2024 Alaska Rural Energy Tour Report

Produced by IEEE Smart Village

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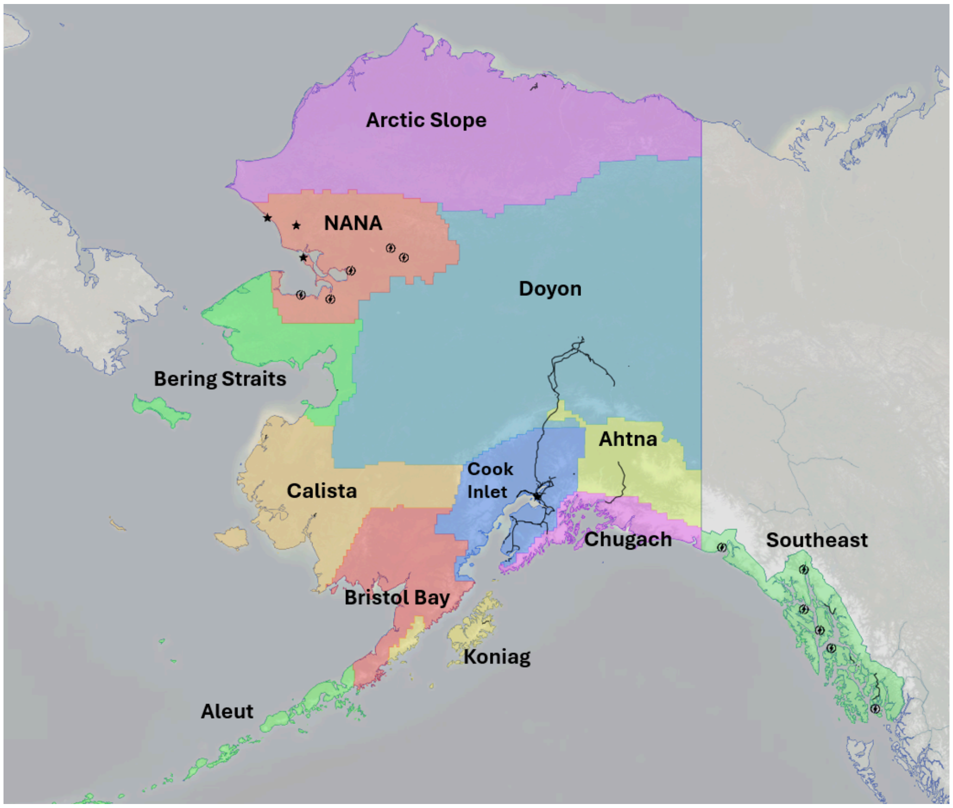

(Map, photos from trip, and report with clickable links available at https://github.com/overview-solutions/AlaskaEnergy)

Abstract

Rural communities in the harsh environment of the Arctic face a number of unique challenges given the high costs for energy, transportation, resources, and other basic needs. Given the planet's warming climate, there are several emerging changes to the local ecosystems that can be difficult to understand and plan in light of, and present potentially significant risks to these marginalized communities. Meanwhile, there are a number of emerging technological advancements that are driving both the supply and demand for energy. This report will focus on emerging trends in these natural and technological ecosystems with respect to energy that may create unique opportunities for these communities to align with in order to prepare themselves for generations to come.

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Introduction

A group of four IEEE Smart Village volunteers (authors of this paper) traveled to Alaska with two primary objectives: attending the Alaska Sustainable Energy Conference, and visiting remote villages considered underserved. With logistical and networking support from Melanie Welsh of Alaska Unlimited, this trip provided a unique opportunity to engage with industry experts and local communities, gaining insights into the challenges and innovations in Alaska's energy landscape.

Trip Itinerary

1. Sunday May 19: Team Members arrive in Anchorage, Alaska
2. Monday May 20: Start of Pre-Conference activities
3. Tuesday May 21: Day 1 of Conference
4. Wednesday May 22: Day 2 of Conference
5. Thursday May 23: Day 3 of Conference and visit to Knik Tribe and USAF’s JBER Alaskan Command
6. Friday May 24: Morning flight to Kotzebue and meeting with KEA in the afternoon.
7. Saturday May 25: Charter flight to Kivalina and Noatak. Return to Kotzebue Saturday evening to stay the night.
8. Sunday May 26: Flight back to Anchorage. Everyone goes their own way from here...

Insights from the Sustainable Energy Conference

At the conference, there was a strong focus on the nuclear industry and its potential benefits for Alaska, both for its communities and its mineral extraction industry. There was significant excitement around the deployment of Micro Reactors and Small Modular Reactors (SMRs). However, this enthusiasm was tempered by the realization that the first commercial systems would not be available until 2029-2030. Our team finds the current value in this space lies in the efforts to explore how these systems can integrate into and impact a range of communities and their respective power grid topologies.

Additionally, the conference highlighted the innovative approaches adopted by small co-ops and villages to enhance resilience by connecting to one another and providing electrical services. There is a determined push towards renewable energy systems, but the harsh conditions of Alaska necessitate a reliance on multiple energy sources. Consequently, while communities are eager to transition to renewables, they are cautious and deliberate in their implementation strategies. Projects in Homer, Kotzebue, and others presented on the use of excess energy from wind turbines for heating the hospitals, while others presented on hydro-powered data centers, an innovative hydro-kinetic generation system, tidal power, and several other concepts.

Combined with lessons collected from site visits in the Northwest Arctic Borough region, these insights are synthesized into this report, succeeded by recommendations for further focus.

Explorations in the Northwest Arctic Borough Region

This year, the volunteers visited the northwest borough region, contrasting with last year's visit to the central Kuskokwim region. The northwest borough is even farther north, with strong wind resources and decent solar resources, although its winter months are predominantly dark. The region has minimal industry, and many residents continue traditional subsistence lifestyles, with many supplies being flown in.

Despite the challenging conditions, some communities excel at securing federal and state funds for innovative projects. Kotzebue, in particular, stands out as a hub for this region, with a utility that is capable and innovative, making it an ideal location for pilot projects, including the potential deployment of Micro Reactors. The presence of Department of Defense resources in Kotzebue could also support and benefit from such developments.

Alaska

Alaska spans a vast land area, larger than the next three largest states combined—Texas, California, and Montana—or roughly two and a half times the size of Texas. Despite this immense size, Alaska's population is less than a million. The state's extensive territory and low population density present numerous challenges for its communities. Key issues include:

1. **Limited access to essential services**: The considerable distances between Alaskan communities often result in restricted access to vital services such as healthcare, education, and emergency response. Sparse population density makes it economically challenging to establish and maintain infrastructure and service providers in remote areas.
2. **High transportation costs**: Due to Alaska's expansive geography, transportation costs for both people and goods are significantly higher. Remote communities heavily depend on air travel, which can be expensive, particularly for transporting bulky or perishable items. This leads to higher prices for goods and services, impacting the cost of living for residents.
3. **Harsh climate and geographic hazards:** Alaska faces extreme weather conditions, including long winters, heavy snowfall, and severe storms. These conditions challenge infrastructure maintenance, transportation, and the overall well-being of communities.
4. **Limited economic opportunities**: The low population density restricts employment opportunities, especially in remote areas. Many communities rely on subsistence activities, such as hunting, fishing, and gathering, for sustenance. The lack of diverse economic sectors and limited job prospects can result in high unemployment rates and economic vulnerability.
5. **Inadequate telecommunications and internet connectivity**: Providing reliable telecommunications and high-speed internet access across such a vast and sparsely populated state is a significant challenge. Remote communities often struggle with

limited connectivity, hindering access to online education, telemedicine, business opportunities, and communication with the outside world. Efforts to address this issue include the rollout of Starlink, which has recently begun.

6. **Environmental and ecological concerns**: Alaska is home to diverse and fragile ecosystems. Balancing economic development with environmental conservation is an ongoing challenge. Climate change impacts, such as thawing permafrost, melting sea ice, and changing wildlife habitats, directly affect subsistence activities, wildlife populations, and traditional ways of life for Alaska Native communities.

Current Landscape

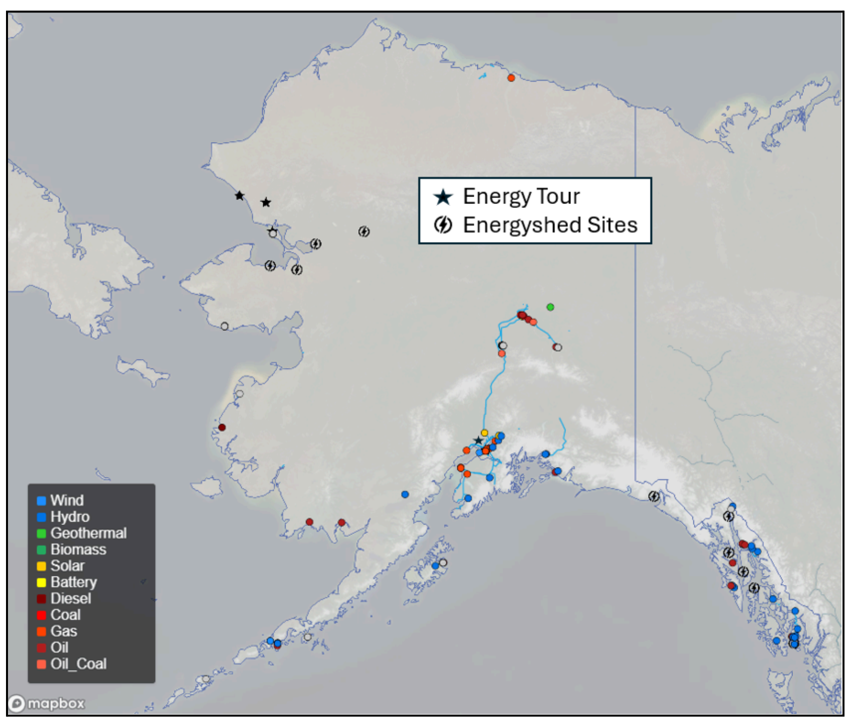
Broad Energy Context

To give a brief breakdown of the cultural dynamics that play into the use of Energy, it can best to simplify the dynamic into two main sections:

1. The developed power grid, as part of the core urban centers of Alaska
2. The disconnected microgrids of the rural villages and industrial sites.

Basically, you're either paying the city prices, or you're in a rural area getting the Power-Cost Equalization (PCE) to support the cost of energy in such rural areas.

To help outline this context, the map on the title page of this report shows the various Alaska Native Corporations (ANCs) that the state is jurisdictionally structured, similar to counties for the rest of the US. Transmission lines are traced mostly in regions around Anchorage, Fairbanks, and Juneau. In addition, Launch Alaska and the DOE's Energyshed projects are highlighted, mostly situated in the NANA and Southeast regions. Our focus on this trip was in the upper red NANA corporation. Additionally, to the right is a map of the various Generation sources currently in use throughout the state.

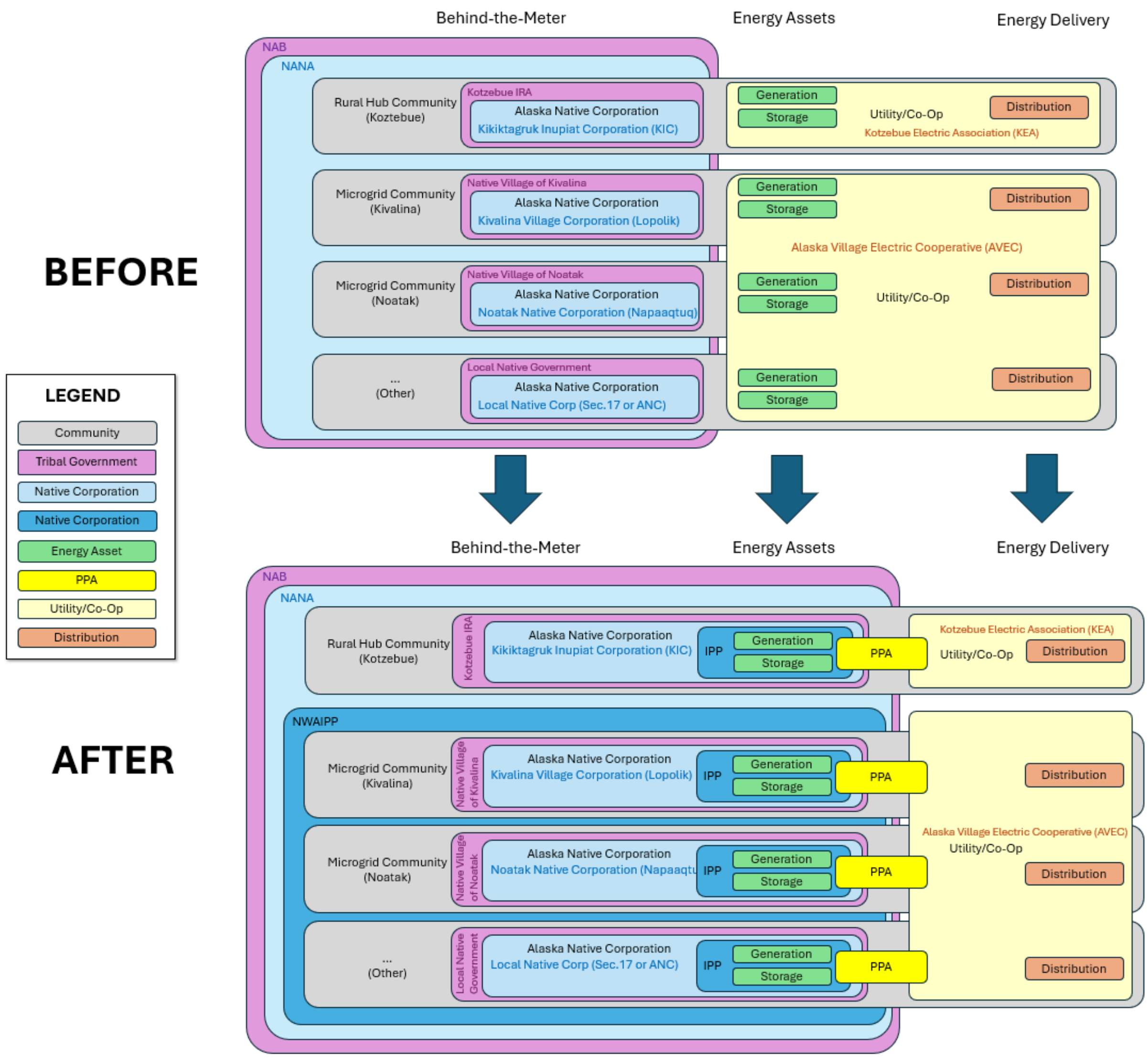


To set the stage for how PCE works, we will explore a few scenarios of how these native corporations play into relationships around the supply and demand of energy..

Energy Relationships with Native Corporations

As our team met with leaders of the various native energy stakeholders, we teased around the differences between Tribal Councils, Native Corporations, Electrical Co-ops, Utilities, and other relevant organizations that play various roles in grid operations. After several discussions we began to make sense of a transition many of these communities are going through in order to drive innovation towards energy security - defined as the stable access to energy sources on a timely, sustainable and affordable basis. This transition is something our team member Gerro Prinsloo learned of during the first ISV trip here in 2023, which Ingemar Matthiason has championed in several rural villages, and we sought to develop a greater understanding of during this trip. With this in mind, we developed the visualization below to capture how this transition happens from the operational roles of various organizations involved in this transition.

PCE-Driven Energy Stakeholder Transition



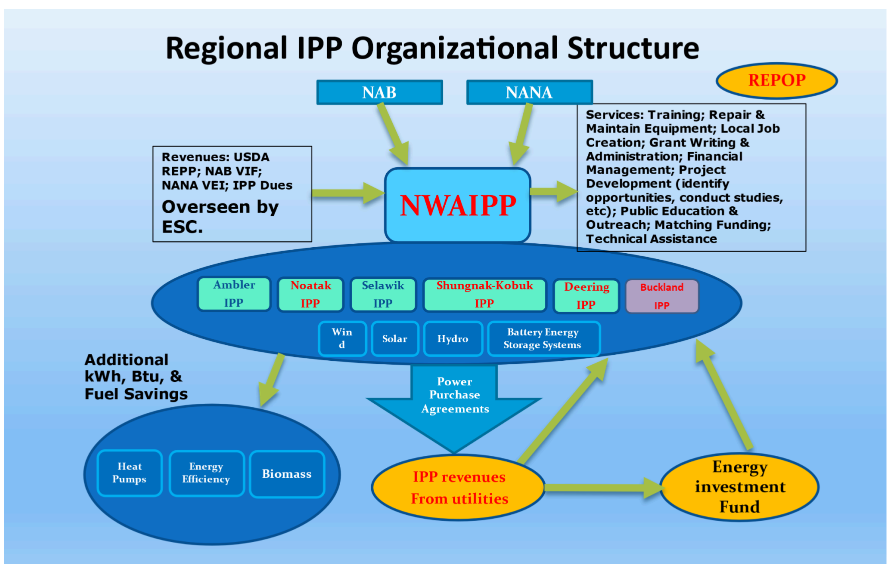
In general, this diagram only captures the 3 communities visited by our team as we toured the Northwest Arctic Borough (NAB), which is reflected in the largest purple box. Below are all of the acronyms included in this visualization:

NAB - Northwest Arctic Borough
NANA - The NANA Regional Tribal Corporation
IPP - Independent Power Producer
PPA - Power Purchase Agreement
NWAIPP - Northwest Arctic Independent Power Producer

To highlight the changes in these structures, the primary change is that the Native Corporation within each village is essentially becoming the Energy Asset operator. Their responsibilities are expanding from simple Behind-the-Meter practices to becoming in charge of the various Generation resources for the community, as well as Battery and Thermal Storage systems. To accomplish this, a Power Purchase Agreement (PPA) is established between the Native Corporations and the Co-op or Utility of the region, with the agreement that the Co-Op/Utility will purchase power at a set rate. Meanwhile the Co-op/Utility will continue to operate the Energy Delivery components of the grid (i.e. Distribution Lines, Meters, Transformers, etc) to the end customers.

The tribal governments, and other native organizations play a crucial in the decision making of these corporations, as well as the use of the revenue generated from such an enterprise. We will now explore the PCE policy that these organizational changes are adapted for, with an example that illuminates how this can drive progress in energy security.

For reference, before developing our diagram on the previous page, this diagram to the right was provided by AVEC as their original breakdown of the NWAIPP specific structure. We developed our diagram to frame things in a more tabular format that could be scaled for other villages outside of the NWAIPP, although felt it still important to include this for context.

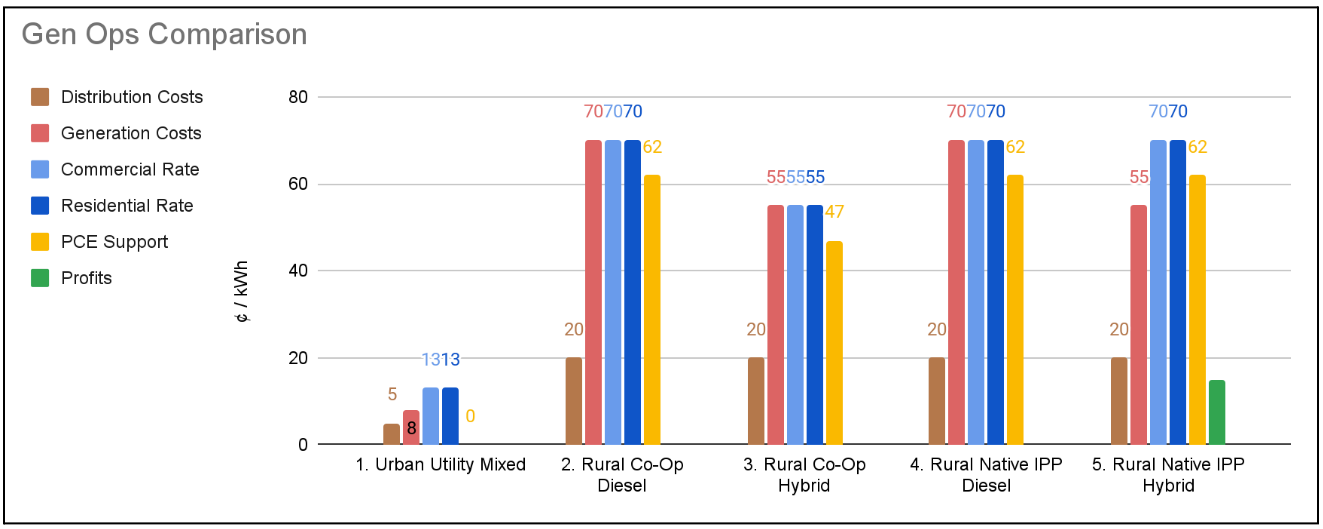


Power Cost Equalization (PCE)

Following the discovery of oil at Prudhoe Bay and the completion of the Trans-Alaska Pipeline System (TAPS) in the late 1970s, the state experienced a significant increase in oil revenues. This influx of funds led to the financial capacity for the Alaska Energy Authority (AEA), and the Regulatory Commission of Alaska (RCA) to administer a program to be known as Power Cost Equalization (PCE) in 1984. The basic approach around PCE is to make electricity more affordable in rural parts of the state. To do this, the cost of energy is averaged between the 3 most populated parts of Alaska: Anchorage, Fairbanks, and Juneau. We learned during our trip that the price of Natural Gas directly influences this rate. Whatever this cost happens to be for a certain time period, this rate is used as the cost of energy for rural areas, but only for Residential customers, and this only applies for the first 750 kWh every month. For context, the average household uses roughly 900 kWh per month.

Example Village's PCE Breakdown

Now we will explore 5 different Generation Operations ("Gen Ops") scenarios using cost estimates assisted by OpenAI's ChatGPT 4o Model (closely reviewed by humans), captured in the visualization below.



1. Utility Urban Mixed: This first scenario captures what the Urban energy breakdown. Cost of Generation based on mixed resources is on average $0.05/kWh, and then about $0.08/kWh to deliver to customers via power lines. This adds up to $0.13/kWh, which is what customers pay. On average, the distribution to Commercial and Industrial customers might be less costly than to Residential, but for this example they are relatively the same.

2. Rural Co-Op Diesel: For a rural village with a Utility/Co-Op operated Diesel system, a not-uncommon rate is $0.70/kWh to Generate electricity. Distribution costs are estimated to be at $0.20/kWh, however these values will not change throughout the various Rural scenarios, so we will ignore them when calculating the costs and bills respectively. That said, Residential and

Commercial customers are both charged **$0.70/kWh**, and the community sees **$0.62/kWh** back into a bucket village account for every Residential kWh (up to 750kWh/month per resident).

3. Rural Co-Op Hybrid: If the rural Utility/Co-Op integrates a Solar PV system that genertates electricity at $0.40/kWh, and this covers about half of the electrical needs for the community during the summer, then this brings the cost of Generation down to **$0.55/kWh**. Residents and Commercial customers pay **$0.55/kWh**, and the difference between this Generation and the urban average (of $0.08/kWh) is **$0.62/kWh**. Every customer gets a $0.15/kWh discount, although this also means that much less from Residential bills can go towards community projects.

4. Rural Native IPP Diesel: In this case, all costs are the same as in scenario 2. If there are no Generation sources other than Diesel, then there is no value in operating as a Native IPP.

5. Rural Native IPP Hybrid: This configuration is the most beneficial to the community - given the PCE dividends are fairly utilized for community development. While the cost of operations of a Hybrid system are **$0.55/kWh**, the Native IPP can still charge the going rate of Diesel-based energy of **$0.70/kWh**. They still receive PCE for the difference between the local cost of Diesel-based Generation ($0.70/kWh) and the Urban going-rate of Diesel ($0.08/kWh) for every Residential kWh which is **$0.62/kWh**, although on top of this they receive an additional **$0.15/kWh** for the cost difference between what they're able to set in their PPA of (**$0.70/kWh**) and what it actually costs them to produce the electricity ($0.55/kWh for Hybrid).

Below are the numbers used for this example:

Generation Operator	Distribution Costs	Generation Costs	Commercial Rate	Residential Rate	PCE Support	Profits
Urban Utility Mixed	5	8	13	13	0	0
Rural Co-Op Diesel	20	70	70	70	62	0
Rural Co-Op Hybrid	20	55	55	55	47	0
Rural Native IPP Diesel	20	70	70	70	62	0
Rural Native IPP Hybrid	20	55	70	70	62	15

To repeat the core difference: When the Co-Op/Utility operates Energy Assets, they cannot sell it for more than the means of production, so they have to sell it at $0.55/kWh in this case. When a Native Corporation IPP operates Energy Assets, they can sell it at the full avoided cost of diesel ($0.70/kWh).

One other nuance of this is that in the case of the Native Corporation operating the 50/50 energy profile, the PCE fund has to pay more money to offset the difference between that and the averaged rate for populated areas ($0.08/kWh), while it doesn't have to pay as much to a Co-op/Utility that might be only capable of selling it at the cost for production of $0.55/kWh). In other words, if the Native IPP doesn't distribute the PCE recovered funds effectively, then it is in the community's interest to operate from a Utility/Co-op Hybrid perspective.

It is important to note here that Commercial customers could offset this $0.70/kWh bill by installing their own renewable energy sources. The community wouldn't receive any PCE support as that energy wouldn't be metered and accounted for in PCE adjustments, but whatever they can produce at a cost that averages out to anything less than the going cost of diesel is in their interest if the Native IPP isn't utilizing the PCE recovered funds effectively.

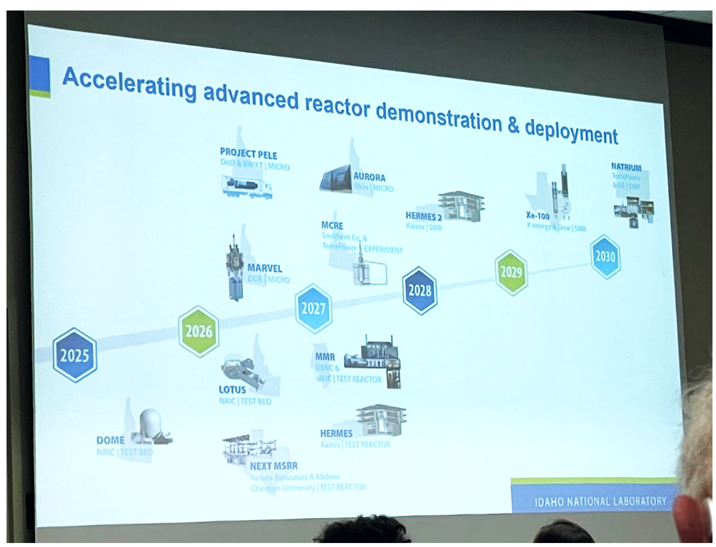
This is an adaptation of a few scenarios covered in the University of Alaska at Fairbank's (UAF's) Alaska Center for Energy and Power (ACEP), designed to more accurately capture what the customers a billed, versus how much money from PCE is proportionally received using ChatGPT-4o assisted estimates that were closely reviewed by humans: https://www.uaf.edu/acep-blog/a-back-of-envelope-look-at-how-pce-and-renewables-interact-in-rural-alaska.php

For more information on PCE from AVEC, follow [this link](#).

Emerging Trends

Trend 1: Nuclear

Small Modular Reactors (SMRs), or nuclear reactors of roughly 20-300MW(e), have slowly earned more public interest over the past few decades for their much smaller size and risk portfolio compared to typical reactors that were built in the mid 1900s. More recently a new wave of Micro Nuclear Reactors (1-20MW[e]) have accelerated interest with an even greater reduction of risk as well as improved modularity of systems. Pacific Northwest National Laboratory (PNNL) gave several presentations around their strategy over the next several years to test and approve several advanced reactors shown below, with actual units to be commercially available by the end of the decade. Their goal is to prepare these reactors for commercialization by 2030, offering a promising solution for reliable, low-carbon energy in the coming years.



Westinghouse, Radiant Industries, and BWXT participated in the event through a mix of information booths and panel discussions, and Okla was rumored to be in attendance as well.

Radiant, in particular, is developing an innovative Micro Reactor designed to fit within a 20-foot shipping container. This compact reactor is targeted at the 1-megawatt diesel generator market, providing a potential replacement for existing diesel gen sets with a cleaner, more efficient energy source.

The discussion included perspectives from both government and industry representatives. Industry representatives expressed enthusiasm about the soon-to-be-ready products they expect to release, while government representatives echoed this excitement, acknowledging the high interest in Micro Reactors from various sectors in Alaska. These sectors include the mining industry, the oil and gas industry, and Native Alaskan tribes, all of whom are keen on utilizing this technology.

Government representatives at the conference tempered this excitement with a cautionary note—not about safety, but about the availability of these Micro Reactors. They warned that despite the anticipated commercial readiness by 2030, obtaining one could be challenging, with availability possibly limited until 2035. This reality dampened the optimism of many attendees, particularly those from Native Alaskan tribes who had entered the conference with high hopes of securing Micro Reactors in the near future. Post-conference, there was a noticeable shift in sentiment, with some considering the need to deprioritize this approach due to the extended timeline and uncertainty of access.

Trend 2: Artificial Intelligence (AI)

With the recent advancements of AI in the past few years, demand for stable power across the grid is booming. Many developed areas that have seen growth stagnate in the past several decades matching population levels are now seeing a rapid spike in bids for new generation, transmission, and energy storage systems to serve the needs of the data centers associated with AI, as well as the populations making use of this technology.

While attending the Alaska Sustainable Energy Conference, our team listened to Alaska's Governor Mike Dunleavy harp on estimates of the growth of AI driving demands for a 6x increase in power needs over the coming years. While the timeline and actual numbers seem somewhat vague, this drove a lot of justification for the continuation of all fossil resources at their current rate in addition to any new clean and renewable energy sources.

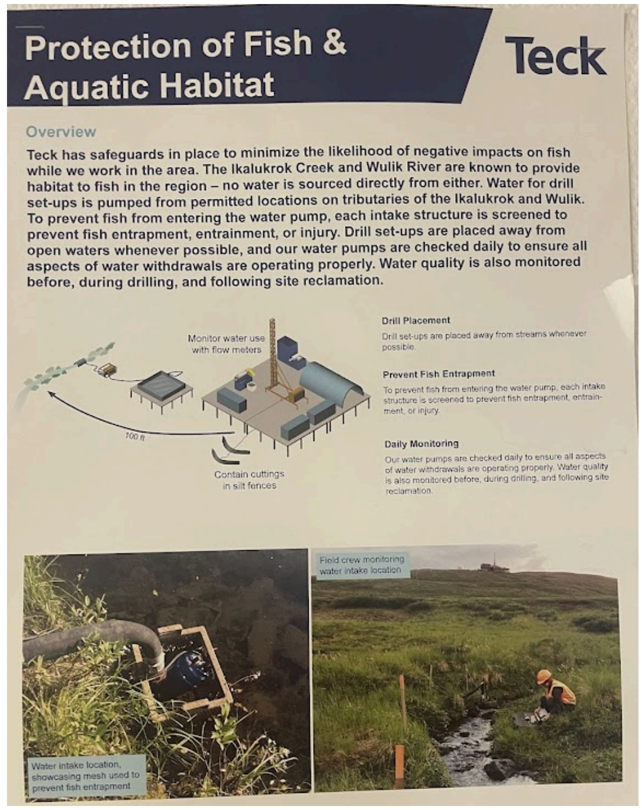
Trend 3: Hydrogen

Hydrogen offers an innovative solution as a stable long-term energy storage fuel. This can be especially useful for long winters where diesel fuel runs out. There are many generators and fuel cells that can be retrofitted to run as hybrid engines using both diesel and hydrogen as fuel sources. Using a number of clean energy sources, it can be separated from water through a process called Electrolysis, and when consumed its only byproduct is pure water.

Trend 4: A Rapidly Warming Climate

Climate Scientists have been raising the alarm on the rate of warming the planet has seen since the start of the Industrial Revolution, and high increases in greenhouse gas emissions that have come from modern civilization. While the average energy consumption per person seems to continue to increase with time, Alaska is in a unique location where the changing Arctic may lead to significant regional impacts to the environment. One emerging trend reflecting the need to improve our ability to monitor this is the FAA's drive to install more weather stations across the state. Remote monitoring, including satellite and aerial imagery, along with soil and water sample testing, flow meters, and a number of other methodologies is increasing to better

With the warming of the Arctic, not all environmental changes are bad. The melting of snow and ice, and the thawing of permafrost, opens up part of land for new uses, such as agriculture, forestry, and other developments. The production for crops might be an opportunity to leverage these natural changes to improve the income and livelihood of the region. As many Methanogenic (Methane producing) wetlands are emerging with these changes, techniques to aerate the land help promote Aerobic biological processes which can lead to more Methanotropic behavior (Methane absorbing) than before. Tilling the soil can be one way of doing this, as well as the disruption caused by migrating herds of Caribou, Buffalo, and other animals that are free to roam.



Trend 5: Food Production

A number of nations have found large economic value out of greenhouses. With a controllable climate, lighting, and nutrient delivery, these also offer a strong reduction in the need for pesticides and other chemicals that can harm the environment.

In addition, the Native Conservancy, Just Transition Alaska, and the Alaska Climate Alliance are working to support projects like a new Seaweed Farming operation in Cordova, Alaska. Upon more information, it was determined that this type of operation requires native seaweed to be present in a region to be developed into a marketable product, and we received confirmation that there is native seaweed in the Kotzebue region.

The economist Mike Jones with Institute of Social and Economic Research (ISEP) presented at a similar event, highlighting the cost to deliver various produce items and medical supplies to rural regions, emphasizing simple solutions that are lacking such as refrigeration/insulation systems to prevent freezing/spoilage, as well as limited cargo flight carriers.

Future Alignment

As a team of technologists and scientists, we are focused on advancing the integration of technology for socioeconomic development within these rural disadvantaged communities while preserving and improving the natural ecosystems they are a part of. To this end, we focus this report on the ways in which these communities can align their own strategies for growth with these trends using the 3 pillars of the IEEE Smart Village community:

1. Energy
2. Education
3. Entrepreneurship

1. Energy

The de facto source of energy in these rural communities is Diesel Generators, with Wind and Solar as auxiliary systems installed after Diesel was already well established. From running Hospitals, Schools, and other commercial enterprises, to residential power,
Following these guiding principles, we will focus on how To paint the picture of a future in which these variables have aligned favorably, we will break down the health of the local ecosystem into 3 main categories:

1. Electrical Infrastructure Development
2. Heating Systems
3. Transportation

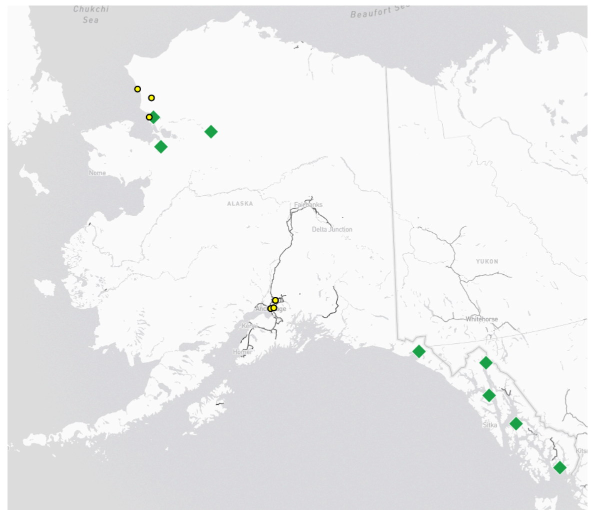
Electrical Infrastructure Development

There are a few ways in which the rapid growth in AI can lead to increases in energy infrastructure. For one, some companies are finding that identifying profitable energy intensive use cases can help drive demand for connectivity to Transmission networks, and develop local generation sources. Gridless Inc is a company in Kenya developing a business model around bitcoin mining centers paired with hydroelectric dams. With the knowledge that these data centers will generate a relatively stable economic return, investments in regional grid reliability can be made with more predictable returns. As Gridless focuses on installing these mining centers near rural villages, now the cost to connect residential customers is greatly reduced.

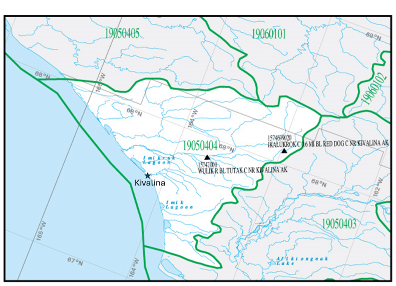
Our team met a company called GreenSparc that is exploring a similar approach at the conference. They've installed a small hydroelectric generator in Cordova, Alaska, which uses the power to run a data center, and the cold water to cool the system. One leading idea around an application like this is installing data centers that can operate in variable loading conditions. When there is excess energy generated from the various local sources, more servers can be powered on and run for power intensive processes, but when power is needed for other human activities these services can be tapered off accordingly. This alone is something very valuable to the grid, as it improves the reliability of the grid, and reduces the risk for further related infrastructure investments.

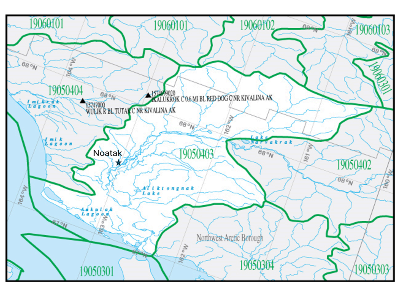
In the use case of data centers, actual use cases can vary from training AI models, to mining cryptocurrencies, running batch data processes for data companies, and can even include computations that help the grid operate more reliably, such as demand forecasting, battery and hybrid systems optimization, dynamic grid balancing, and predictive maintenance estimations.

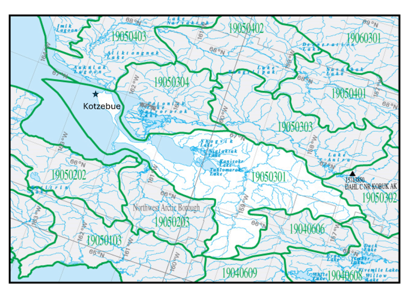
The positioning of these data centers can also be ideally aligned with the interests of the local ecosystem. GreenSparc was one of several startups featured at the conference as part of the Alaska Energyshed program. An energyshed, similar in concept to a watershed, considers all the energy demand in a given region as well as local energy generation. The idea here is to reduce the amount that energy resources are relocated long distances, and to make sure their benefits are being realized by the local community. Shown on the map to the right are Green diamonds for each location selected for an Alaska Energyshed project, with Kotzebue selected as one of the spots.



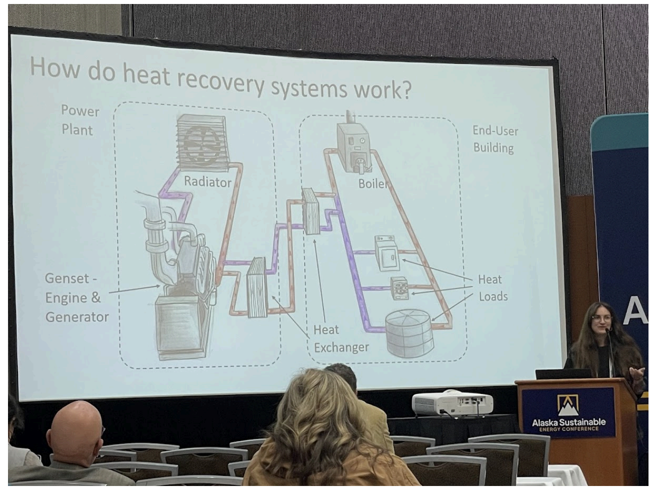
Upon further research, another innovative and holistic approach to data center projects in particular is to direct the planning of these systems with respect to the local watershed itself. Google recently released a Whitepaper on their approach to planning liquid-cool data centers in light of the local watershed, including considerations for the capacity of the watershed, water quality, impact to community, and a host of other issues. One option would be to require data centers to publish real-time monitoring of the water leaving each unit. One additional step might be to require data centers to be located on waterways known to be adding hazardous minerals into the watershed, that way the project would be required to filter the water and serve as a long-term stakeholder in the regional water quality. One downside to this approach is that the heat generated from these data centers could not be as easily recaptured for other heating needs. Deeper research is needed in these regions to compare these two variables. Below are the watershed maps for region 19050404 (Kivalina and Red Dog Mine), 19050403 (Noatak) and 19050301 (Kotzebue) from the US Geological Survey (USGS). Further collaborations with groups focusing on the general 1905 watershed region are highly recommended.



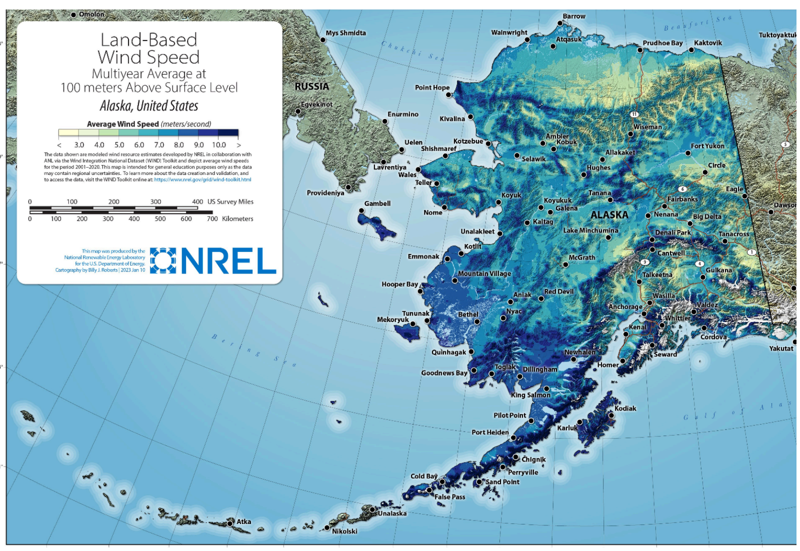




Heating Systems



Heating is the leading use of energy in this region, especially in the harsh winter months. The town of Kotzebue already uses excess energy from its Wind Turbines to heat the main hospital in town using ElectroThermal Storage Heaters (ETSH). This and other similar projects in other communities have been led by the Alaska Native Tribal Health Consortium, with the Senior Project Manager Jim Fowler presenting some of their work on a similar project in Bethel, Alaska at the conference, they were able to offset close to a million gallons of diesel fuel in a year. One item noted during the talk though was that this new system required support from the diesel system that might increase some people's fuel costs depending on end-user PCE structures.

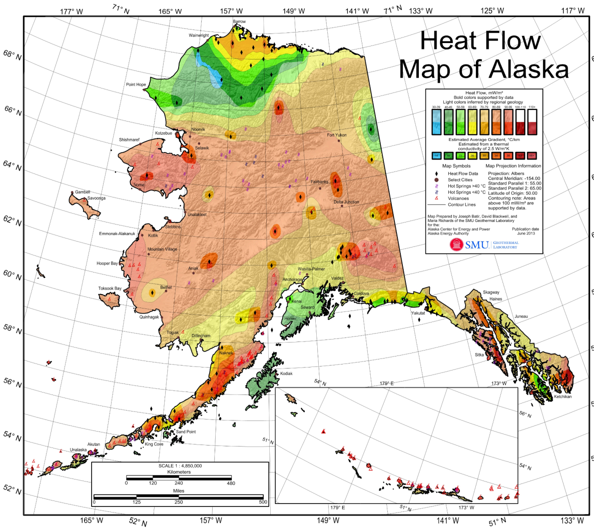


With wind resources serving as the primary source of clean energy in these rural regions, this map from National Renewable Energy Lab (NREL) shows that many of the coastal regions especially are ideal for increased generation based on Wind resources.The Kotzebue Electric Association (KEA) has developed a pipeline for federal and state grants for additional wind turbines in that region. Other idea wind regions that work their way inland might serve as an opportunity for their own energysheds, or energy corridors, which might make sense to plan transportation corridors, sensor networks, and other developments in alignment with.

Data Centers produce a lot of heat, which often requires energy intensive cooling systems to be installed, however in this environment there is an interest in deploying more heat transfer systems to make use of that heat throughout the community.

Identifying other sources of heat are also ideal for improving this infrastructure. While this isn't driven by AI, the opportunity to effectively utilize geothermal energy (both for power generation as well as typical heating processes) is seen as widely underutilized in Alaska. To the right is

Alaska's Geothermal Potential Map based on a combination of field tests and various Thermal, Hydrological, and Chemical models, which shows Kotzebue uniquely positioned relative to other Arctic opportunities. As more Geothermal hotspots are explored and realized, this offers a great opportunity for researchers and developers alike to direct the expansion of our grids with a clean and renewable source of both thermal and electrical energy.



Another form of clean heat production may come from the process of pyrolysis, which is the burning of trees and other organic matter in a setting with minimal amounts of Oxygen. This leads to less of the carbon being released as CO_2 in the combustion process, and offers a way to sink more carbon as solids that can be dealt with rather than released into the atmosphere.

One company in the Launch Alaska cohort (Cache) is moving forward with a novel approach to long-term energy storage in the form of low-cost solid mineral thermal storage

Additionally, a well maintained inventory of Alaska's infrastructure can be found here: https://www.wilsoncenter.org/arctic-infrastructure-inventory-0

Transportation

Alaska's airport is uniquely positioned as a refueling stop for many Northern Pacific flights, and one of the United States' primary lines of defense for the region, making it the 3rd busiest airport in the world. One hot topic that Governor Dunleavy explored with Premier Danielle Smith of Alberta was a Alaska-Canadian corridor for energy and increased transportation.

In the winter, many Alaskan communities rely on ice-bridges as a cheaper form of transportation compared to air travel. The Alaska Department of Transportation & Public Facilities (DOT & PF) has recently launched a new program called Alaska Rural Remote Operations Work Plan (ARROW), which will scale up the usage of drones to inspect these ice bridges, along with a number of other public assets to assure the safety and reliability of Alaska's transportation network. This new network of drones will be operated from a Beyond Visual Line of Sight (BVLOS) perspective, requiring a large growth in the autonomous ability to inspect these facilities using computer vision detection systems, and a telecommunications infrastructure to support streaming of this media over long distances.

The knowledge of existing and emerging permafrost thaw regions, as well as other environmental changes, will grow in parallel with this network, creating a host of new up-to-date datasets to predict and mitigate the effects of future natural disasters like earthquakes, wildfires, floods, and extreme weather events.

2. Education

Fairbanks seems to be the primary locus of Energy and Environmental research in Alaska. With the University of Alaska Fairbanks' (UAF's) Alaska Center for Energy & Power (ACEP), along with National Renewable Energy Laboratory's (NREL's) Cold Climate Housing Research Center, most of the academic work happens here. These institutions hold a variety of exchange and education programs throughout the state to keep a strong understanding of the state's rapidly changing environment. Several researchers from ACEP were at the conference, and on the same flights with us to and from Kotzebue.

In each of the communities we visited, schools were among the most robust facilities in the area. In Kivalina, the school was the first (and so far the only) establishment to be moved inland as the threat of rising sea levels introduces significant risk to the future of this coastal community.

In addition to standard K-12 education, many of the mining operations that provide a majority of the jobs for each of these communities operate training facilities for various safety, business, and trade related skills training.

One trend that is loosely emerging with AI is the growth of platforms that allow for self-paced growth in digital education, and with the increase in telecommunications infrastructure comes better access to these services. One thing the GreenSparc team iterated, that we heard the governor and others reiterate at the conference, is "bringing AI into the schools". This seems a little tricky to understand and make sense of at first. The goal wouldn't simply to install data servers in a classroom, but rather build Electrical Engineering, Computer Programming, IT, and a number of other related skills so that the next generations have more employment opportunities that can allow for remote work, freed up mobility, and a way to realize their own growth and exploration into their professional careers.

One organization focused on Education within this region is the Next-Generation Ecosystem Experiments (NGEE). They have a group dedicated to understanding Arctic ecosystems that presented, and seem to be pretty active in engaging local schools with their efforts to understand the local ecosystems.

AVTEC (Alaska Technical Vocational Center) offers several vocational training programs for energy systems throughout the region.

3. Entrepreneurship

One major obstacle presented by the Power Cost Equalization (PCE) program, is that by only subsidizing the cost of Residential power, it effectively disincentivizes the development of local businesses and startups. A lot of people with interest in bettering these communities feel the current PCE policy puts them in a bit of a Catch 22 position, where they don't want to complain about PCE and lose the incentives for residential customers, although at the same time they're stuck having to increase their operational costs if they want to start a business. Improvements to this policy should be dealt with carefully, and the ISV team proposes to engage with IEEE USA policy teams to get their inputs and recommendations.

On that note, there are a number of federal and state grant programs focused on improving the development of projects in this region. The Alaska Energyshed mentioned earlier was a highlighted program of Launch Alaska, which along with Alaska Venture Fund and the 49th State Angel Fund were all in attendance to support a strong startup ecosystem throughout the state. It is recommended that any startup related efforts through IEEE Smart Village's support also explore opportunities for growth with these networks for further growth.

Recommendations

To help formulate some possible ways this knowledge could translate to tangible ideas, we've collected some thoughts into organized recommendations. These aren't budgeted project proposals, but merely examples of how one might take lessons learned from the conference into some reasonable action moving forward.

Recommendation 1: Data Center

Let's support the completion of a Data Center for Kotzebue, with separate server racks to compare the economic opportunities of a variety of AI and compute related data processing applications. All profits can go to a fund managed by the tribe to support local tech education, and the waste heat can be used to heat buildings in the winter..

Server 1	**Server 2**	**Server 3**	**Server 4**
Bitcoin Mining	ML Training	Batch Processing	Climate Modeling

One approach might be to install this at the Kotzebue Middle School, the largest building in the city (followed up by the hospital). This could provide an ideal opportunity to make the project a learning experience, giving children first-hand exposure and familiarity to these technologies, while providing an additional heating source with the existing school's boiler system.

To bring this full circle, learning experiences designed around studying the watersheds in this region as a whole could actively engage the students in topics from remote sensing, computer programming, and the scientific theory, giving the future generations of the region the tools and experience to find more clarity on how to leverage this emerging trend in technology to plan in light of the changing climate.

As each of these communities we visited expressed issues in terms of water quality, as well as water-driven erosion, rising sea levels, and waste management, bringing expertise in hydrology, and water infrastructure seems essential to the health and development of these communities.

Recommendation 2: Geothermal Well

The plan here is to drill a well in each community for geothermal analysis. Prior reports already show that Kotzebue is in a verified spot of increased Geothermal potential, and this would be the best place to demonstrate feasibility for further studies and wells.
Upcoming conference:
https://grc2024.mygeoenergynow.org/indigenous-geothermal-symposium

Recommendation 3: Food Production

In response to the food related problems, a focus on food production facilities - from greenhouses to food preservation - could find much success in providing for the unmet need for fresh produce in the region. Aquaponics, hydroponics, aeroponics, and other controlled climate growing systems can produce nutrient dense produce, as well as

Recommendation 4: Hydrogen Production

Summer solar production is nearly 24 hours in this region, with winter solar production down to zero. Hydrogen can be used as seasonal storage in Alaska, as here the summer can be shifted to the winter using hydrogen stored in the summer for use in the winter. It is also recommended to look at hydrogen storage and use it to help with load variations when paired with nuclear as part of the nuclear feasibility study recommendation mentioned below.

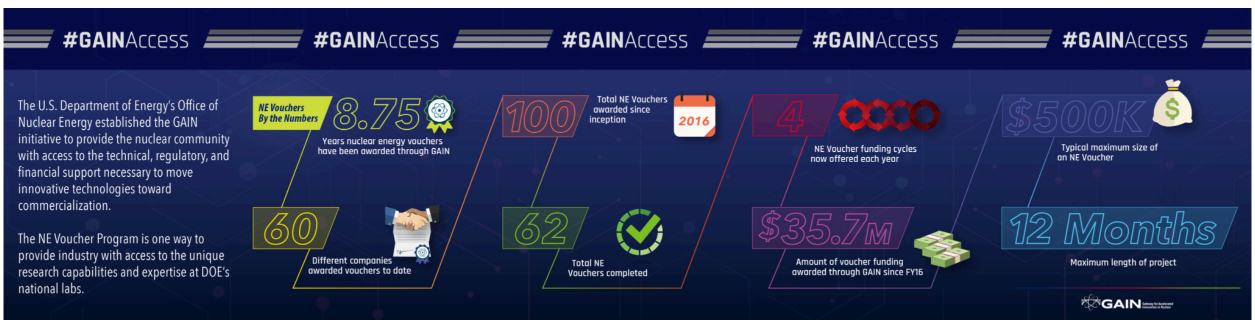
Recommendation 5: Drone Delivery Pilot

Transporting essential goods, medicines and perishables from Kotzebue to the surrounding villages is done thru very expensive chartered flights. Another recommendation is to do a Drone delivery pilot to see the feasibility and economic advantage and safety of using drones for delivering essential goods, medicines and perishables from Kotzebue to the surrounding villages.

Recommendation 6: Nuclear Feasibility Study

The US DOE (Department of Energy) and GAIN (Gateway for Accelerated Innovation in Nuclear) offered support for feasibility studies for adding Nuclear in a region. This includes up to 80% of the cost to a project, and gave examples that if we put $100k towards a study, they would put $400k of resources towards that study, including a lot of their team's personal focus. These are in the form of vouchers. This approach could be a good option especially for the Knick Tribe we met with, as they expressed interest in a Small Modular Reactor (SMR) for their community in Houston, Alaska.

In addition, we used our partner Melanie Welsh's (Alaska Unlimited's Executive Director) DoD connections to meet with Air Force personnel to talk about resilience of the long distance radar in Kotzebue to see if we could use their support to go after an early Micro Reactor deployment in Kotzebue. As they are currently in the reactor selection process to install a Micro Reactor at their Eielson Air Force Base. They were supportive of the idea of a reactor at Kotzebue, but expressed they wouldn't have personnel on-site to operate the unit.



If it's possible to integrate Hydrogen, Data Centers, Heat Transfer systems, and other concepts that might become more feasible because of the excess energy produced into this study, then this might be the most effective path to galvanize a follow through on all of these options.

Conclusion

These recommendations are but a few of the ideas we think could be explored further in this region. Given the beginnings of understanding the relationship structures for native corporations and their respective utilities, a follow up trip would make more sense to explore a larger collection of similar scenarios across Alaska, possibly involving the Tanana Chiefs Conference (TCC), the Bristol Bay Native Association (BBNA), Alaska Federation of Natives (AFN), the Alaska Power Association (APA) and other tribal focused energy organizations. The leading opportunity for this is this coming October 2-4 at the Rural Energy Conference in Fairbanks, Alaska. The Federal Government is supporting a lot of these efforts, so projects in this space could benefit from alignment with their efforts (some captured here):

In addition, see this article regarding some of these native tribal corporation concepts are spilling over into Canada.