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Alaska's Renewable Energy Economy

Progress and Possibility

PREPARED FOR

The Nature Conservancy

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Executive Summary

This briefing paper summarizes the opportunity in Alaska for investment in renewable energy infrastructure. This issue is timely and especially important for Alaska for several compelling reasons:

- Transition to renewables is imperative for Alaska. As the nation's only arctic state, Alaska is on the front lines of climate change. High northern latitudes are warming much faster than more temperate zones. Alaska has warmed at more than twice the rate as the rest of the nation and the cost of addressing damage in Alaska caused by climate change is expected to cost hundreds of millions of dollars annually.
- Alaska's energy needs are intensive. Alaska ranks fourth on a per-capita basis in energy use, yet extremely high costs in rural Alaska require public subsidies (such as the Power Cost Equalization program) to bring consumer costs down to manageable levels. Reducing the cost of energy would increase community financial sustainability, particularly for the remote, rural, and often majority Alaska Native villages which face the highest cost burdens.
- Timely, near-term investment in Alaska renewable energy infrastructure can spur economic recovery from the COVID-19 pandemic. Alaska was hit harder, economically, than the rest of the nation, losing 8.1% of wage and salary jobs in 2020, while employment in the United States overall was down 6.2%.

Renewable Energy Adoption

Investment in Alaska Renewable Energy Projects, 2010-2020

$690 million Invested

260 Projects

160 Communities

448 million Pounds of CO2 Offset Annually

15-20 Construction Jobs per million Invested

Recent decades have seen a steady march of renewable energy infrastructure installed across Alaska's more than 150 energy grids. In most cases renewables components have been added to existing diesel grids, and Alaska has become a leader in hybrid systems that augment diesel fuel generation with wind, solar, hydroelectric, and other renewable resources.

More than $690 million in public and private investments were made in renewable energy projects throughout the last decade across Alaska, from small rural villages to Anchorage. Of all renewable energy investments between 2010 and 2020, more than 80% funded construction activities, with the remaining investment funding feasibility, design, permitting, and planning work.

Opportunities

Alaska has significant and varied renewable resources that present opportunity for further development, including:

- Some of the highest **hydroelectric** power potential in the United States.
- An established **wind** energy sector, with potential for additional large-scale and micro-level development.
- Increasing opportunities in **solar** generation as hardware costs decline and benefits of Alaska's climate, such as low ambient temperatures, are recognized.
- The nation's greatest potential for seaweed production for **biomass energy**.
- 90% of U.S. **tidal** energy resources for use in hydrokinetic electricity production.
- **Geothermal** potential that has been the subject of several feasibility assessments and is now being developed in Unalaska.

In addition, Alaska has several opportunities to further develop the state's renewable energy landscape:

- With abundant resources, Alaska may capitalize on the emerging global appetite for renewable energy. Capturing excess renewable energy as **hydrogen**, which can be stored and transported in fuel cells, is one way to meet this global demand.
- Upgrading the **Railbelt Transmission System** would unlock renewable electricity generation potential. Current capacity constraints mean variable renewable energy generation is near capacity along the Railbelt; system upgrades would increase the potential market for new renewable generation.
- Implementing **beneficial electrification** using electricity to displace heating and transportation energy use would increase the scale of projects in rural Alaska, which often improves project financial feasibility. Consortiums such as the Chaninik Wind Group, with excess wind generation used for home heating, illustrate the success of this design in remote Alaska.
- Growing an Alaska **resident renewable energy workforce** will be key to harnessing economic benefits of renewable energy projects. With no in-state training programs or apprenticeships in emerging occupations such as wind technician, utilities must make significant investment in training employees for these roles. Industry growth can be supported by promotion of renewable energy courses currently offered through the University of Alaska and Alaska Vocational Technical Center, along with development of new course offerings.

With well proven technology and a track record of integrating renewable energy with existing systems, the state is poised for investment in transmission capacity and energy projects to unlock Alaska's significant renewable resource potential.

Introduction

Alaska's energy system is unique in the United States. The state stretches across a landmass of 665,000 square miles, with significant regional variation in geology, hydrology, and regional energy resources such as water, wind, and solar. Outside the state's Railbelt region, energy infrastructure is characterized by islanded micro-grids that have been built on a backbone of diesel power generation. This type of power is costly and resource-intensive, particularly in remote communities that rely on long logistical supply chains and limited local resources. Most of these communities are off the road system, rural, and predominantly Alaska Native populations. In addition, diesel generation is carbon-intensive – not only in the fuel source itself, but also along the supply chain that is required to bring fuel to remote communities. Even in the state's urban areas, power generation is relatively expensive and reliant on natural gas, with limited transmission capacity.

Against this backdrop communities throughout Alaska have been looking to renewable energy resources and mobilizing the concepts, partnerships, and funding needed to integrate renewable energy sources into local power grids. While the primary driver for these efforts is the high cost of diesel-based energy production, secondary benefits of energy security and reduced greenhouse gas emissions also contribute to the trend. The availability of public and other funds, either in the form of grants or credits, or through special financing programs, also supports the transition.

This paper describes the investments made in renewable electricity generation across Alaska over the past decade and presents opportunities for new renewable energy projects across the state.

Special thanks to the following organizations, which participated in this research:

- Alaska Energy Authority
- Denali Commission
- Kodiak Electric Association
- Launch Alaska
- Puvurnaq Power Company
- Renewable Energy Alaska Project
- Renewable IPP

Alaska's Energy Landscape

Alaska's total energy demand is among the lowest in the country. Yet factors such as the state's harsh climate and energy-intensive industries contribute to Alaska's place as the state with the fourth highest per capita energy consumption in the nation.[1]

On average, retail electricity consumers in Alaska pay nearly double the U.S. average price per kilowatt hour (kWh) at 20.22 cents/kWh, the second highest average in the nation and following only Hawaii.[2] Costs remain high due to the high cost of transporting fuel to remote communities for use in diesel-generated power plants and limited interties, among other factors. High electricity prices contribute to an overall high cost of living for residents and deter potential industrial development in the state.

Energy Infrastructure

Alaska's energy infrastructure is spread over a vast area: the state's landmass represents more than 17% of the U.S. total. Because of the great distances between communities, the state's energy infrastructure is characterized by only one major transmission system and more than 150 standalone microgrids.

The largest transmission grid in Alaska runs from Fairbanks in the north through Anchorage and to the Kenai Peninsula. Known as the "Railbelt," this electrical grid provides about 79% of the state's electrical energy.[3] While about 73% of Railbelt electricity is generated using natural gas, hydroelectric resources are also tapped along the Railbelt, including the Bradley Lake plant near Homer and the Eklutna plant near Anchorage. Wind farms, such as Golden Valley Electric Association's Healy wind farm (the largest in the state) and the Fire Island wind farm near Anchorage, are also included in the Railbelt's energy profile, as are solar resources in Willow.

Outside of the Railbelt, Alaska communities are generally served by standalone electrical grids. Rural standalone grids often rely on diesel fuel for electricity generation. High transportation costs contribute to high diesel fuel prices across Alaska. Lacking road access, these communities rely on water or air transportation of fuel. Communities that can receive fuel by barge often have fuel tank farms for winter storage. However, when demand is high and/or storage capacity low, these communities too must rely on costly air transportation of fuel. Across rural Alaska, many

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[1] U.S. Energy Information Administration. *State Energy Data System 1960-2018*.
[2] U.S. Energy Information Administration. *State Electricity Profiles*. 2019.
[3] Alaska Energy Authority. *Renewable Energy Atlas 2019*.

communities have integrated renewable energy resources with traditional diesel generators to reduce reliance on diesel.

While Southeast Alaska also has some electrical interties serving more than one community, most communities in that region are served by standalone electrical grids.

Power Cost Equalization

Given the high cost of electricity generation in rural Alaska, the State of Alaska's Power Cost Equalization (PCE) program is vital to Alaska communities, specifically for those communities that are rural, remote, and lack transportation access; many of these communities are also traditional Alaska Native villages. The PCE program was established in 1985 to equalize rural electricity rates with those of more urban areas that benefit from infrastructure such as the State-funded Alaska Intertie. Under this program, ratepayers in eligible communities receive a per kWh subsidy on electricity rates. PCE-eligible communities range in size from Lime Village (population 15) to Bethel (population 6,200) and many have majority Alaska Native populations.

In state fiscal year (SFY) 2020, more than 30,000 ratepayers, representing nearly 82,000 Alaskans, received PCE credits on their electricity bills. Over the past decade, cumulative PCE disbursements totaled nearly $360 million, including $29 million disbursed in SFY2020..[4]

Table 1. Weighted Average Electricity Rate in Alaska, SFY2020

	$/kWh
Residential rate before PCE credit	$0.4630
Residential PCE rate	$0.2226
Effective residential rate	$0.2404

Source: Alaska Energy Authority

The Regulatory Commission of Alaska (RCA) determines utility program eligibility and calculates the per kWh subsidy using a formula accounting for fuel expenses (including transportation) and non-fuel expenses such as salaries, insurance, parts and supplies, interest, and other reasonable costs.

Added costs paid by the utility to integrate renewable energy sources or purchase electricity from an independent power producer are included in the non-fuel costs for eligible expense categories. However, depreciation expenses for grant-funded equipment such as generators are not included in eligible costs under this formula.

Decreases in total fuel expense, which may be the result of integrating renewable energy, affect PCE rate calculations. Reduced fuel and nonfuel expenses and ineligible grant-funded costs can result in PCE-eligible ratepayers experiencing no decrease or an *increase* in effective electricity

[4] Alaska Energy Authority. Power Cost Equalization Program Statistical Report FY2020. March 2021.

rates following integration of renewable energy.[5] Commercial customers and state and federal government customers, including schools, are not eligible to participate in the PCE program.[6]

Electricity Production

In 2010, nonrenewable resources accounted for nearly 80% of electricity generated in Alaska. More than half (55%) of generation was fueled by natural gas, followed by 21% from conventional hydroelectric energy, and 14% from petroleum liquids. That year, the Alaska Legislature enacted a non-binding goal of generating 50% of the state's electricity from renewable resources by 2025. By 2019, increases in electricity generated from renewable resources and declines at nonrenewable-resource facilities contributed to renewables composing 30% of net electricity generation.

Long a top source of electricity in the state, conventional hydroelectric facilities experienced the largest increase with net generation up 13% over the decade. With significant projects such as Eva Creek (Healy) and Fire Island (Anchorage) added to Alaska's energy profile, electricity generated from wind resources grew tenfold between 2010 and 2019.

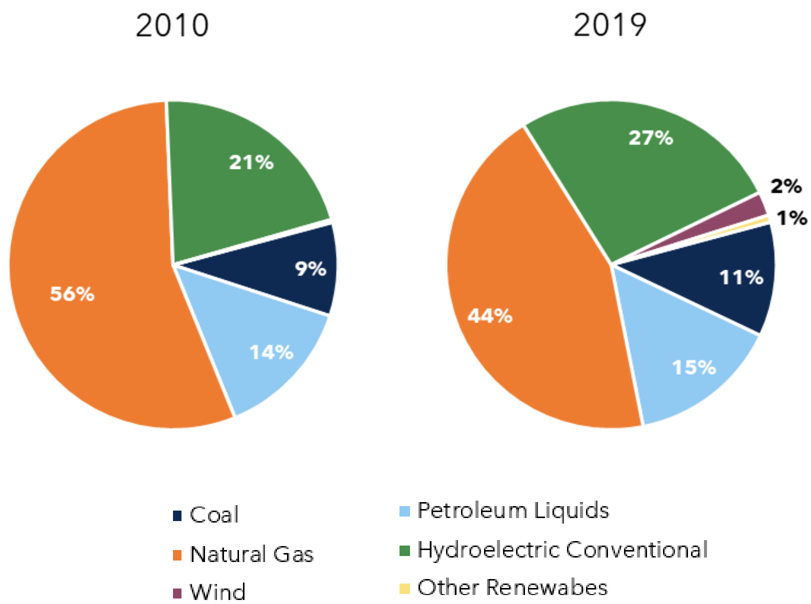
Table 2. Net Electricity Generation in Alaska by Energy Source, Thousand Megawatt hours

	2010		2019		% Change 2010 - 2019
	Thousand MWh	% of Total	Thousand MWh	% of Total	
Non-renewable Facilities	**5,307**	**79%**	**4,271**	**70%**	**-20%**
Natural Gas	3,750	55%	2,687	44%	-28%
Petroleum Liquids	937	14%	901	15%	-4%
Coal	620	9%	683	11%	10%
Renewable Facilities	**1,452**	**21%**	**1,808**	**30%**	**25%**
Hydroelectric (Conventional)	1,433	21%	1,623	27%	13%
Wind	13	0%	143	2%	1,000%
Biomass	6	<1%	38	1%	533%
Solar	0	-	4	<1%	-
Total	**6,759**	**100%**	**6,079**	**100%**	**-10%**

Source: U.S. Energy Information Administration, Electric Power Annual
Note: Net generation refers to electricity generation by utility-scale facilities for all resource types and utility and small-scale facilities for solar photovoltaic plants.

[5] University of Alaska Anchorage, Institute of Social and Economic Research. Power Cost Equalization Funding Formula Review. March 2012. https://iseralaska.org/static/legacy_publication_links/2012_03_14-NREL_PCEfinal.pdf
[6] Alaska Energy Authority. *Power Cost Equalization Program Guide*. September 2019.

Figure 1. Percentage of Total Electricity Generation in Alaska by Energy Source, 2010 and 2019

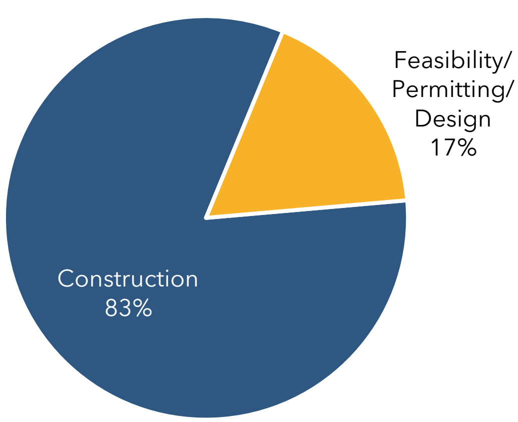


Source: U.S. Energy Information Administration, Electric Power Annual

Renewable Energy Investment in Alaska

Over the last decade, more than $690 million in public and private investment was made in renewable energy projects throughout Alaska. More than 260 projects were studied or developed across 160 communities ranging in size from villages with 100 residents up to the state's largest city, Anchorage. Of investments between 2010 and 2020, more than 80% funded construction activities, with the remaining investment funding feasibility, design, permitting, and planning work.

Figure 2. Renewable Energy Project Funding in Alaska by Project Type, 2010-2020



Source: McKinley Research Group

Resource Adoption

While many energy projects developed in Alaska over the last decade integrate renewable resources with diesel generation, the following sections describe investments by primary renewable energy type.

Table 3. Renewable Energy Investment in Alaska by Energy Source, 2010-2020

Primary Energy Source	Investment ($millions)	% of Total
Hydroelectric	$330	48%
Wind	$240	35%
Biomass	$30	5%
Geothermal (Testing and Assessment)	$30	4%
Solar	$10	2%
Other Renewables	$50	7%
Total	**$690**	**100%**

Source: McKinley Research Group

HYDROELECTRIC

Between 2010 and 2020, hydroelectric projects represented nearly half of renewable energy project investment in Alaska. Hydroelectric projects such as Blue Lake in Sitka, Allison Creek in Valdez, and expansion of AEA-owned Bradley Lake in Homer were among the largest projects in Alaska in terms of construction cost and generation capacity. "Lake tap" infrastructure requiring no dam and "run-of-river" hydroelectric projects were implemented in the state over this time period.

WIND

Over the past decade, wind projects represented 35% of investment in renewables. Large wind projects developed between 2010 and 2020 include Eva Creek in Healy, Fire Island in Anchorage, Phase II of Kodiak's Pillar Mountain development, and the Snake River project in Nome. Many wind projects developed over the past decade contributed to Alaska's role as a leader in implementing wind-diesel hybrid systems.[7] Investments in wind-diesel hybrid systems in rural communities included efforts such as Chaninik Wind Group's project, which incorporated thermal stoves for residential heating using excess wind generation. Enhancements in energy storage also provided opportunity for further investment between 2010 and 2020.

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[7] Renewable Energy Alaska Program. https://alaskarenewableenergy.org/initiatives/alaska-wind-working-group/ *Alaska Wind Working Group*. Accessed June 2021.

BIOMASS

Biomass facilities across Alaska use renewable resources like wood, sawmill waste, fish byproducts, and municipal waste to generate heat and electricity. Projects such as installation of a chip-fired boiler at the Tok School, the landfill waste project in Anchorage, and the ongoing sawdust and waste wood project in Hoonah represent the range of Alaska regions in which biomass projects were developed over the last decade.

GEOTHERMAL TESTING

While no community-scale geothermal projects are yet operating in Alaska, testing and assessment of various geothermal resources are among the renewable energy investments in Alaska between 2010 and 2020. The most expensive of these projects was the U.S. Department of Energy (DOE)-funded Southwest Alaska Regional Geothermal Energy Project, which explored geothermal resources around Naknek.

SOLAR

Solar projects accounted for 2% of investment in Alaska in renewable energy between 2010 and 2020, including the state's first utility-scale solar farms constructed in Healy and Willow.

Economic Impacts of Renewables in Alaska

While reducing carbon emissions is an important goal of renewable energy development, these projects come with added economic benefits. New lower-cost diesel technology charts a path toward savings for utilities and ratepayers. Further economic impacts are described below.

Development and Construction Phase Impacts

Renewable energy feasibility studies, design work, permitting, and especially construction activity all support short-term employment in Alaska. This includes high-wage construction and professional and business services jobs. Based on average annual spending on renewable energy projects between 2010 and 2020, renewable energy investment directly supported about 350 jobs in Alaska each year, resulting in an estimated $30 million in annual labor income (wages, salaries, and employer-paid benefits). Additional spending from construction companies and developers purchasing services and materials in Alaska and employees spending their wages locally supported an additional 200 jobs annually, resulting in an additional $10 million in labor income.

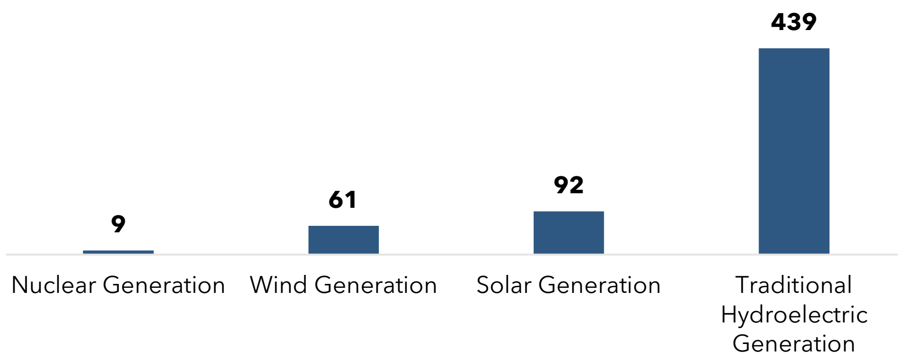
Renewable energy-related construction creates jobs at a rate of 15 to 20 jobs per million dollars invested, typical for construction projects in Alaska, but particularly important when jobs are created in rural areas where employment opportunities are scarce.

Long-term Impacts

The long-term positions required to operate and maintain renewable energy infrastructure depend largely on the type and scale of renewable energy deployed. Positions range from wind turbine technicians, who monitor and maintain systems, to maintenance jobs for clearing snow and vegetation from solar plants. Particularly in rural communities, where employment opportunities are often very limited, the skilled positions needed to support renewable energy projects can be a significant source of income.

By the end of 2019, about 600 people were employed in renewable electric power generation in Alaska across industries such as utilities, construction, professional services, and others. Jobs in renewable power generation represented about 40% of all electric power-generation industry employment in the state.[8]

Figure 3. Renewable Energy Electricity Generation Jobs, 2019



Source: National Association of State Energy Officials

Contractors specializing in renewable energy installation in Alaska illustrate the potential to further develop the renewable energy industry in the state. Alaska Native Renewable Industries, a solar-installation company based in Huslia, is one example of the type of business already operating in Alaska and employing locals in project development.

Community Sustainability

Reducing reliance on expensive diesel-fueled electricity in favor of more cost-effective renewable generation enhances community self-sufficiency and financial sustainability in rural Alaska. While PCE subsidies are vital to rural Alaskans, the program faces the same fiscal constraints impacting the overall state budget. Developing renewable resources to provide more cost-effective electricity can provide a path forward in the face of these financial constraints. In the case of community-owned renewable energy systems, the opportunity to sell

[8] National Association of State Energy Officials. *U.S. Energy and Employment Report 2020*.

electricity to the utility company can also provide a source of local revenue and keep residents' money in the local economy.

Alaska communities whose fuel storage cannot meet annual demand often need to supplement seasonal barge shipments with high-cost air-delivered fuel, driving up costs for all consumers. Declines in overall fuel consumption can translate to better alignment of demand with communities' diesel fuel storage capacity, eliminating these airborne fuel deliveries and reducing fuel costs.

Any success in reducing the cost of energy in rural Alaska would have the benefit of more sustainable communities, particularly those most remote.

Social Cost of Carbon

The "Social Cost of Carbon" provides a tool to express in dollar terms the value of reduced carbon dioxide (CO_2) emissions. This cost is designed to account for the long-term, worldwide damage from CO_2 emissions on agricultural productivity, human health, property damages from increased flood risk and changes in energy system costs, and other factors.[9]

Based on the additional electricity generated by renewable energy resources in Alaska in 2019 compared to 2010 and the state's average CO_2 emissions per MWh generated, the renewable energy capacity added over the decade offset an estimated 448 million pounds of CO_2 emissions.[10] Using a standard U.S. federal government social cost of carbon estimate of $51 per metric ton of CO_2 emissions, the long-term value of the offset emissions from the additional renewable energy generation in Alaska is $10.4 million.[11]

[9] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. February 2021.
[10] U.S. Energy Information Administration. State Electricity Profile: Alaska 2019. November 2020. CO_2 emissions generated per MWh of electricity produced vary by type of fuel and plant efficiency.
[11] The $51 social cost of carbon estimate is based on an emissions year of 2020 and the average 3% discount rate.

Case Studies

The following are case studies that illustrate the diversity of Alaska's renewable energy opportunities.

Kodiak Microgrid

Kodiak has long used hydroelectric energy resources from its Terror Lake facility, but with significant additions to its renewable energy portfolio, Kodiak Electric Association (KEA) has largely gone "diesel off." In 2009, KEA installed three wind turbines at Pillar Mountain, then doubling capacity with another three in 2012. The utility leveraged AEA grants to fund the combined $28.6 million in projects. The addition of battery storage to stabilize variable wind generation was key in integrating wind turbines with the existing hydroelectric infrastructure. Among KEA's recent renewable energy projects is the 2013 Terror Lake expansion.

The utility now employs four full-time wind technicians. Nearly all the wind technicians hired by KEA had no prior experience in the field, and the association has made a significant investment in training employees for this role.

With cost-effective generation from renewable resources, KEA has enabled new industrial electricity use. A 2015 partnership between KEA, Matson, and the City of Kodiak brought a $10 million electric crane to Kodiak's port, replacing a diesel-power crane used for loading and unloading shipping containers.

Renewable generation is significantly more cost-effective for KEA than diesel generation. When last estimated, power from the combined hydroelectric and wind resources costs KEA about 7.7 cents per kWh, compared to a previous diesel-generation cost of 28.9 cents/kWh. With cost savings from increased renewable energy use, KEA has capitalized new projects such as the $81.7 million Upper Hidden Basin project, which diverted water for use at Terror Lake, without raising customer rates.

Combining generation from Terror Lake and Pillar Mountain, renewable energy use offset 899 million gallons of diesel fuel in 2020, avoiding over a million metric tons of CO_2 emissions.

> "The economic benefits to our community from developing the Pillar Mountain wind project when compared to diesel are high. By reducing the dependence on fossil fuels, we are able to provide the community of Kodiak a lower cost of power, a cleaner source of power, and maybe the most important is a stable source of power."
>
> – **Kodiak Electric Association**

Willow Solar Farm and Renewable IPP

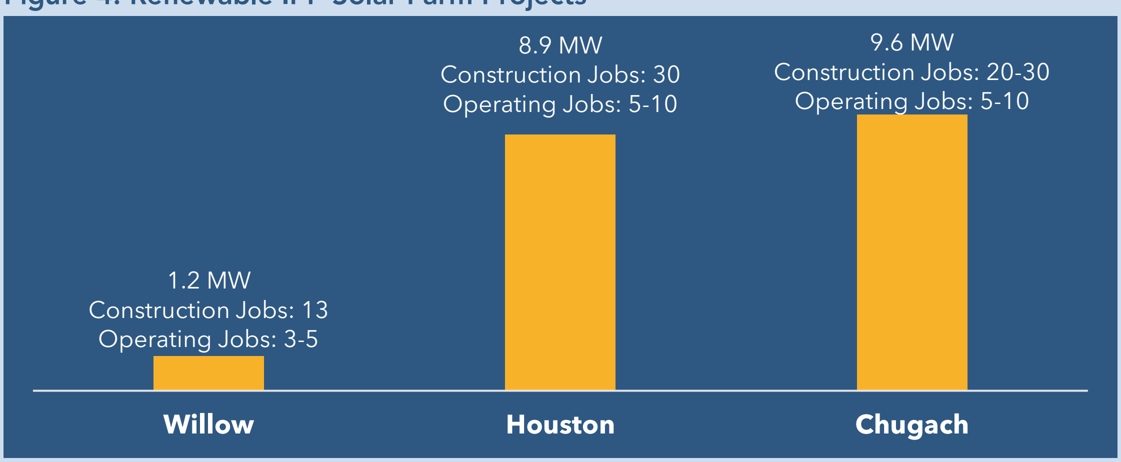
In 2019, with the completion of the Willow Solar Farm (WSF) in the Matanuska-Susitna Valley, Renewable Independent Power Producers (IPP) became one of Alaska's first utility-scale solar farm operators. The $1.5 million WSF installation was financed with an AEA Power Project Fund loan and private capital.

WSF construction directly employed about 13 laborers hired by Renewable IPP and supported additional short-term contractors in positions such as engineer, electrician, lineman, and others. Laborers and subcontractors hired for the WSF installation were all Alaska residents and companies. WSF's ongoing economic impacts include new jobs created to maintain the solar farm and new property tax revenue for the Matanuska-Susitna Borough. With high solar panel asset value, Renewable IPP has a high assessed property value and paid $16,400 in property tax to the Matanuska-Susitna Borough in 2020.

With the success of WSF, Renewable IPP is developing two additional projects – the Houston Solar Farm (HSF) and Chugach Solar Farm (CSF) – whose capacity would dwarf that of the WSF. Representing more than $20 million in combined investment, Renewable IPP expects to fully fund the projects through private investment.

As interest grows in reducing carbon emissions, funding renewable energy developments without increasing costs to ratepayers presents a challenge. In the case of Matanuska Electric Association (MEA), which purchases electricity generated by WSF, a 2020 annual member survey found more than 77% of members support the utility developing a carbon reduction goal.[1] Independent power producers such as Renewable IPP assume responsibility of the significant costs of integrating with the existing grid, thereby increasing renewable energy use without burdening ratepayers with the cost of infrastructure development or additional business risk. While electricity from WSF is currently sold to MEA for the same rate it costs the utility to produce its own electricity, Renewable IPP hopes to sell generation from HSF and CSF at a lower rate compared to the utilities' current costs.

Figure 4. Renewable IPP Solar Farm Projects



Source: Renewable IPP

Chaninik Wind Group and Kongiganak

In 2005 Chaninik Wind Group (CWG), a consortium of stand-alone utilities in Southwestern Alaska, was formed to combat the high electricity and home heating prices in many rural communities unconnected to Alaska's road system. Representing Kipnuk, Kongiganak, Kwigillingok, and Tuntutuliak, CWG integrated wind resources into diesel-generation systems. By forming this consortium, CWG demonstrated one model for increasing renewable energy projects' economies of scale, which often constrain developments in rural Alaska.

One method employed by CWG to increase the projects' scale was embracing beneficial electrification, designing wind systems with excess capacity diverted to electric thermal stoves installed in village homes. Households with thermal stoves see significantly lower home heating costs compared to the use of heating oil. In Kongiganak, Puvurnaq Power Company (PPC), charges $0.10 per kWh for energy used by thermal stoves, equivalent to purchasing heating fuel at about $3.00 per gallon, a significantly lower cost compared to current heating fuel prices of $5.05/gallon.[1] For villages with a subsistence-based economy, home heating and energy cost savings can positively impact residents' ability to pay for necessary supplies and fuel to continue traditional hunting, fishing, and gathering subsistence activities.

Even residents without thermal stoves see positive economic benefits from these wind/diesel hybrid systems. Electricity sold for home heating represents an opportunity for utilities to increase sales, spreading costs over more kilowatt hours and keeping residents' money in the local economy. For Kongiganak, reduced diesel demand has also allowed PPC to rely solely on waterborne fuel deliveries and avoid high-cost air deliveries, reducing power costs communitywide.

Wind technician jobs supported by these hybrid systems provide important employment opportunities in communities with few other available positions. In each CWG community, utilities now employ local wind turbine technicians who receive on-the-job training in town. These technicians are trained to maintain and repair the system, avoiding the time and expense which would otherwise be required to bring technicians to the community on an as-needed basis.

> "About 90% of residents rely on subsistence for food so more fuel savings for heating their home goes to [pay for] fuel to practice subsistence."
>
> **– Roderick Phillip, Plant Manager, Puvurnaq Power Company**

Opportunities for Future Investment

Over the last decade, advances in renewable energy technology and declining hardware costs have contributed to increased adoption of renewables throughout Alaska. Energy storage technology has helped operators integrate renewables with existing infrastructure. While hundreds of millions of dollars have already been invested statewide, further investment will be required to meet or exceed Alaska's informal goal of 50% renewable energy production.

Developed and Emerging Technologies

Alaska's abundant natural resources make the state ripe for further renewable energy development employing existing technology and new methods of generation.

SOLAR

Communities and companies in Alaska are continuing to recognize the state's solar energy generation potential. Even with considerable seasonal variation in sunlight, many parts of Alaska have solar resources comparable to Germany, which is the world leader in installed solar generation capacity.[12] Characteristics such as low ambient temperatures and ability to reflect sunlight off snow cover enhance opportunities throughout the state. A 2016 analysis by the U.S. DOE yielded promising results, showing that solar installations can be economically competitive in rural Alaska even with relatively high hardware costs.[13] The state's proven record of successful solar installations in communities such as Ambler and Eagle indicate Alaska's potential. Reductions in hardware costs and energy storage to smooth variable generation will increase the financial feasibility of solar projects. Maintaining federal tax incentives such as the Solar Investment Tax Credit will continue to play an important role in developing Alaska's solar potential.

BIOFUELS

With thousands of miles of coastline, marine resources such as kelp present an opportunity to implement new biomass energy systems. The University of Alaska Fairbanks is leading a project to design and develop model kelp farms with the goal of reducing capital and operating costs to produce this marine resource, which may be used in the production of new biofuels.[14] With development of a cost-effective model, kelp biofuel has potential for increasing biomass generation across coastal Alaska.

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[12] U.S. Department of Energy, Office of Indian Energy. Solar Energy Prospecting in Remote Alaska: An Economic Analysis of Solar Photovoltaics in the Last Frontier State. February 2016.
[13] Ibid.
[14] University of Alaska Fairbanks. Could Kelp Be the New Energy Source? April 2021.

TIDAL

With 90% of all U.S. tidal energy resources, Alaska's coastline also provides great potential for further hydrokinetic energy production. Studies of tidal energy potential in Yakutat and Turnagain Arm found sufficient wave energy for tidal generation. In 2021, developers were moving forward with the Turnagain Arm Tidal Electric Generation project which would harness tidal resources in Cook Inlet.

GEOTHERMAL

With 97 known thermal springs, Alaska is a geothermally active state and one of only eight in the nation generating electricity from geothermal activities.[15] So far, the state's geothermal resources have only been used in small-scale projects such as the plant at Chena Hot Springs. However, over the last decade several studies have been conducted to determine geothermal feasibility in specific communities such as Nome and Tenakee Springs. The state's significant geothermal potential is starting to be realized in places such as Unalaska, where Ounalashka Corporation and Chena Power LLC have formed a joint venture to develop a geothermal power plant.

HYDROGEN

Alaska's considerable renewable resources offer an opportunity to harness excess energy to produce hydrogen, which can be stored and transported to markets outside of Alaska. Building capacity to participate in this emerging export market could unlock potential from Alaska's stranded resources. This could shift some of the state's renewable energy projects from fuel import-substitution to an export industry.

> "We all want to know how to foster economic opportunity for Alaskans. Our economy wasn't built on oil and gas alone - it was built on the backs of Alaskans willing to think big. The legacy of oil and gas in Alaska is our ability to work together to accomplish the seemingly impossible and to build big things. That's why our economic future should be built on clean energy the same way we built our fossil fuel fortune - at scale and for sale. By leveraging our decades of experience as an energy state, our incredible natural resources, and our unique location at the geographic center of global commerce, the energy transition presents an economic opportunity that will ensure prosperity for generations of Alaskans to come."
>
> **– Rob Roys, Chief Innovation Officer, Launch Alaska**

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[15] Alaska Department of Natural Resources, Geological and Geophysical Surveys. *Geothermal Energy*. https://dggs.alaska.gov/energy/geothermal.html

Rural Economies of Scale and Risk

In rural Alaska, communities face limited access to private capital due to the small scale of renewable projects and perceived risk of private lending. Standalone systems in small communities often mean projects cannot achieve economies of scale, making projects financially infeasible and contributing to a perceived risk in private lending. The ability to leverage public funding has been important to overcome barriers to project financing. Public funding is also important in overcoming the inherent financial risk of commissioning feasibility studies.

Pooling resources, as in the case of the Chaninik Wind Group, to increase project scale can help counteract these inherent financial challenges. AEA's Regional Energy Planning initiative provides a template for further comprehensive energy planning which could identify these opportunities to combine projects. Continued planning efforts should be supported.

Beneficial electrification initiatives combined with renewable energy projects present an opportunity to increase project scale, which can improve project financial feasibility. Electrification opportunities, ranging from heating rural homes to industrial equipment in Kodiak, provide a record of success in Alaska.

The perceived risk of PCE rate reductions can be a significant barrier to community support for renewable projects. Key to overcoming this barrier is continued consideration of how best to use the PCE program to support energy equity in rural Alaska while incentivizing cost-effective, financially sustainable energy projects. The formation of an Independent Power Producer (IPP) to operate renewable energy projects and sell electricity to the community's utility could provide a model for further renewable energy deployment while preserving PCE subsidies.

Transmission System Upgrades

In urban Alaska, transmission bottlenecks along the Railbelt Transmission System are a barrier to increased renewable energy generation. Current capacity along the transmission system restricts the amount of energy transferred from the site of renewable energy projects to different areas of the Railbelt system, and the current level of variable renewable energy generation is close to reaching the available renewable resource penetration of the system. These capacity constraints restrict the market for new generation from existing infrastructure, such as the Bradley Lake Hydroelectric plant on the Kenai Peninsula, and new project development. Implementing the projects outlined in AEA's Railbelt Transmission Plan to achieve the Railbelt Transmission System Planning Standard would unlock further renewable electricity generation potential along the Railbelt.[16] In addition to expanding the potential market for increased

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[16] Alaska Energy Authority, Electric Power Systems Inc. *Alaska Energy Authority Railbelt Transmission Plan*. March 2017.

generation, the $885 million in proposed projects could support thousands of short-term jobs and millions in wages associated with project development and construction.

Training Needs

While different renewable energy technologies require varying degrees of skilled work, increasing investment in harnessing Alaska's renewable energy could increase demand for local, skilled employees. Wind farm operators are making significant investments in training a skilled labor force in Alaska, "growing their own" by providing training for new wind technicians. Training is provided either by contracting with a provider located in the Lower 48 or on-the-job training by experienced technicians. Currently no specific in-state wind technician training or apprenticeship programs exist outside of employer-provided training.

Operators regularly contract with firms to provide additional maintenance and support, with some functions provided remotely and contracted employees brought in from out of state. As individual operators gain experience with these systems and train staff, they can reduce reliance on these outside firms. Still, as more wind resources are developed throughout the state, a ready labor force and in-state training opportunities will help Alaska harness the economic benefits of renewable energy.

Alaska's public postsecondary institutions offer limited coursework in renewable energy and could play a larger role in training to build a skilled energy labor force. At the University level, the University of Alaska Anchorage (UAA) offers coursework in topics such as solar photovoltaic systems and sustainable energy project development. The University of Alaska Fairbanks (UAF) offers a Sustainable Energy Occupational Endorsement in which students may specialize in a range of topics such as wind, biomass, or photovoltaic systems. The Alaska Vocational Technical Center (AVTEC), located in Seward, provides renewable power generation coursework through the Industrial Electricity and Plumbing & Heating programs. This network serves as a foundation for workforce development, and increased course offerings and promotion of these institutions will be important to further developing the state's renewable energy economy.

Conclusion

Advances in technology, including energy storage, have enabled renewable energy adoption throughout Alaska. Yet significant capital investment will be needed to further transition the state's intensive energy needs. Investment in feasibility studies, project planning and construction, along with workforce development, will all contribute to building Alaska's renewable energy economy. With well proven technology and a track record of integrating renewable energy into existing systems, the state is poised for investment in transmission capacity and energy projects to unlock Alaska's significant renewable resource potential and reduce high energy cost burdens, especially in rural Alaska.