; AVEC is currently working to procure and install a 3-phase grid-bridging system that promises to buffer steep reductions in power generated and maintain power quality whenever the wind speed at the Pitka's Point wind turbine drops off. The grid-bridging system combines inverters, lithium batteries and supercapacitors; it promises to reduce how often the diesel generators turn on and off, or ramp up or down in operating speed when running, as they follow the demand curve; this in turn will increase fuel efficiency and decrease wear and tear on the diesel gensets.

AVEC entered into a Ground Lease and Agreement with Pitka's Point Native Corporation on October 04, 2011, which secures site control for the subject wind turbine and all related facilities through October 2061.

To gain access to the undeveloped site, a 26-foot-wide, .3-mile long gravel access road was built off the main gravel road connecting St. Mary's to Pitka's Point; a 126' x 150' gravel pad was then built at the end of this

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access spur. Both the access road and site pad were underlain with geotextile. The turbine's tower is attached to concrete mat gravity foundation constructed in a pit excavated approx. 10' deep through the gravel pad to bedrock. The essential components are a cylindrical 14' wide, 7' thick steel-rebar-reinforced concrete pier poured atop an octagonal 29' wide, 4' thick steel-rebar-reinforced concrete footing. Concrete was mixed on site and poured into rebar cages fabricated on site. This monolithic foundation was then backfilled with compacted aggregate to the grade of the surrounding pad. All aggregate used in the access road and gravel pad was supplied from a gravel source located adjacent to the site and owned by PPNC; specified aggregate used in the concrete mix was imported by barge from a qualified source in Nome, Alaska, approx. 200 miles away.



The subject project also accomplished the following scope:

- Prior to this project, a single-phase distribution line ran along the preexisting main road, both of which connect St. Mary's (and its prime power plant) to Pitka's Point (and its local electric grid); the subject project upgraded that entire preexisting line to three-phase;
- A new three-phase primary distribution line segment along the access road, to connect the new wind turbine to the newly-upgraded distribution line running along the main road;
- A new fiber optic link attached to the distribution line poles, that provides communication between the new wind turbine and the control switchgear of the St. Mary's prime power plant; this allows the wind turbine to be either manually or automatically controlled both at the power plant and from AVEC headquarters in Anchorage, maximizing operating stability and allowing remote trouble shooting in the event of alarms or warnings;
- A secondary load system comprised of a 327 kW electric water heater and related controls and switching relays all help integrate the naturally-intermittent wind power. This system will absorb excess electrical energy during those periods when the output of the wind turbines exceeds the community load, and will transfer the excess energy to the glycol-based heat recovery loop in the AVEC power plant and ultimately to an existing heat recovery loop serving City of St. Mary's' facilities (water treatment plant, City offices, and shop/hotel).

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Feasibility phase: the bulk of feasibility and pre-design investigations were accomplished with other funding, prior to this award DE-IE0000035. Several sites in the three communities were evaluated, the Pitka's Point site proved to have the best wind resource. Instruments mounted on a 36-meter tower gathered meteorological data there from October 2007 to February 2009. These data were studied and feasibility was evaluated in 2010 – 2012. These efforts generally indicated a class 6 wind regime at the Pitka's Point site, with potential for rime ice conditions in winter. Geotechnical conditions of the preferred turbine site and of the adjacent gravel source were studied and evaluated in August 2011 (reconnaissance level) and in October 2011 (extensive field study).

Design and construction phases: AVEC utilized a Statement of Qualifications (SOQ) procurement process to award the wind turbine prime construction contract, ultimately to STG, Inc. In general, STG subcontracted the distribution line upgrades (using required quote-level procurement process), and accomplished all other scope with its in-house resources combined with locally-available labor and other resources. The secondary load system was installed by field crews from AVEC's Operations Department. Major engineering and design for the entire scope was accomplished by CRW Engineering Group, LLC; additional engineering by AVEC Engineering Department staff. Wind energy studies were conducted by V3 Energy, LLC; geotechnical services were provided by Golder Associates, Inc.; and permitting was coordinated by Solstice Alaska Consulting, Inc.



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Design, permitting and construction milestones summary:

2012Q1	AEA award 7040017 executed 3/14/2012
	FAA Determination of No Hazard to Air Navigation issued 1/10/2012, for initial configuration of 4 towers each at 190 feet AGL
2012Q3	FAA Determination of No Hazard to Air Navigation issued 9/04/2012, for revised configuration of 1 tower at 250 feet AGL
	95% design achieved
2014Q3	Revised 95% design achieved (for AEA REF construction funding application???)
2016Q1	Final selection of turbine make and model
2016Q3	USDOE award IE00000-35 executed 3/01/2016
	AEA award 7040017 Amd 4 (construction funding) executed 8/16/2016
2016Q4	Executed Turbine Purchase Agreement with EWT 12/14/2016 (procured by AVEC)
	STG, Inc., selected as prime construction contractor
2017Q2	Completed design of 3-phase distribution upgrades
	STG commenced procurement of foundation materials
2017Q3	Received foundation materials at site; access road and foundation pad completed; foundation 85% completed
2017Q4	Foundation completed; construction shut down for winter
2018Q1	Wind turbine (incl nacelle and blades) inspected by AVEC, STG and EWT at Port of SEA
2018Q3	Wind turbine and tower arrived at St. Mary's; tower erected onto completed foundation
2018Q4	Distribution line incl 3-phase upgrade completed
	Wind turbine commissioning attempted then postponed due to faulty PLC/HMI programming
2019Q1	Wind turbine successfully commissioned
	Secondary load control boiler install commenced
	Design specs for grid bridging system completed; procurement of components put out to bid
2019Q3	Secondary load control boiler install completed
	Vendor for grid bridging components selected

Funding and costs on this project are depicted in the table on the following page:

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AVEC - St. Mary's/Pitka's Point EWT 900kW Wind Turbine Project			Funding	Expenditures	Additional AVEC Contribution
Source	Award #	Phase			
State of Alaska - Alaska Energy Authority (AEA)	7040017	Design	\$ 275,554	\$ 275,554	
Alaska Village Electric Cooperative, Inc. (AVEC)	match to AEA 7040017	Design	\$ 34,444	\$ 108,929	\$ 74,485
State of Alaska - Alaska Energy Authority (AEA)	7040017	Construction	\$ 4,348,540	\$ 4,348,540	
U.S. Department of Energy, Office of Indian Energy (DOE)	DE-IE0000035	Construction	\$ 779,001	\$ 779,001	
Award and Project Totals			\$ 5,437,539	\$ 5,512,024	\$ 74,485

Construction costs, net of design costs as shown in the table above, and net of distribution line upgrades costs of \$741,413, totaled \$4,386,128; yielding a constructed cost of the new wind turbine = \$4,873 per kW.

**Project Outcomes** – In the last 11 months of 2019, this new wind turbine produced 41.5% of all the power generated and consumed on the St. Mary's/Pitka's Point grid, well within the range of design expectations.

Though not included in the scope of this grant, the newly-constructed intertie connecting the Mt. Village electric grid to the prime power plant in St. Mary's is an integral part of this project overall; it will share the power generated from a renewable source with a third community on (now) the same grid and, consequently, lead to lower electric costs there as well. In the future, an envisioned wind-to-heat system in Mt. Village will take further advantage of any unrealized wind turbine capacity and provide energy to heat community buildings there. Operationally these two components, combined with the in-progress grid bridging system, are expected to maximize the utilizable wind power, and eliminate or all but eliminate any need to curtail the EWT (except in rare instances of threatened damage to the turbine from excessively high and/or turbulent winds).

**Bibliography (all prepared for Alaska Village Electric Cooperative, Inc.):**

V3 Energy: 1) *St. Mary's Area Wind Power Report (July 20, 2010)*; 2) *Pitka's Point, Alaska Wind Resource Report (April 25, 2012)*; 3) *St. Mary's, Alaska Wind Power Conceptual Design Analysis (September 21, 2012)*.

Golder Associates, Inc: 1) *AVEC Wind Turbine Site Reconnaissance – St. Mary's & Mt. Village (August 24, 2011)*; 2) *Geotechnical Exploration and Conceptual Level Foundation Recommendations For Proposed Wind energy Project, St. Mary's, AK*.

CRW Engineering Group LLC: *St. Mary's/Pitka's Point Wind Energy Project, (Plans) Issued for Construction (July, 2017)*.