Cover Page

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Technical Contact:	Sonny Adams, Director, Alternative Energy Programs NANA Regional Corporation 909 W. 9th Ave Anchorage, AK 99501 907-265-3700 sonny.adams@nana.com
Project Partners:	Northwest Arctic Borough, PO Box 1110, Kotzebue, AK 99752; Ph: 907-442-2500; Ingemar Mathiasson, Director, Energy Programs; imathiasson@nwabor.org; Regional Government Maniilaq Association, PO Box 256, Kotzebue, AK 99752; Ph: 907-442-3321; Tim Gilbert, President/CEO, tim.gilbert@maniilaq.org; Health Care Provider Northwest Inupiat Housing Authority, Kotzebue, AK 99752; Ph: 907-442-3450;Guy Adams, Executive Director, gadams@nwiha.com; Regional Housing Authority Kotzebue Electric Association, P.O. Box 44, Kotzebue, AK 99752; Ph: 907-442-3491; Martin Shroyer, General Manager; m_shroyer@kea.coop; Electric Utility Kuna Engineering (formerly WH Pacific), 4300 B C Street, Anchorage, AK 99503; Ph: 907-339-6500;Jay Hermanson, ; jhermanson@kunaeng.com; Architecture and Engineering Firm Deerstone Consulting LLC; 3200 Brookside Drive, Anchorage, AK 99517; Ph: 907-299-0268; Brian Hirsch, CEO/President, brian@deerstoneconsulting.com; Renewable Energy Consulting Firm

Alaska Native Tribal Health Consortium; 3900 Ambassador Drive, Anchorage, AK 99508; Ph: 1-800-560-8637; Dustin Madden, Program Manager, Rural Energy Initiative, dmmadden1@anthc.org, Statewide Healthcare Provider and Energy Efficiency

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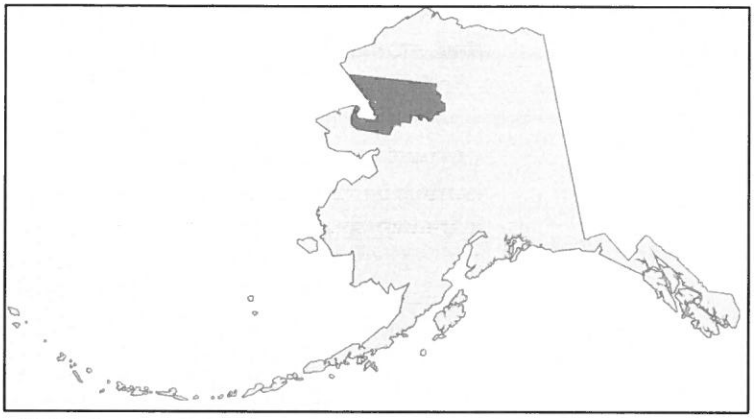
Table of Contents

Executive Summary

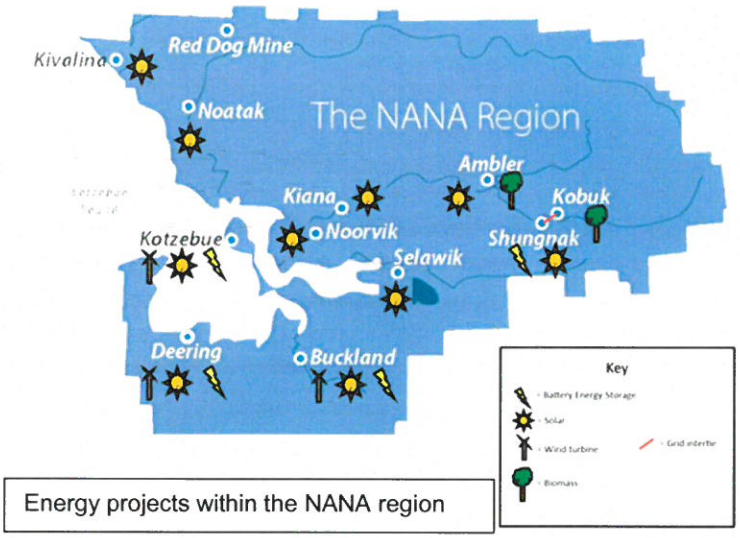
NANA Regional Corporation, Inc. is an Alaska Native Regional Corporation created under the Alaska Native Claims Settlement Act (ANCSA). NANA's land base of 2.2 million acres lies within 38,000 square miles in the northwest Arctic region of Alaska, within which 11 federally recognized tribes are located. Known as the NANA region, it is larger than the state of Indiana and coincides with the borders of the Northwest Arctic Borough (NAB). The NAB is the region's primary governing body and a close collaborating partner on many infrastructure projects such as solar and wind energy development across the region to improve the lives of NANA shareholders who are also residents and citizens of the NAB.



NANA Region within Alaska

Our territory is vast and remote, with no roads connecting our region to outlying areas. Practically all commodities are barged or flown into the region, which results in extremely high prices for basic goods, including food, fuel, and building materials. All of the 11 villages in the region, which straddles the Arctic Circle and experiences extremely harsh winters, are served by diesel-based, islanded microgrids for electricity and diesel heating fuel, in many cases relying on air deliveries because barges are unable to navigate the upper stretches of the Noatak and Kobuk Rivers.

The US Department of Energy-Office of Indian Energy's (DOE-OIE) support for NANA's establishment of an Inter-Tribal Technical Assistance Network in the Northwest Arctic was a ground-breaking effort that led to many individual community successes and a regional escalation of clean energy for all our Tribes. Before this grant award was initated, high penetration renewable-diesel hybrid systems were primarily aspirational. Now, after five years of intensive technical assistance and multi-institution collaboration and funding, the NANA region has three high penetration solar-wind-battery-diesel hybrid systems and one solar-battery-diesel hybrid system fully operational with diesel-off operation occurring regularly; another solar-battery-diesel hybrid system fully funded with a Request For Proposal for construction targeted for early 2022; a current grant application about to be submitted to begin the final design process for solar-battery-diesel hybrid systems for four other villages in the region; and initial funding to begin a high penetration wind-battery-diesel system for the remaining village in the region. Clearly, our goal to demonstrate and replicate high penetration renewable hybrid technology has been accomplished and is increasing in scale and pace.



Energy projects within the NANA region

Along with technology implementation, through this Technical Assistance award, we researched the concept, analyzed the economics, and then created Independent Power Producers in rural Alaska to develop these high penetration renewable hybrid systems that are owned and operated by the Tribal governments in the region, and are now selling power back to the Alaska Village Electric Cooperative (AVEC), the largest electric utility in rural Alaska. Through a Power Purchase Agreement (PPA) between the Tribes of Shungnak and Kobuk as the IPP and AVEC as the buyer of Tribally produced renewable energy, this is the first such arrangement with AVEC in Alaska, and we are now poised to replicate this in several other village locations within the region where AVEC is the incumbent utility. We are also in process of replicating this in the stand-alone utilities (i.e., non-AVEC, locally owned) in our region. This effort is being watched closely across the state and if successful, will likely lead to many other PPAs throughout Alaska.

Described in more detail below, the following list of items briefly distills some of the project accomplishments achieved with DOE-OIE Technical Assistance support.

- Community Energy Meetings in:
  - Shungnak
  - Selawik
  - Noatak
  - Deering
  - Buckland
  - Kotzebue
  - Ambler
  - Kiana
  - Kobuk

- Solar PV on Water plants in every village and ongoing performance monitoring
- Multi-agency collaboration across state and federal agencies and service providers in the region including DOE, USDA, EPA, BIA, Denali Commission, AEA, ANTHC, AVEC, Crowley Fuel, Vitus Marine
- Engagement with energy technology developers, vendors, project supporters, and others, including hosting in-region site visits and/or project development with Lockheed-Martin, ABB, Saft, BoxPower, Blue Planet Energy, Ageto, Launch Alaska, Alaska Center for Energy and Power, Renewable Energy Alaska Project, Solar Energy International

- Secured funding/supported diesel powerhouse and/or distribution system upgrades serving five villages (Deering, Buckland, Shungnak, Kobuk, Noatak)
- Project development and MOU established with Northwest Arctic Borough (NAB) to coordinate and collaborate across NANA and NAB Energy programs
- Heat Pump Calculator & Economic Study (collaborated with other entities) to determine optimal use of heat pumps across the NANA region and statewide
- Supported Buckland, Deering and Kotzebue solar installations (676 kW combined across all three communities)
- 7 Energy Steering Committee meetings held, over 275 people in attendance (two scheduled meetings were canceled because of Covid-19)
- Additional funding secured (~$9 million) for targeted projects
- Ambler Biomass Project Support
- Ongoing Heat Pump research and implementation in all villages in the region
- Developing diesel-off technology & renewables integration across the region
- Over 15 public presentations
- Supported research to establish a Joint Action Agency and Regional Energy Organization for tribal collaboration, mutual support, and capacity development
- Supported Shungnak and Kobuk to develop solar-battery-diesel hybrid high penetration system and establish an Independent Power Producer (IPP) with both Tribes in Shungnak and Kobuk, becoming first IPP in Alaska to sell power to the Alaska Village Electric Cooperative (AVEC)
- Assisted NAB with developing Noatak solar and battery project, currently in development with support from DOE-OIE, NAB's Village Improvement Fund, and NANA's Village Economic Investment contribution
- Received several earned media coverages, in print and audio with statewide audiences, highlighting various energy projects and successes

Project Objectives & Evaluation

Communities in our region pay among the highest energy costs in the United States. We are highly dependent on diesel fuel for electricity generation and space heating and rely on challenging and highly uncertain logistics for fuel delivery. Over the past several years, river water levels have dropped as climate change has reduced precipitation, thus making fuel delivery by barge even more costly and often times impossible to our more remote communities, which results in needing to fly in fuel at exorbitant cost. These costs are locked in during the winter months and remain high even if the nation sees a reduction in energy prices. Fuel prices are then weighed in with the previous years' fuel price when the fuel barge arrives in the summer. The community of Noatak in particular has suffered from changes in river water levels and course of the river such that now it is not possible to barge fuel in under any circumstances and all fuel is flown in, resulting in some of the highest fuel costs in Alaska and the US.

The goals of this project included developing sustainable utility business plans and practices to facilitate deployment of high penetration wind-solar-storage-diesel hybrid systems, provide workforce training and capacity development, and lay the foundation for a Regional Energy Authority or similar structure for the 11 tribal communities in the NANA region. The overall aim of this three-year (that was ultimately extended to five year) technical assistance effort was to reduce fossil fuel use and energy costs by 7% across the region through improved management and efficiency—both generation and end-use—along with establishing a framework for an integrated, self-supporting, energy-focused regional entity to support all communities and business enterprises in the Northwest Arctic Borough of Alaska.

To evaluate if we achieved our quantitative objectives, it was necessary to conduct detailed data collection to establish baseline figures. The following table illustrates the total fuel consumption for electricity generation in the region in 2019, the most recent year with complete data and representative of pre-Covid levels of consumption and production.

	Ambler	Buckland	Deering	Kiana	Kivalina	Kobuk
Fuel for Power Generation (Gallons)	92,452	131,514	47,196	114,624	105,010	-
Avg Fuel Cost Power (2019 PCE Data)	$3.91	$3.17	$2.86	$3.54	$3.35	$0
Power Generation Fuel Costs (2019	$361,328	$416,371	$135,028	$405,923	$351,852	$0
Fuel for Heat (Gallons)	72,105	144,801	72,190	177,953	117,051	48,476
Cost /Gal Stove Oil	$9.53	$6.89	$4.90	$5.67	$4.49	$8.24
Cost of Stove Oil for Heat	687,158	997,679	353,732	1,008,991	525,557	399,439

	Noatak	Noorvik	Selawik	Shungnak	Kotzebue	Total
Fuel for Power Generation (Gallons)	133,496	140,876	186,297	117,643	1,273,584	2,342,692
Avg Fuel Cost Power (2019 PCE Data)	$6.47	$3.42	$3.41	$4.10	$2.49	
Power Generation Fuel Costs (2019	$863,953	$481,380	$635,477	$482,577	$3,171,894	**$7,305,783**
Fuel for Heat (Gallons)	140,158	190,130	223,936	140,133	2,173,276	3,500,208
Cost /Gal Stove Oil	$10.29	$5.64	$7.99	$8.42	$6.33	
Cost of Stove Oil for Heat	$1,442,226	$1,072,333	$1,789,245	$1,179,921	$13,756,838	**$23,213,120**
			Total Region Fuel Cost for Heat & Power			**$30,518,903**

Based on this table, it is clear that we have indeed reduced fossil fuel use, at least as it applies to electricity generation, by more than 7% across the region. In Kotzebue alone, annual wind energy production is now displacing more than 250,000 gallons of diesel fuel, while solar PV production in 2021 displaced over 41,000 gallons of diesel fuel.

From a financial standpoint, the impact of our efforts is much less clear, since the price of delivered fuel is based first and foremost on global supply and demand dynamics beyond our control and secondarily on transportation delivery costs also beyond our control. It should also be noted that this table shows just the cost of fuel for electricity production, not the total end-user cost of electricity, which also includes non-fuel costs such as labor, maintenance of equipment, and other expenses. These additional expenses approximately double the total cost of delivered electricity to end-users in the NANA region (to over $12.7 mlllion in 2019). That said, in terms of operational efficiency and creation of Independent Power Producers, as described in more detail below, it appears we are indeed lowering the cost of electricity with regard to the fuel component although it will take longer to achieve a 7% overall price reduction. This is because the total cost for electricity production includes non-fuel components and certain sectors, namely residential and community facilities, receive the Power Cost Equalization fuel subsidy from the state of Alaska, which counteracts the community economic benefits of reducing diesel fuel consumption in electricity production. As well it should be noted that the table above shows that fuel use for space heating is even larger than fuel use for electricity, so there is still much to be done to continue to lower fuel consumption and overall energy costs for Tribes in our region.

Description of Activities Performed

We have developed a Northwest Arctic Energy Steering Committee (ESC) to address the issues described above and keep us on track toward meeting our goals of reduced diesel fuel use, increased local energy production, and improved economic development. The ESC process brings all local and regional stakeholders together, along with outside experts, to develop innovative solutions and evaluate our

progress over time. It has been in place since 2008, but DOE-OIE support under this Technical Assistance grant allowed us to increase activity and capacity development for the ESC.

Specifically, the ESC typically gathered informally one day each year to review regional progress. Once the DOE-OIE award was in place, we formalized the ESC by requesting each of our 11 villages to designate a community representative to attend the ESC meetings and report back to the community. We also expanded the ESC meetings to occur twice each year and for two days each, allowing for one day to review progress and set new priorities, and another day to provide a focused technical training for all village participants. A detailed agenda, invitation list, meeting notes, follow-up efforts, training priorities, and other initiatives accompanied the scaling up of ESC activities and impact in the region as a result of DOE-OIE support for this effort.

As well as community representatives, ESC participants included representatives from NANA, the NAB, AVEC, regional fuel delivery providers (Crowley and Vitus Marine), Kotzebue Technical Center, Maniilaq Health, Northwest Inupiat Housing Authority, Northwest Arctic School District, Alaska Native Tribal Health Consortium (ANTHC) and other stakeholders. We also included our consultant team to take detailed notes, convert goals into actions, provide additional technical expertise and training for local Tribal members, and assist in pursuing new initiatives and opportunities that were identified in the ESC meetings. Other participants at one or more of the meetings included vendors and technology providers such as Lockheed-Martin, ABB, Saft, BoxPower, and Alaska Native Renewable Industries.

2017 Summary

In Q1 2017 we held the first ESC meeting under this TA grant. It was highly successful with over 40 participants and training and discussions centered on heat pumps, bulk fuel, and creating a Joint Action Agency. In Q2 2017, with the same agenda, we held community meetings in Kiana, Deering, and Buckland. In Q3, we held our last community meeting of 2017 in Selawik. This brought together the City and Tribe as well as other local entities and highlighted the ongoing challenges with energy requirements to maintain a sprawling and antiquated piped water and sewer system, in particular to keep it from freezing. This has remained a focus of our program and is now centered on a collaborative effort with AVEC to improve reliability and heat recovery in the power plant along with a high penetration solar-battery hybrid system and possible re-evaluation of the wind regime in the community for future wind energy development.

2018 Summary

In Q1 2018 we held a community energy meeting in Noatak, where we discussed the unique challenges there with no direct river access to the community, requiring all goods, including diesel fuel, to be flown in. In Q2 2018, we partnered with the Alaska Technical Center in Kotzebue to have Solar Energy International conduct Solar PV training in Kotzebue. In Q3 2018, we held village energy meetings in Shungnak and Ambler with the Northwest Arctic Borough. With DOE-OIE Senior Management and other DOE Office personnel based in Washington, DC in attendance at the community meetings, we discussed the solar potential, and an intertie between Ambler and Shungnak. This resulted in a more formal request for additional technical assistane from DOE's in-house staff, including representatives from the National Renewable Energy Laboratory, to evaluate the technical and economic options for an intertie that could open up access for a large hydropower project and wind development to serve the three communities of Ambler, Shungnak, and Kobuk (Ambler and Kobuk are already electrically

interconnected). In Q4 2018, NANA and the NAB held the Energy Steering Committee Meeting on October 16 – 17 in Kotzebue. In attendance were 40 participants from the villages, energy industry, state and federal agencies. In November 2018, we also presented at the NAB's Economic Development Committee meeting in Kotzebue. The presentation aimed to articulate a regional energy structure similar to what the NAB has done with sewer and water, namely, regionalize the services to create an economy of scale and incentives to reduce costs, which has resulted in a reduction of sewer and water rates of over 50% throughout the Borough.

2019 Summary

In Q1 2019, NANA and the NAB held another Energy Steering Committee Meeting in Kotzebue. On the first day, DOE, BIA, NANA, NAB, and DeerStone Consulting gave solar and battery project updates and informational presentations. Climate change issues and alternative funding opportunities associated with a Green Bank were presented by the Renewable Energy Alaska Project (REAP). The Alaska Native Tribal Health Consortium discussed their projects in the region, especially around energy savings coming from energy efficiency improvements in the sewer and water systems and heat recovery. The Alaska Village Electric Cooperative presented on their projects in the region. Village Representatives also discussed their current projects, along with energy priorities. This dialogue continued to help develop the action plan for future projects. For example, we identified some land management needs resulting from biomass harvest activities around the village of Kobuk and their biomass boiler used for community water heating. We are applying these lessons learned as the community of Ambler is now developing its biomass project that is patterned off of Kobuk's project. Based in part on this discussion and collaboration, Ambler was eventually successful in securing funding from USDA to essentially replicate the project in nearby Kobuk. This is an ideal example of the ESC process and the technical assistance activities that this effort is designed to address. It was also decided by the Energy Steering Committee that climate change mitigation would be included in the overall ESC Mission Statement.

We also continued our research on the formation of a regional energy authority. This overall effort became a combination of DOE support under this Technical Assistance award for community outreach and education combined with the Bureau of Indian Affairs – Tribal Energy Development Capacity program. Specifically, we contracted with Baker Tilly using BIA-TEDC funding to evaluate the feasibility of creating a Joint Action Agency to facilitate energy development, efficiency, and cost reductions throughout the region. The results of this preliminary research were presented in Kotzebue during Q1 2019 accompanied by a robust discussion on day 2 of the ESC meeting. A final report was completed in Q4 2019. NANA, NAB, Baker Tilly, and DeerStone Consulting continued to build a roadmap to stand up a Joint Action Agency or a Northwest Arctic Power Agency for the Northwest Arctic Region. A Joint Action Agency slide deck was prepared for the ESC that was scheduled for October 7, 2020. Covid-19 intervened to cancel this ESC meeting in October 2020 and the scheduled spring 2021 ESC meeting.

In Q3 2019, we identified another concept that we are now exploring: the development of regional Independent Power Producers (IPP) that would sell power to the local utilities such as the Alaska Village Electric Cooperative (AVEC). This concept has emerged as an outgrowth of our successful solar-wind-battery-diesel hybrid systems in Deering and Buckland, which are now operational, and a successful grant for developing solar and batteries in the communities of Shungnak and Kobuk, which intends to sell power to AVEC, as it is the local utility. An IPP would help to minimize the loss of Power Cost Equalization (PCE) when powering the communities with renewable energy rather than diesel fuel. The current PCE formula decreases state subsidy if diesel consumption decreases but allows for purchased power costs in the PCE formula, which could be accomplished with an IPP. An introductory and

educational presentation was made for the upcoming virtual Energy Steering Committee meeting that is to be held on October 7, 2020.

In Q4 2019, NANA and the NWAB held another Energy Steering Committee (ESC) meeting in Kotzebue. On October 15 & 16, we had 54 people attend, when we were expecting 40-45 people. On the first day, the NWAB and NANA reviewed the energy priorities with village representatives and regional entities. All village representatives presented on their community's energy issues and we discussed potential solutions. The NWAB also discussed regional fuel cost/usage and the heat pump training that was held at the Alaska Technical Center in Kotzebue. On the first day of the ESC meeting, NANA gave a microgrid description and an update on the Buckland and Deering microgrids. Deering and Buckland were both able to achieve diesel-generator off operation when renewable energy and battery charge met the load. NANA also discussed upcoming projects, which include Joint Action Agency formation, and the Shungnak-Kobuk solar-energy storage project. Village reps talked about their energy concerns and priorities. Also in attendance were Denali Commission, Boxpower, Baker Tilly, Saft, and the US Department of Interior's Division of Energy and Mineral Development and Alaska Village Electric Cooperative (AVEC). Each guest gave an educational presentation and talked about upcoming energy projects in the NANA Region. Our next ESC meeting is scheduled for July 2021, pending covid 19 mandates.

Separately, and discussed in more detail below, the NANA energy team participated in and presented at the DOE-OIE Annual Program Review in Denver in Q4 2019. We also attended the Energy Storage North America conference in Q4 2019, where we learned more about batteries, microgrids, residential technology options, new and emerging energy storage technology, and met with individual vendors and service providers that may be useful to our region. In Q4 2019 we also began the application process to pursue a DOE-OIE grant for solar and energy storage for the village of Noatak, but based on various requirements of the application including 50% cost share, we collectively decided to not pursue this opportunity despite Noatak's tremendous need. In lieu of the DOE-OIE grant, an application for the USDA High Energy Cost grant was submitted to address the energy needs for the village of Noatak. The USDA grant application was denied.

2020 Summary

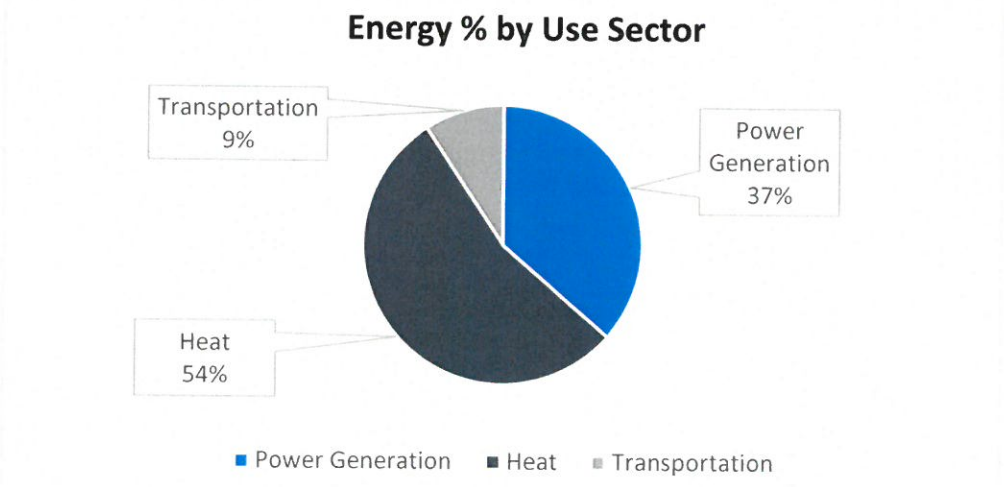
On January 11, 2020, we traveled to Noatak with a coalition including representatives from the Denali Commission and DOE-OIE to discuss Noatak's intent to apply for future funding for a community-scale solar and battery storage project. With approval from the tribe, we began weekly meetings with a technical team consisting of NANA, NWAB, AVEC, Deerstone Consulting, and KUNA engineering to support a USDA grant proposal for a solar-battery project in Noatak. This was modeled off of the ongoing Shungnak-Kobuk project in terms of coordination with AVEC and negotiating a Power Purchase Agreement with a locally sponsored IPP. Ultimately the USDA grant application was not awarded, however we were able to re-use much of this work for the DOE-OIE grant application for the next year.

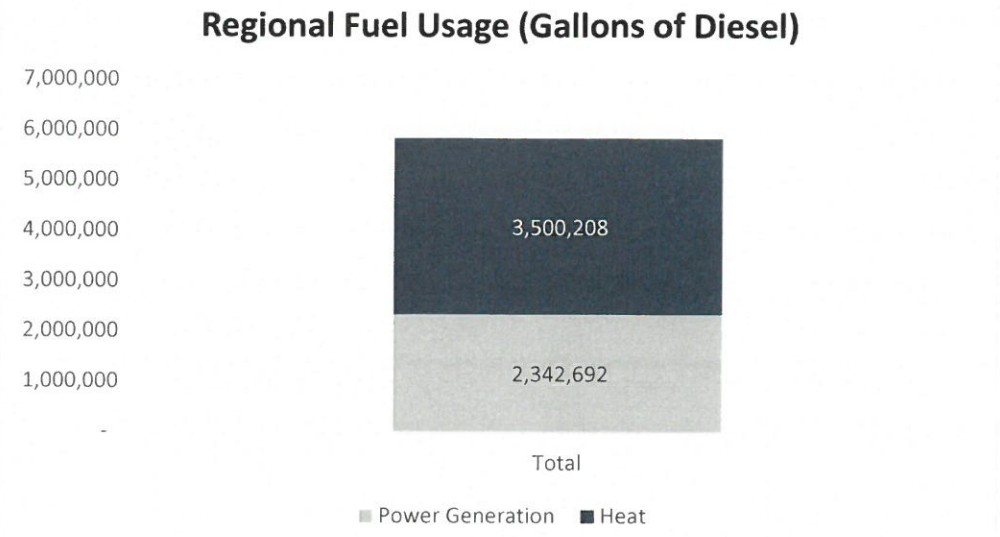
In Q1 2020 we also made significant progress on developing an "IPP Calculator" to demonstrate the value of having an IPP develop renewables projects in individual communities and preserve the overall PCE payment to the community, regardless of utility structure. We prepared a public presentation that we eventually shared much more broadly across the region and shared with DOE-OIE in a quarterly report. The DOE TA funds are instrumental for developing and testing this IPP Calculator. In fact, we were planning on having it ready for our Spring 2021 Energy Steering Committee meeting that was

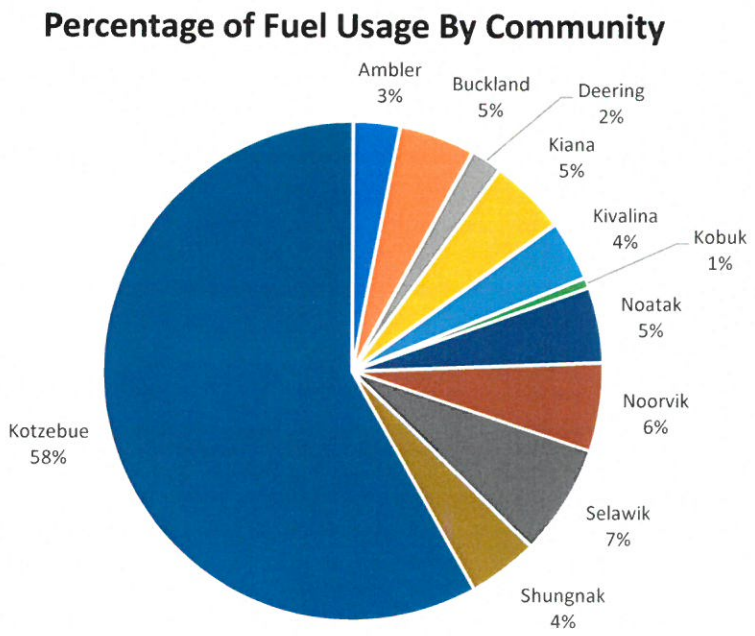
originally scheduled for April 6-8 in Kotzebue, but this meeting was cancelled because of the Covid-19 crisis, along with any other travel to the region.

In Q1 2020 we also supported the Northwest Arctic Borough in advancing the Shungnak-Kobuk solar-battery project, specifically by assisting with the Request for Proposals that was issued to solicit contractors for implementing the USDA-funded project. The RFP was initially issued in late January 2020 and then revised because of various legal concerns and technical details, with a final due date of mid-March. Ultimately the award of funds to one or more contractors was delayed because all of the bids came in over budget and because of ongoing Covid-19 concerns with completing the project this year. We put the project on hold, and aimed to secure additional funds, which required significant effort in Q1- Q3 2020.

Much of 2020 was of course subsumed by responses to the Covid-19 global pandemic. Many NANA villages were hard hit with high case counts, severe illness, deaths of several elders and tribal members, school and business closures, complete village lockdowns, and loss of a regional air carrier, to name but a few of the impacts. Travel to the region was generally unavailable, so we had to shift to remote operations, which was complicated by the poor internet connectivity of most of the communities. Our efforts primarily focused on developing a robust data collection process for establishing baselines and a clearer picture of energy use and production in all of our villages. This resulted in detailed information presented to NANA's Board of Directors that fed into a broader regional strategic energy planning effort. Some of the findings of this analysis are presented below.







Percentage Diesel Fuel Consumption by Community in the NANA region. Includes Fuel used for Heat and Power Generation. Approximate annual average, 2016-2018.

Community	Total kWh Generated	Amount of PCE Eligible kWh	Percent of Eligible PCE kWh vs Total kWh	Average PCE payment per eligible kWh	Total PCE $ Provided by State[1]
Kotzebue	19,495,001	5,193,926	26.6	$0.17	$882,967
Ambler	1,203,842	512,557	42.6	$0.35	$179,395
Kobuk	589,251	244,188	41.4	$0.37	$90,349
Shungnak	935,175	401,851	43.0	$0.37	$148,684
Kiana	1,559,473	704,591	45.2	$0.36	$253,652
Noorvik	1,889,048	941,454	50.0	$0.30	$282,436
Selawik	2,474,856	1,194,311	48.3	$0.31	$370,236
Buckland	1,370,629	559,286	40.8	$0.11	$61,521
Deering	679,579	288,781	42.3	$0.34	$98,185
Kivalina	1,462,209	504,690	34.5	$0.34	$171,594
Noatak	1,809,413	814,374	45.0	$0.54	$439,762
Total	**33,468,477**	**11,360,009**	**33.9%**	--	**$2,978,785**

Total Annual PCE Contribution to NANA Region, 2019.

Clean Energy Projects in the NANA Region, 2020

[1] *Total does not add exactly because of rounding error*

Current NANA Regional Clean Energy Projects

Location	Project Description	Status	Expected Savings	Note
Kotzebue	576 kW solar PV	Complete July 2020	~ 39,000 gallons annually	
Kotzebue	2 MW Wind + 950 kWh battery storage	In operation for over 3 years	~250,000 gallons annually for KEA + ~8,000 gallons annually for Maniilaq health care facility in wind-to-heat application	This is currently factored into regional consumption, but results in KEA having ~ 850,000 gallons spare storage capacity annually
Kotzebue	2 MW Wind + 2 MWH battery storage	Future goal, but no existing funding or plans for implementation	~ 300,000 gallons annually	Achieving this amount would allow KEA to use entire 1 million gallon storage tank as excess for other purposes, e.g., lease space, sell #1 fuel for heating instead of #2 that they use for generation
Deering	100 kW wind + 50 kW solar PV + 120 kWh battery storage	In operation for ~ 5 months	~23,000 gallons annually	Performance addressed in Appendix 1
Buckland	200 kW wind + 50 kW solar PV + 2400 kWh battery storage	In operation for ~ 15 months but data collection just now starting	~43,000 gallons annually	Performance monitoring in process
Buckland	250 kW diesel generator replacement	Funding received August 2020; implementation in 2021	~10,000 gallons annually	Will include improved monitoring for entire power system, including renewable energy
Shungnak-Kobuk	200 kW Solar PV + 335 kWh battery storage	Project funded, construction expected 2021	~13,000 gallons annually	Will create Independent Power Producer with power sales to AVEC; first ever in Alaska
Noatak	150 kW Solar PV + 335 kWh battery storage	Funding request rejected, July 2020; Considering re-submission	~10,000 gallons annually	
Ambler	Biomass - wood energy displacing diesel heating fuel at Washeteria	Under Construction, expected completion - October 2021	~5,000 gallons annually	
Ambler	30 residential heat pumps + 50 kW of solar PV + whole village energy efficiency	Under Construction, expected completion 2021	unknown	Funded through Village Improvement Fund
Kobuk	Biomass - wood energy displacing diesel heating fuel at Washeteria	In operation for over 3 years	~6,000 gallons annually	Currently factored into regional consumption

Our first ESC meeting for 2020 was scheduled for early April, but of course, that was cancelled. The second scheduled ESC meeting, for Fall 2020, was also cancelled.

On September 25, 2020, ANTHC notified NANA that they had lost recovered heat in the water treatment plant in Deering. Initially, ANTHC thought that the newly installed microgrid had shifted energy costs from the electric grid to the water/sewer plant. Throughout Q4 2020, NANA assembled a team consisting of NANA, ANTHC, DeerStone Consulting, Kotzebue Electric Association, and the Community of Deering, to troubleshoot the loss of recovered heat. After a thorough investigation that included detailed troubleshooting (albeit remotely) of several subsystems and coordination with the local power plant operator to check designated components, it was found that a flow valve had been closed, preventing recovered heat from the diesel generators from flowing to the heat exchangers and on to the glycol system and the water treatment equipment. The remedy—opening the valve—is now saving a few thousand gallons of fuel annually and was the direct result of the team effort that was sponsored in part through this DOE-OIE grant support.

In Q3 2020 we re-engaged on the Shungnak-Kobuk solar and battery RFP with the Northwest Arctic Borough. Specifically, we revised the draft RFP and re-issued the Request, soliciting bids for the project. Along with a revised RFP, the communities applied for additional funding through the Village Improvement Fund. It was awarded, which provided additional funds to fully complete the project in terms of preferred system sizing, which would be about 200 kW of solar and 335 kWh of battery storage. We worked closely with the Northwest Arctic Borough, the Tribes in Shungnak and Kobuk, and the Alaska Village Electric Cooperative (AVEC) to develop this project, which included the creation of an Independent Power Producer to sell power to AVEC. This also required AVEC to upgrade the diesel powerhouse in Shungnak, and we were involved in coordinating the necessary system integration and controls to be compatible with AVEC's new equipment. This is now the first IPP in the region (and the state) that will be selling renewable power on any significant scale to AVEC, the largest utility cooperative in rural Alaska.

The Joint Action Agency (JAA) formation/Northwest Arctic Power Agency was still on-going in Q4 2020. NANA and Baker Tilly partnered with the Native Village of Kiana to submit a grant application that completed the JAA feasibility assessment and identified detailed requirements for the formation documents along with additional economic analysis. This BIA support, awarded through the Native Village of Kiana for the entire region, allowed us to complete the financial and institutional analysis to develop both the Joint Action Agency and the Independent Power Producer corporate structure and formation documents. The grant agreement was signed on April 5, 2020. Though this grant remained distinct from the existing DOE-OIE Technical Assistance grant, it supplemented our efforts and accelerated the development of a regional entity to provide energy services and lower costs for our communities.

Throughout much of 2020, we held weekly meetings with many of the potential stakeholders in the formation of a JAA, and DOE TA funding supported NANA staff and DeerStone contractors in these meetings, which have also refined the IPP calculator and an ever-evolving public presentation on these issues. NANA and Deerstone Consulting also assisted the Northwest Arctic Borough and Tribes in the region in submitting an Economic Development Administration grant application to help with start-up funding for the Joint Action Agency. The EDA grant application was submitted on July 10, 2020 though most of the work occurred in Q2&Q3 2020. The Economic Development Administration funding request was denied because it did not meet the Covid-19 guidelines. (In Q1 2021 EDA did reach out to the NAB and asked them to submit another funding request for the project.)

As well, we assisted the community of Buckland with developing and submitting a grant to replace some of their diesel gen-sets through the Diesel Emissions Reduction Act (DERA) program with funding provided by the US Environmental Protection Agency. This was another group effort with NANA's Village Energy Program, the Tribe and City of Buckland, the Northwest Arctic Borough, and DeerStone Consulting. This work occurred primarily in Q2 2020 and the proposal was submitted in early July 2020, at the beginning of Q3.

After receiving a rejection from the USDA for the proposed Noatak solar and battery hybrid system, in Q4 2020 the Regional Energy Team decided to pursue once again the DOE-OIE Tribal Deployment grant opportunity once the 50% cost share was reduced to 10% by DOE-OIE approval.

2021 Summary

In Q1 2021 Buckland received notification that the EPA DERA grant for diesel generator replacement would be awarded to them. Later that quarter we conducted a site visit to Buckland to collect data and meet with the community and then drafted two RFPs, one for diesel generator purchase, and one for generator installation. The generator purchase RFP was posted and a winner selected. These activities, i.e., to help the community and accelerate the process so we can place equipment on the upcoming summer barge, occurred with support from this DOE TA grant, but the generator and installation will be paid for with the EPA DERA funds. We also helped Tribes request Volkswagon funding for diesel generator replacement in Deering and Buckland. As well, we were troubleshooting Buckland's and Deering's new microgrid controls with ABB, including detailed data collection, remote internet access, and integrating the communications between the ABB supervisory controller and all the other assets such as the solar PV, wind, diesel, and batteries, and starting to analyze performance of the various renewable energy systems.

This resulted in some very interesting determinations, such as the village of Deering operated with the diesel generators turned off for 71% of the month of April 2020 and over 90% of all generation in April was from wind and solar power. As a result of our new and increased ability to collect detailed performance data, we essentially completed the development of an "Independent Power Producer Calculator" for the community of Deering, demonstrating the value of creating an IPP and the community benefits this can provide. We also created a presentation for the Northwest Arctic Borough and NANA's leadership to describe the concept of a Joint Action Agency and highlight the differences between a JAA and a cooperative.

In Q1 2021 we attempted to travel out to Deering to present on the Independent Power Producer concept and its opportunities. Deering was identified as an early adopter to establish an IPP that would lead to the formation of the regional energy entity for all the Tribes and communities in the region. However, bad weather prevented us from traveling to Deering. Instead we met with the NAB in Kotzebue to discuss regional priorities and energy funding opportunities. As well we met with Kotzebue Electric Association(KEA) and the Native Village of Kotzebue to present on the IPP concept. We also talked about building an IPP calculator for Kotzebue-specific data. It would show KEA what the benefits are if a local IPP sold solar and possibly wind energy to KEA. By preserving the Power Cost Equalization (PCE) state subsidy, the utility could use the money for insurance and maintenance purposes.

Also in Q1 2021, as stated previously, we continued to help the Native Village of Noatak refine their project concept for a high penetration solar and battery hybrid system to integrate into the existing diesel electric grid. This culminated in a DOE-OIE deployment grant application under a TEDO that was formed between the Native Village of Noatak and the Northwest Arctic Borough that was submitted in Q1 2021. In Q3 2021, the TEDO was informed that the grant application was successful and negotiation for final award has been ongoing.

Alaska Native Renewable Industries installed the solar and battery system in Shungak over Q2-3 2021 and the system is now fully operational, successfully integrated with AVEC's diesel powerhouse and running in diesel-off mode whenever there is sufficient battery charge.

In Q2 2021, Deerstone Consulting and NRC traveled to Deering to perform several operating and troubleshooting tasks. The team retrieved data from the ABB system for performance analysis, which was not possible to do remotely because of internet connectivity challenges. Some of the operating data that was analyzed include wind, solar, battery, and diesel generator off operation. During the site visit, it

was discovered that the HMI production data is different than the Easygen's production data. The team discussed where to pull the daily production data from for Power Cost Equalization (PCE) Reporting.

For several months, the wind turbines were not operating. It seemed there was no communication from wind turbine to the powerhouse. It was found that the Ubiquiti radio was damaged by a raven. This has since been repaired, and is currently operating. Another issue that was discovered was the powerhouse router needs to be upgraded. The existing router has been in place since 2005.

DeerStone Consulting and NANA performed another site visit to Deering on May 17. The purpose of the visit was to repair the wind turbine communications, and perform annual maintenance on the wind turbine. Antennas were replaced for both the wind turbine and the community solar array. ABB still needs to integrate the HMI and ensure that full communication is restored to the wind turbine. NANA and Deerstone Consulting are scheduling final commissioning for with ABB and the utility operators. This activity will occur after the end of this DOE TA grant and will be supported by NANA's Energy Program.

NANA and DeerStone Consulting continued to support the village of Buckland with procurement and installation of new diesel generators under EPA Diesel Emissions Reduction Act grant award. A contractor was selected and the generators were installed in Q3 2021, despite significant Covid-19 created supply chain bottlenecks and delays.

In Q2 2021 we also supported the Native Village of Noatak IRA Tribal Council in applying for a Northwest Arctic Borough Village Improvement Fund award to advance their solar and battery project goals and begin discussions with AVEC to similarly sell renewable power to them if the solar PV and battery project is fully funded. This was successful and will result in a solar array of approximately 275 kW and a larger battery capacity.

In Q3 2021 our energy team traveled to Deering to install a Fortigate router. This helped to operate the power system and allowed the system to operate in auto mode. A meter for Deering is still not finalized. The new diesel generator in Deering has been installed and commissioned, and has been integrated into the microgrid controller by ABB Hitachi.

A Power Purchase Agreement to sell solar and battery power from the Shungnak-Kobuk solar array to AVEC was completed in 2021. This agreement has been a major focus of technical support for our NANA Energy team. We worked closely with the Northwest Arctic Borough and DeerStone Consulting on finalizing this agreement. This will be groundbreaking for rural Alaska – the first sale of power from an Independent Power Producer to AVEC in history. This could not have occurred without DOE Technical Assistance support from this grant project.

On July 23, 2021 NANA and the DOE Arctic Energy office traveled to Deering to observe the microgrid in operation. During this visit, diesel-off operation was demonstrated.

NANA and the DOE Arctic Energy Office toured the Kotzebue Solar Array. During this tour, it was observed that Alaska Center for Energy and Power (ACEP) were setting up equipment to perform a vertical bifacial solar data analysis.

On August 4, 2021, NANA and the NAB met with the community reps to let them know that the energy team would be updating the Northwest Arctic Regional Energy Plan. Specific potential projects such as Kivalina wind and Selawik wind were discussed at this meeting, as well as future partnership

opportunities with ANTHC and AVEC. All of these partnership opportunities have been enhanced by the expanded technical capacity demonstrated by NANA's energy team that has been significantly supported through this DOE TA grant.

On August 5, 2021, NANA and the NAB held another Energy Steering Committee meeting in Kotzebue. We limited our attendance to 27 people due to the Covid mandate. The NANA Energy team started off by giving an update on the Deering and Buckland microgrids. Our focus was on preliminary performance results along with operational issues. On another project, Edwin Bifelt of Alaska Native Renewable Industries gave an update on the Shungnak-Kobuk Solar/Battery Project. Edwin talked about the equipment and some of the challenges during construction (i.e. permafrost and ground-screw installation and almost 30 straight days of rain). Our solar discussion then moved on to the announcement that the Native Village of Noatak is receiving a $2M grant from DOE-OIE to install a community solar array and energy storage batteries. These projects led to the continued discussion of the Independent Power Producer formation for Shungnak-Kobuk Solar Project. AVEC gave an update on their regional energy projects and also talked about the importance of PCE to rural Alaska, which is once again threatened by the current Alaska governor. ANTHC gave an update on the Ambler Biomass Project, where they discussed gravel needs and an October start up date. University of Alaska came in and discussed the Kotzebue Mitsubishi Heat Pump study, where they are collecting data on home heating fuel usage. NAB gave an update on the Ambler Energy Efficiency project utilizing LED, Solar, and heatpumps. 70 households in Ambler received a heat pump, along with LED upgrades. ANTHC – Community Utility Assistance Program (CUAP) gave an update on the program benefits, which are reduced water and sewer costs, and improved training to reduce system failures. Finally, the communities and regional partners talked about their energy issues and priorities.

Conclusions and Recommendations

The last ESC meeting in August 2021 was a culmination of five years of intensive work, much of which would not have occurred without support by DOE. While we limited the attendance to 27 people because of Covid requirements, there was significant interest and we could have likely had twice as many participants. True to the original requirements, we are attempting to make this a self-sufficient effort through creation of IPPs and regional membership that will support a regional energy organization, but the economics are challenging and we are still in the early phases. Additional regional support would be a tremendous boon to our ongoing efforts so we do not have to scale back and reduce the momentum that we have generated over time.

Through this work, we have substantially strengthened our relationships and technical sharing with all the villages in the region along with AVEC and ANTHC. This has already demonstrated potential benefits, as we are now in discussions with AVEC about a new funding application for the next round of Alaska Energy Authority's Renewable Energy Fund in which we would conduct final design for four solar-battery hybrid systems to cover most of the remaining NANA region communities that do not have high penetration renewables in their system. These projects are premised on the system designs and installations we have completed to date and an assumption that we will be able to easily replicate the PPA with AVEC to establish locally, Tribally-led IPPs throughout the region. Once these are all established, there should be sufficient funds for a regional organization to support these projects, but this is likely two years away at a minimum.

Another round of DOE Technical Assistance support would go a long way toward sustaining the momentum we have created. This grant was unique in that it was multi-year and largely open-ended to

allow us to respond in a timely way to local and regional issues that were sometimes unanticipated but needed to be addressed quickly, as well as providing resources to conduct long-term planning and scenario analysis that could help us direct our future instead of always been reactive to events.

The capacity development that occurred through this grant award cannot be over-stated. Both internally at the regional level, i.e., NANA and NAB, and also locally at the Tribal level, this TA grant was instrumental in providing technical training, information exchange, and overall energy education and expectations to the region such that "clean energy" and "diesels-off" are now commonplace terms with multiple real-world examples to examine and reference. Much as Kotzebue was an early leader in low temperature wind turbine development with permafrost soils and islanded diesel electric grids, the rest of the region has become an early leader in high penetration wind-solar-battery-diesel hybrid systems and diesel-off operation. DOE's support and contribution to these efforts have been fundamental and irreplaceable. We are both grateful and hopeful that our collaborations will continue in various ways long into the future.

It should also be noted that NANA's Inter-Tribal Technical Assistance efforts intersected with other regions' initiatives under the same DOE funding, which included our ESC meetings hosting representatives from the Kawerak and Calista regions and coordinating closely with the Tanana Chiefs Conference Energy Program Manager and the other TA grant recipients across Alaska and with the Midwest Tribal Energy Resources Association (MTERA) as well. This has resulted in MTERA personnel performing some contractual work in our region and across Alaska that has added to our capacity and ongoing relationships among many stakeholders that would not have had the opportunity to share and exchange information were it not for these venues. While it is important to quantify the tangible benefits, it is also important to recognize the intangible benefits, such as capacity building and enhanced collaboration that has resulted in, for example, Power Purchase Agreements, that have emerged from this DOE support. In short, our primary recommendation/request would be to re-establish a Technical Assistance funding solicitation that allows for a similar approach as that applied here, i.e., maintaining the overall DOE-OIE technical assistance infrastructure from an institutional perspective, but also funding local/regional solutions that include the on-the-ground stakeholders, private contractors who have unique expertise and experience with Tribal communities, and energy technology providers and project developers.

Lessons Learned

There is a need for more capacity building and microgrid training. Power plant operators and the process control technicians need more on-site training to trouble shoot problems when they arise. There's a broad spectrum of skillsets that are needed to support future energy projects. Some of these include train the trainer, diesel mechanics, utility management, and IT support.

These needs and challenges will remain, and even increase, as more sophisticated systems, such as renewable energy hybrid microgrids, are installed and integrated with legacy infrastructure. Hence, we see technical assistance support as essential for long term community and system sustainability. This support has been provided in the past by DOE and the Alaska Energy Authority, among others. NANA and the Northwest Arctic Borough have also provided institutional resources for technical support and continue to do so. We look forward to continuing this effort in partnership and are grateful for past support.