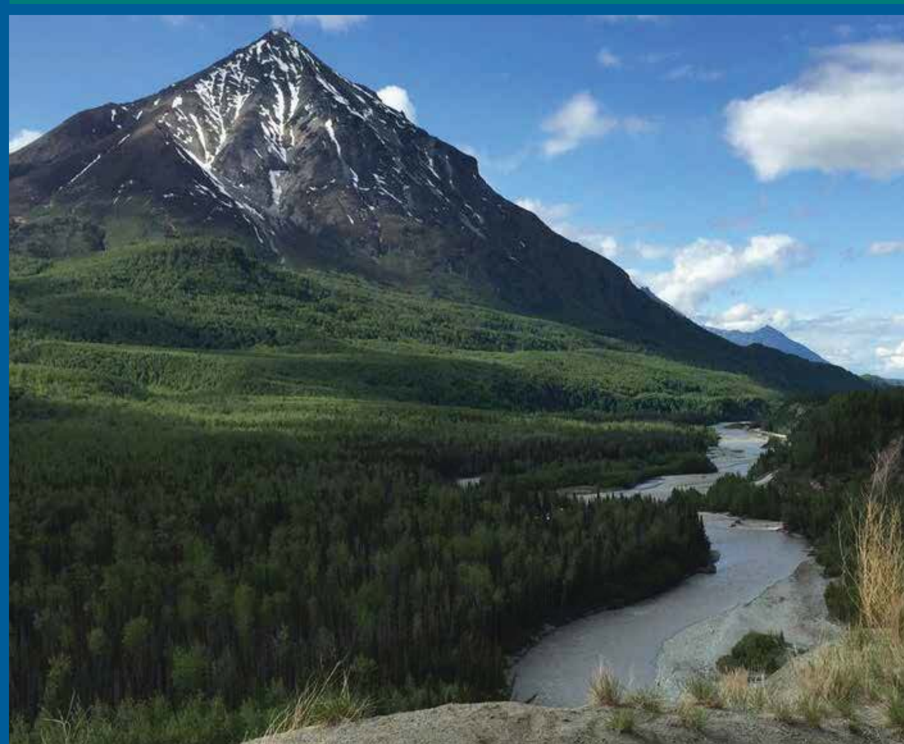


Sustainable Energy Solutions for Rural Alaska



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LBNL-1005097

Sustainable Energy Solutions for Rural Alaska

Prepared for the
U.S. Department of Energy
Office of Indian Energy Policy and Programs

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April 2016

The work described in this report was funded by the Office of Indian Energy Policy and Programs under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.

Acknowledgments

Riley Allen, David Farnsworth, and Rich Sedano of the Regulatory Assistance Project (RAP) and Peter Larsen of Lawrence Berkeley National Laboratory (LBNL) were principal investigators in this report for LBNL and the U.S. Department of Energy (DOE) Office of Indian Energy. They were part of a research team that also included Givey Kochanowski of DOE and Jim Lazar of RAP. Peter Larsen of LBNL and Riley Allen, David Farnsworth, and Donna Brutkoski of RAP authored this report. The team is grateful for the assistance of the Alaska Energy Authority (AEA), especially Sara Fisher-Goad, Jed Drolet, Cady Lister, Neil McMahon, Katie Conway, Jessie Huff, and Emily Ford; Chairman T.W. Patch, Commissioner Robert Pickett, and staff of the Regulatory Commission of Alaska (RCA); Douglas MacCourt, Christopher Deschene, David Conrad, and Michael Rodrigue of DOE; Jared Temanson of the National Renewable Energy Laboratory (NREL); Jimmy Ord, Scott Waterman, and staff of the Alaska Housing Finance Corporation (AHFC); David Hill and Chris Badger of Vermont Energy Investment Corporation (VEIC); and Chris Rose of the Renewable Energy Alaska Project (REAP). Regional energy ambassadors also assisted the team in their travels throughout Alaska. The team would particularly like to thank ambassadors Sonny Adams, Dave Pelunis-Messier, Kord Christiansen, Connie Fredenberg, George Guy, Bryant Hammond, Jason Hoke, Tyler Kornelis, Brent Latham, Jackie Qatalina Schaeffer, Anahma Shannon, Fred Smith, Lawrence Sorensen, Robert Venables, Dean Westlake, and Tiffany Zulkosky. Others that provided guidance in the early stages of the process included Brent Sheets of the Alaska Center for Energy and Power (ACEP); Bruno C. Grunau and Jack Hebert of the Cold Climate Housing Research Center (CCHRC); Matt Berman, Steve Colt, and Ginny Fay of the University of Alaska's Institute of Social and Economic Research (ISER); Dennis Meiners of Intelligent Energy Systems; Denali Daniels and staff of DDA, Inc.; and Brian Hirsch of Deerstone Consulting. The research team also thanks Meera Kohler and Anna Sattler of the Alaska Village Electricity Cooperative (AVEC); Anna traveled with and helped to guide the research team through early visits in the Bethel region. We are grateful to the staff of the Denali Commission, including Joel Neimeyer, Jodi Fondy, and Karen Johnson. Utility managers and staff, tribal leaders, and local officials provided invaluable insight into the challenges faced and innovations happening in the communities visited by the research team. A number of the people cited above offered useful peer review feedback on the draft report, as did Duff Mitchell of the Alaska Independent Power Producers Association (AIPPA); Bob Grimm and David Custer of Alaska Power & Telephone (APT); Fran Ulmer of the U.S. Arctic Research Commission; John Duhamel of the Copper Valley Electric Association (CVEA); and Andrew Mills of LBNL. Crystal Enkvist of the Alaska Power Association (APA) circulated an early draft to APA members for their input. Tim Newcomb designed and illustrated this report.

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Acronyms

ACEP	Alaska Center for Energy and Power
ADCCED	Alaska Department of Commerce, Community and Economic Development
AHFC	Alaska Housing Finance Corporation
AIPPA	Alaska Independent Power Producers Association
ANCSA	Alaska Native Claims Settlement Act
ANTHC	Alaska Native Tribal Health Consortium
APT	Alaska Power & Telephone
ARRA	American Recovery and Reinvestment Act
ARMI	Alaska Rural Manager Initiative
AVEC	Alaska Village Electric Cooperative
BNEF	Bloomberg New Energy Finance
CCHRC	Cold Climate Housing Research Center
CEC	Cordova Electric Cooperative
CEFIA	Clean Energy Finance and Investment Authority (Connecticut)
CVEA	Copper Valley Electric Association
DOE	Department of Energy
EIA	Energy Information Administration
ESCO	Energy service company
GHG	Greenhouse gas
GVEA	Golden Valley Electric Association
ISER	Institute of Social and Economic Research (University of Alaska Anchorage)
JAA	Joint action agency
KEA	Kodiak Electric Association; Kotzebue Electric Association
kW	Kilowatt
kWh	Kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
MDMS	Meter data management system
MW	Megawatt
MWh	Megawatt-hour
NREL	National Renewable Energy Laboratory
PCE	Power Cost Equalization
PPESCO	Public purpose energy service company
PV	Photovoltaic
RAMP	Rural Alaska Maintenance Partnership
RCA	Regulatory Commission of Alaska
REAP	Renewable Energy Alaska Project
REF	Renewable Energy Fund
RPSU	Rural Power System Upgrade
RUBA	Rural Utility Business Advisor
RUS	Rural Utilities Service
SRF	Simplified Rate Filing
START	Strategic Technical Assistance Response Team
VEEP	Village Energy Efficiency Program
VEIC	Vermont Energy Investment Corporation

Executive Summary

Introduction

Rural Alaska is "a world away" from the state's more populated Railbelt, where homes and businesses benefit from connection to abundant and inexpensive power from hydroelectric dams, natural gas, and other sources. By contrast, Alaska's rural communities stretch across hundreds of miles of remote landscape. Harsh weather conditions and long distances make electrical interties between communities impractical. About 200 of the state's rural villages have unsustainably high electric utility and energy costs. Each of these villages has its own power microgrid, and for decades they have relied almost entirely on diesel fuel to power and heat their homes, businesses, and community buildings.

The price of diesel in rural Alaska is higher than nearly every region in the United States because conditions make road transport inviable, and shipping fuel via air transport or barge is very expensive. As a result, rural utilities can pay up to four times more for fuel than utilities elsewhere in Alaska. Maintenance costs are also higher than other places, and keeping the lights and heat on is a must in winters when temperatures fall as low as 70 degrees below zero—making power outages potentially life-threatening. Rural electricity systems frequently require costly emergency assistance from the state if a generator fails.

The state of Alaska recognizes the challenges these rural communities face and provides financial support via the Power Cost Equalization (PCE) program. The PCE subsidizes the electricity prices paid by customers of these high-cost utilities. The PCE program is designed to spread the benefits of Alaska's natural resources more evenly throughout the state. Yet even with this subsidy, electricity is still much more expensive for these rural customers. And beyond the PCE, other forms of assistance to rural utilities are becoming scarce given the state's current fiscal environment. Nearly 90 percent of Alaska's unrestricted budget funds in recent years have been tied to oil royalties—a sector experiencing significant declines in production and oil prices. Consequently, as Alaska looks to tighten budgets, the challenge of lowering rural utility costs, while encouraging self-sufficiency, has become more urgent.

In recent years, many of these communities have started to integrate alternative sources of energy into their diesel-based power systems as a way to increase self-sufficiency and lower energy costs. These efforts are fostering innovation at a local scale and could be shared with other communities throughout rural Alaska. Emerging renewable energy technologies, combined with storage and energy efficiency, offer the promise of lower costs, as well as an increase in the self-sufficiency of communities.

The U.S. Department of Energy (U.S. DOE) Office of Indian Energy Policy and Programs, in partnership with Lawrence Berkeley National Laboratory and the Regulatory Assistance Project, set out to understand the current challenges and identify opportunities for rural utilities to move toward a more sustainable future. Throughout 2015, the team visited more than 30 communities across all regions of Alaska. The team met with local leaders and utility managers, and toured facilities—along the way gaining a strong sense of both the challenges and the potential in these communities.

This study examines reliability, capital and strategic planning, management, workforce development, governance, financial performance and system efficiency in the various communities visited by the research team. Using those attributes, a tier system was developed to categorize rural Alaska utilities into Leading and Innovating Systems (Tier I), Advanced Diesel Systems (Tier II), Basic Systems (Tier III), and Underperforming Systems (Tier IV). The tier approach is not meant to label specific utilities, but rather to provide a general set of benchmarks and guideposts for improvement.

Analysis and Options

Solutions to Achieve Scale

The small size and geographical remoteness of Alaska's rural communities means that their utilities do not enjoy the "scale economies" of their larger counterparts, so costs per kWh are higher and reliability is more difficult to maintain. In many instances, state and federal programs are able to help bridge some of these gaps. The Alaska Energy Authority (AEA) trains power plant operators to maintain facilities in compliance with codes and standards, or bookkeepers to keep up with filing requirements of the PCE. Elsewhere, however, achieving scale is a struggle.

One model that utilities could consider to improve scale is to organize with other utilities in similar situations, pooling their efforts to buy fuel in bulk or plan training for staff. There are several models of organization that provide these services, including utility cooperatives, such as the Alaska Village Electric Cooperative (AVEC), and private non-profits, like the Norton Sound Community Development Corporation that purchase fuel in bulk for multiple villages in the Bering Straits Region of Northwest Alaska. Utilities in communities in closer proximity, such as the villages of the North Slope Borough, can make agreements to aggregate services. The regional corporations established under the Alaska Native Claims Settlement Act could function as umbrella organizations for groups of village utilities, as they are financially stable and experienced in energy issues. Third-party providers working under contract can offer services from system planning to metering and billing. A joint action agency model could involve municipalities joining together to function as a regional power authority, or an adjunct, and provide more reliable and lower-priced energy services.

Improving Long-Range Planning and Resource Decisions

For most of Alaska's high-cost rural utilities, planning occurs in the context of the grant-making process—focused on upgrades to the powerhouse, fuel storage tanks, and distribution system—and can be ad hoc. In many U.S. jurisdictions, utilities undertake integrated resource planning (IRP) processes to assess least-cost options and weigh future uncertainty. A longer-term approach to planning of this kind could help utilities better anticipate their needs, plan better investments, and look more broadly at alternative energy sources and approaches. The regional energy planning process launched recently by the AEA is a promising start, particularly in rural regions where the plans review all forms of energy use, including electricity, heating, and transportation.

As Alaska tightens its fiscal belt, the next step in the regional energy planning process is for communities to pick up where the state left off. The AEA will have an ongoing role, but it can also tap federal partners. DOE's Strategic Technical Assistance Response Team (START), for example, is already working in a number of communities visited by the study team.

Meeting Rural Utility Capital Requirements

Utilities require large amounts of infrastructure investment, and to make sure this happens on time, managers, owners, and community leaders must recognize the need for timely investment and capital planning. To improve their standing with lenders who could provide this needed capital, utilities must "get their financial house in order" by cutting down on customer arrearages and maintaining improved financial records. The Regulatory Commission of Alaska (RCA), which already requires that PCE communities meet certain accounting standards, could play a role in encouraging this added financial discipline and showing utilities that they have the means to fund reasonable borrowing.

As historic levels of financial support are changing, the state can consider strategies to shift from a system of one-time subsidies and grants to one that places greater reliance on tools such as loans, revolving loan funds, and even insurance products that make the most of the amount of energy produced (or saved) for every dollar of public funds made available. To some extent, this shift is already underway. Concepts such as the "green bank," which leverages public funds to attract private investment, could help to get rural utilities much-needed financing. Though utilities in the most distressed communities will still need grants to keep operations going, longer-term sustainability could be improved if these grants are targeted to specific needs and paired with technical assistance.

Developing Workforce Capacity and Utility Management

Utility administration requires a broad set of business and technical skills that rural utilities sometimes struggle to acquire. Human resource needs extend to village leaders with utility and management oversight responsibilities. The state of Alaska offers a variety of training programs for power plant operators and utility clerks and managers, and furthers the dialogue about training needs through programs such as the Rural Alaska Maintenance Partnership (RAMP). DOE also provides support for training efforts. These programs are a solid foundation on which to build and focus in-depth efforts to help utilities improve financial performance, maintenance, and integration of renewables, among other goals.

The state could consider, for example, expanding the AEA's Utility Clerk Training program to deliver more accounting and record-keeping training to Tier III and IV utility staff. For Tier I and II utilities, DOE could offer support in developing business plans and strategic future planning. Mentoring is another effective option that would pair experienced utility practitioners with managers and staff in nearby communities to share expertise. In the same vein, peer-to-peer exchanges could tap the experience of utilities that have successfully implemented new programs or system improvements, and allow their peers to benefit from that knowledge. Alaskans have always relied on their neighbors to help get things done, and the state could build on this tradition.

Expanding End-Use Energy Efficiency and Conservation

In 2010, Alaska lawmakers set a goal of reducing per-capita energy use in the state by 15 percent by 2020. Existing programs through the Alaska Housing Finance Corporation (AHFC) and AEA have made progress toward this goal, but the budget crunch unfortunately means that programs are in danger of being cut at a time when they should be strengthened. Rural residents tend to conserve energy to save money, and improvements such as LED community lighting have been embraced. But roughly 85 to 90 percent of existing rural homes are in need of energy efficiency retrofits, and Alaska has not yet fully embraced the efficiency goals seen elsewhere in the United States.

A key lesson from decades of experience is that energy efficiency programs give utilities valuable flexibility. With a few exceptions, however, Alaska's utilities do not invest in end-use efficiency. Such investments generally pay off quickly, and utilities should consider them. Improved building codes could make the energy performance of housing more efficient. And the state can shift dependence on the general fund by tapping the market for efficiency services through such models as the energy service company (ESCO) or public purpose energy service company (PPESCO).

Improving Power System Efficiency

In addition to the need for greater end-use efficiency, the electricity systems themselves can become more efficient. Tier III and IV utilities are troubled by poor fuel conversion efficiency and high "line losses," or electricity wasted because of inefficiencies in transmission and distribution. To address these problems, rural utilities need investment in generation improvements and generation heat recovery; the ability to make use of flexible loads; and interconnection where feasible. The state's Rural Power System Upgrade (RPSU) program provides capital to accomplish these goals, and the state can also explore ways to leverage community funds and outside investment.

Upgrades to power systems must be able to effectively integrate variable renewable energy sources. Communities such as Unalakleet rely on "secondary loads" to ensure that they are able to capture the full value of their wind generation, even when loads are otherwise low. Others, such as Kobuk and Deering, match solar resources with community water heating. Ceramic stoves can also provide flexible storage loads that complement new variable energy resources. Utilities can offer off-peak rates to encourage heating during hours that are most beneficial to the grid. Again, targeted investment and meaningful capital planning, as well as technical expertise, are the keys to making this happen.

A More Effective Power Cost Equalization Program

The PCE program was designed to provide some level of fairness to rural communities whose electricity costs were three to five times higher than those paid in Anchorage, Fairbanks, or Juneau. The program offers a credit that evens out these prices, but it does so only on the first 500 kWh of residential use per month, preserving the price incentive to conserve. Though the PCE has been successful in supporting cost containment for a limited use of energy and preserving a measure of business discipline on many utilities, it could be better tailored to create incentives for communities to pursue lower-cost and more sustainable local resources.

Spending on the PCE could be revamped so that it goes beyond subsidizing customer bills to provide wider incentives for utilities to improve performance. Under the PCE, the AEA is authorized to make grants on "small power projects" that reduce energy costs, so this shift could be done in a way that works under the current statute. This would enable PCE communities to use the funds to invest in energy efficiency, renewables, interconnection, or line loss reduction—improvements that over time could save customers more on their bills than the subsidies provided.

Fostering Measures and Standards of Performance

The RCA oversees the larger rural systems, but the majority of the smallest communities are virtually exempt from this oversight. Improving the quality and access to shared information about the performance of these communities could be beneficial. Rural utility managers and community leaders, and members of the community could benefit from better information about their performance relative to peer communities for targeting needed improvements. Currently, small utilities provide financial, production, and consumption information to the state; information provided shows improvement but tends to be spotty. Improving the collection and tracking of data on outages, system losses, service quality, and other measures over time would help to set useful benchmarks.

The RCA, in requiring such information, could make use of it to ensure that PCE funds are used to strengthen the link between system performance and state supports. To determine that, utilities would need to provide forward-looking planning information, as well as data on maintenance, operations, reliability, and financial performance. Training on data collecting and reporting this data is needed. It is also important to develop a collaborative approach that takes insights and concerns of individual rural communities into account. Such additional support would give the PCE communities greater incentive to seek out lower-cost investments.

Technology Solutions

Technology can help rural utilities overcome many of the barriers discussed in the study and below—challenges of scale, the need for better data, the integration of variable energy resources, and customer empowerment. Weather-related challenges across the state have inspired research and testing at organizations such as the Alaska Center for Energy and Power or the Cold Climate Housing Research Center. The AEA's Emerging Energy Technology Fund has made two rounds of awards to encourage technological innovation, supporting projects ranging from cold-climate wind power in the Northwest Arctic Borough to flywheel technology on remote Saint Paul Island. Technological solutions on the customer side of the meter can help keep bills reasonable and better equip utilities to collect revenue.

Innovation requires investment and cooperation. Regional efforts such as those discussed elsewhere in the report can be valuable forums for the sharing of information. A statewide online information clearinghouse for energy technology in Alaska is another idea that has promise, though the challenges of digital communication in Alaska must be considered.

Fostering Local Renewable Energy Solutions

Alaska has a renewables goal of 50 percent of its energy mix by 2025. Even small communities such as Saint Paul have set ambitious targets. On Kodiak Island, the Kodiak Electric Association has hit a target of close to 100 percent renewables. Many of the communities visited by the study team expressed an ambition of "going diesel off" at some point. But the challenges of distance and size mean that costs are high, and integrating resources requires technical upgrades.

Communities that want to achieve these goals must first identify their potential for renewables, which could include customer-sited resources and third-party provision. They must then plan to fully integrate renewable sources into their power systems, which requires powerhouse upgrades, matching to flexible loads, and adding storage. Efforts to increase scale could reduce the costs of logistics and distribution of renewables installation. In a number of communities, these efforts are moving forward. Utilities will in turn need to carefully plan for potential loss of revenue during this transition, and revenue assurance mechanisms can accomplish that.

Recommendations

The research team found that, in many cases, Alaska energy policies are already having a positive impact on rural communities—but there are additional recommendations that should be considered. In particular, four key areas of focus will help rural utilities to improve performance and lower costs for ratepayers.

Key Recommendation #1:

Encourage Rural Utilities and Communities to Achieve Economies of Scale

Small communities struggle because their size and remoteness do not allow for the economies of scale needed to lower energy costs. The team identified numerous state and regional efforts to overcome this challenge, which could serve as models for other communities to follow. Utilities operating in hub communities have been able to provide support to neighboring systems; Kotzebue Electric, for example, handles management and technical services for Buckland and Deering. Alaska Power Company serves a number of small communities in the central and southeastern part of the state. A number of cooperative utilities, including the Inside Passage Electric Cooperative (IPEC) and the Alaska Village Electric Cooperative (AVEC), also support a broad range of communities across other parts of the state. Economic development agencies such as the Norton Sound Economic Development Corporation, as well as Alaska Native Claim Settlement Act corporations, have played important roles in their respective regions.

These efforts have been valuable, but they fall short of the need for a comprehensive approach to reduce costs across rural Alaska. Communities should work with regional stakeholders to pool their resources in order to apply for loans and grants; coordinate fuel and equipment purchases; attract investment from independent power producers; and receive assistance from third-party service providers. Joint action agencies, comprised of public utilities and/or other stakeholders, could also help provide reliable, reasonably-priced electric service to rural communities.

Key Recommendation #2:
Strengthen Investment in Rural Workforce Development

Increased rural workforce capacity, especially among utility and community leaders, will improve the collective ability to strengthen utility management and attract investment. The Alaska Energy Authority (AEA) already provides entry-level and more advanced training courses for power plant operators to help ensure that rural utility staff have the essential skills to operate their power plants. The Rural Utility Business Advisor Program provides managerial and financial training to Alaska's rural water and wastewater utilities. And U.S. DOE's Office of Indian Energy Policy and Programs provided critical funding to develop a curriculum for the Alaska Rural Managers Initiative (ARMI). Goals of this initiative include making training more accessible to tribal administrators, utility managers, and municipal managers in rural communities.

These training programs should be expanded to help rural utilities improve their billing and financial operations, grant and loan applications, capital planning, and ongoing maintenance activities.

Key Recommendation #3:
Improve Accountability and Align Financial Incentives with Performance

Customer-focused reliability standards and incentives tied to performance will encourage utility management and community leaders to place a greater emphasis on the cost and quality of service that utilities provide. Rural utilities such as Gwitchyaa Zhee Electric, Tanadgusix Corporation (TDX Power), IPEC, and Gold Country Energy that are subject to higher standards of oversight and accountability are typically among the stronger performers in rural Alaska.

Utilities that participate in the PCE program already report some performance metrics (e.g., basic utility financial, production, and consumption information). Utility performance measured this way helps determine their annual rate support and eligibility for cost recovery, creating an incentive to reduce utility system losses. Incorporating additional performance metrics into the PCE program would better align incentives for rural utilities to be more efficient while encouraging the widespread adoption of renewable resources and energy efficiency.

Key Recommendation #4:
Increase the Role for Independent Power Producers and Other Third-Party Service Providers

Increasing the role for independent power producers and third-party providers can help rural utilities improve service and reduce costs to the community. Independent power producers bring access to new sources of capital and valuable experience that can accelerate adoption of innovative technologies that have been successful in other communities in Alaska and beyond. For example, TDX has integrated wind power on Saint Paul Island, using a combination of flywheel technologies and load management. Policies that allow independent power producers, like TDX, to provide technologies to other rural communities should be encouraged.

Many communities already rely on third parties to help run their utilities. Engineering firms and energy service providers are occasionally used to improve power system design, provide maintenance of the distribution system, and assist with bookkeeping and accounting. Marsh Creek LLC, for example, provides operations and technical support to many rural Alaska power systems. They have played a pivotal role in accelerating the adoption of advanced and pre-paid meters in more than 40 communities—an outcome that has significantly improved the rate of collections and the local utilities' financial health. We recommend that regional and community-level services that are funded through the state be strengthened by outsourcing where most appropriate.

Additional Recommendations

- **Accelerate Testing and Adoption of Emerging Technologies.** Alaska's Emerging Technology Fund tests technologies that are "close-to-market." The Cold Climate Housing Research Center plays a central role in ensuring that technologies are appropriately adapted to Alaska's varying weather conditions. Demonstration projects such as a seawater heat pump system at the Alaska Sealife Center in Seward are supported by the Denali Commission and AEA. The state of Alaska and the federal government should continue to support the work of these organizations and similar opportunities for communities to pilot and adopt relevant technologies.

- **Strengthen Commitment to Energy Efficiency.** Alaska should continue to strengthen its commitment to invest in energy efficiency and to retrofit existing homes, government and community buildings, and commercial structures in rural areas. Energy efficiency typically offers a least-cost solution to many homes and businesses. Existing programs, including building retrofits and weatherization, serve as an important starting point for investments. However, only a small portion of the opportunity has been realized, creating a need for more effective and well-funded residential retrofit programs. Promising pathways forward also include more emphasis on new construction by adopting and enforcing better building codes and standards, and consolidating program administration and delivery where possible.

- **Enhance the Role for Cost-Effective Renewable Energy.** Utilities need assistance in assessing the potential for renewable electricity resources and incorporating powerhouse improvements so that renewable electricity can be integrated effectively into these systems. Financial incentive programs could be designed to encourage the use of "secondary loads" (i.e., demand for electricity) such as water and wastewater systems, and demand response can help the utility system manage its load as intermittent renewable resources are brought online. The Chaninik Wind Group in southwestern Alaska provides a good example of effectively integrating wind energy, new secondary loads (ceramic stoves), rate design, and smart grid technologies to manage their system.

- **Strengthen Energy-Related Communications in Rural Communities.** Utility managers and community leaders could benefit greatly from information sharing about operations and standards. The AEA has proposed an online "dashboard" that provides access to utility system information to facilitate this. Still, rural communications face additional technological hurdles including slow and expensive telecommunications access. Energy system improvements are unlikely without wider investment and more competition in information-technology infrastructure and services.

- **Institutionalize and Implement Regional Plans at the Community Level.** Communities should build on the initial success of the state of Alaska's regional energy planning process. Regional Energy Plans provide a mechanism for identifying regional solutions and fostering collaboration between communities in order to achieve economies of scale. The U.S. DOE Alaska Strategic Technical Assistance Response Team (START) program is another successful model implementing regional energy plans at the community level.

- **Strengthen Capital Planning.** The budget challenges facing Alaska mean that state-sponsored grants for rural utilities will become more scarce. Accordingly, utility managers will need help in identifying other means to support and implement capital plans to ensure ongoing investment in power system infrastructure. The U.S. DOE, AEA, and the Denali Commission already require training and planning in conjunction with grant-based awards, and these organizations should continue to support rural utilities efforts to develop long-term capital plans.

- **Improve Access to Low-Cost Capital for Rural Utilities.** The state of Alaska and federal agencies can help improve access to low-cost, debt-based capital by providing incentives for capital planning activities, encouraging loan aggregation and securitization, and supporting the design of a rural energy project development portal. Access to low-cost capital can be improved by combining public funds (e.g., U.S.

Department of Agriculture Rural Utilities Service loan programs) with commercial loans and other sources of private sector capital. Alaska native corporations and other regional development corporations also have the ability to provide other sources of low-cost capital to rural communities.

- **Improve Power System Efficiency.** Performance data submitted to the PCE program indicates that there are improvement opportunities possible to reduce line losses, increase fuel conversion efficiency, and make better use of heat recovered from thermal generation. The AEA's Rural Power System Upgrade and Heat Recovery programs have been effective in promoting recapture of heat from diesel generation in small communities. Communities should consider where best to locate new powerhouses (e.g., next to a school or health clinic) to benefit from the recovered heat produced by electricity generation facilities. Federal agencies could play a role in demonstrating the value of efficiency in these systems and provide technical assistance in their implementation.


LED STREET LIGHT
POWER HOUSE
COMMUNITY CENTER
VILLAGE SCHOOL
HEAT RECOVERY PIPES
DIESEL STORAGE

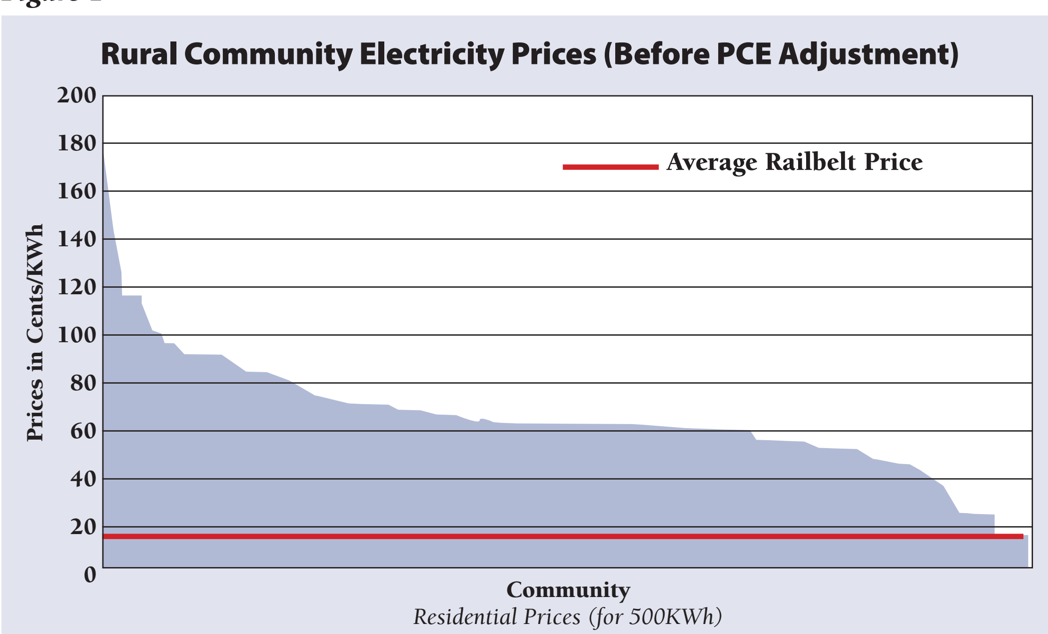
Introduction

The environment in which rural Alaskans live—and the systems that deliver them electricity—look very different from the state's more populous areas and the rest of the United States. In contrast with most regions of the Lower 48, which have been interconnected for more than three-quarters of a century, many Alaskans receive power through physically isolated distribution systems with few practical interties. Approximately 200 high-cost rural Alaska communities are served by these microgrids. These places are generally distinguished by cold weather, difficult topography, and small and isolated populations. The challenges of this environment, combined with concerns for the health, prosperity, and safety of the residents of these communities, led to substantial investment in power plant generation capacity—typically diesel-fired.

The cost of providing electricity service is high compared with other places in Alaska and the Lower 48, particularly because of the high cost of delivering fuel to these remote locations. The average cost of electricity in these communities before price adjustments (see below) is 58 cents per kilowatt-hour (kWh), with two-thirds of that due to the costs of diesel fuel.[1] Figure 1, below, shows the price of electricity in 2014 for the 170 communities listed in a recent report by the Alaska Energy Authority (AEA). Another part of the challenge is that power plant investment levels are high due to the need for redundant facilities to support reliability. According to the Alaska Village Electric Cooperative (AVEC), which serves 56 rural communities, gross plant investment levels per customer are around $17,000.[2] Not surprisingly, the cost of delivering a diesel generator in remote regions of Alaska usually greatly exceeds the typical costs to deliver to a plant located in Anchorage or Fairbanks.

Alaska state agencies have sought to bridge the gap in utility service and cost between these communities and the wealthier, more interconnected Railbelt region. The most prominent effort is the Power Cost Equalization (PCE) price support program, which helps to lower bills for most residential customers and some community buildings in about 200 rural communities beyond the more populous Railbelt. The intent of the program is to recognize and help distribute to communities throughout Alaska the benefits of state support for low-cost resources in more populous regions. Figure 2 shows communities throughout the state that are participating in the PCE. The program has successfully controlled costs for rural villages while preserving the residual price signal that promotes conservation (the subsidy applies only to the first 500 kWh of consumption per month). Still, the costs of two-thirds of consumption (in kWh terms) are fully borne by the commercial businesses, institutions, and residents of these communities. In times of plenty, the program functions well and delivers on its promise. But the long-term

Figure 1



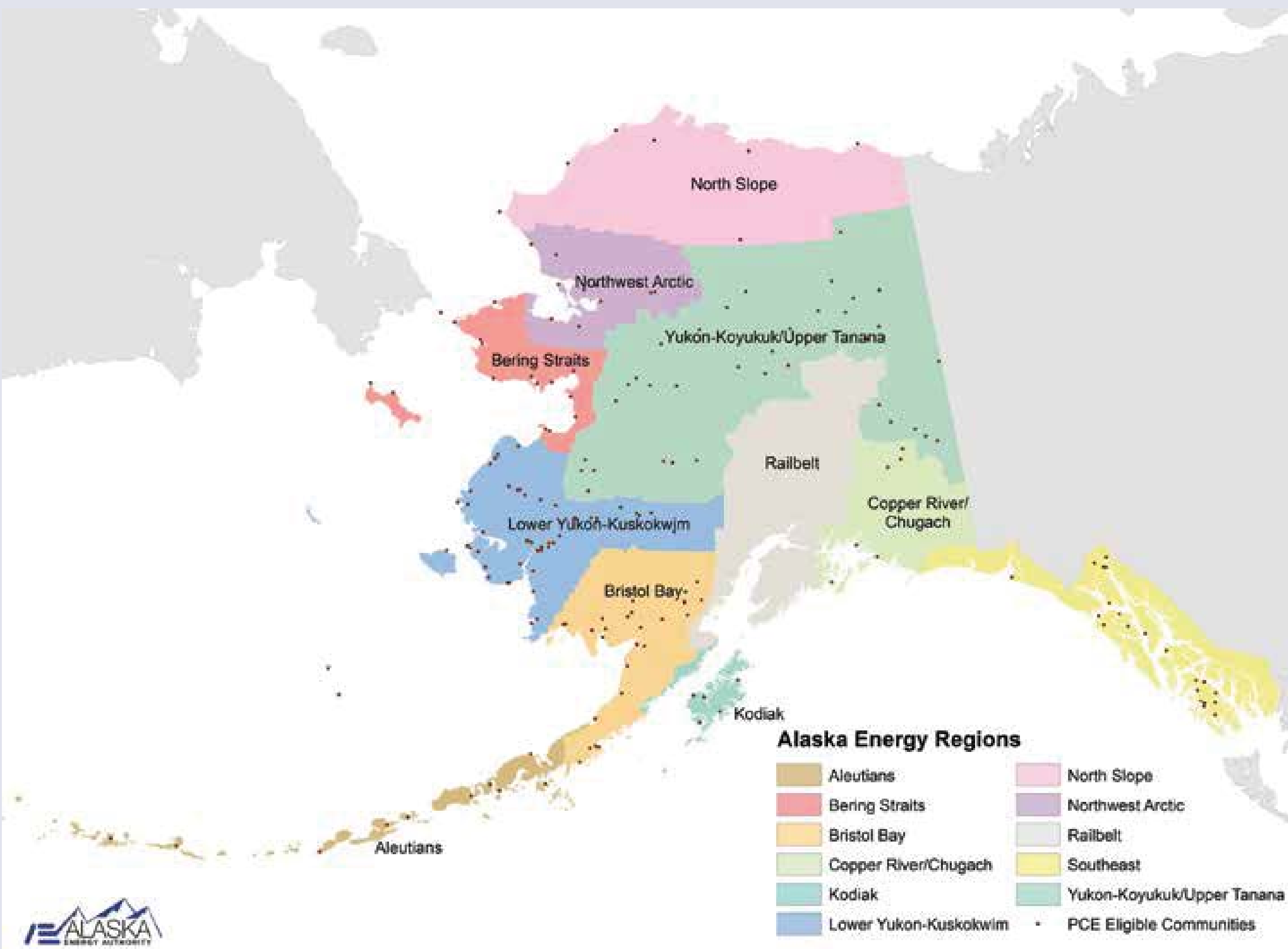
future of the subsidy is a persistent and growing concern given the volatile price environment and uncertain future of Alaska's revenue from resource extraction.

Communities seeking to diversify their energy sources beyond diesel can look to the state's Renewable Energy Fund (REF). However, funding for the REF has been on a steady decline. The program originally envisioned spending roughly $50 million per year through general fund appropriations. But recent years have seen outlays of around $25 million, declining to $11.5 million in the eighth and most recent round of bidding, and the state's budget crunch may lead to further reductions. Also, participation in the REF has been regionally skewed, with funds tending to flow to areas where renewable resource development is already robust. REF funding is partly based on the quality and merit of proposed projects, but also on the persistence of applications, which means that many of the communities that need the most assistance are not necessarily seeking or receiving it.

The state, with help from partners such as the Denali Commission—an independent federal agency established in 1998 to provide critical utility, infrastructure, and economic support throughout Alaska—and the U.S. Department of Energy (DOE), also maintains technical and emergency assistance programs to prevent outages or quickly address them when they happen. There is no official published information available concerning power outages in rural areas of Alaska.[3] However, media reports and field interviews suggest that these events are frequent across a particular group of systems and put great strain on

Figure 2

PCE-eligible Communities



those communities and the agencies charged with providing emergency assistance.[4] Information provided anecdotally from the AEA suggests that these outages often happen because of inadequate maintenance of facilities—especially electricity distribution systems. Just a handful of utilities, shown below (representing 63 communities) reports reliability data to the U.S. Department of Agriculture's Rural Utilities Service (see Figure 3).

Alaska's rural utilities are capable of functioning at a high level of performance, but many struggle to do so, presenting risks to public health, safety, and financial prosperity. Longer-term planning efforts have been undertaken in order to prioritize and identify sustainable projects for these communities. However, declines in federal assistance (even including the recent announcements during President Obama's September 2015 visit[5]), combined with falling oil revenues for the state, are straining the ability of government agencies to offer a wide range of solutions to these problems. Alternative pathways need to be considered, and this report will explore some of them.

Why Is This Report Timely?

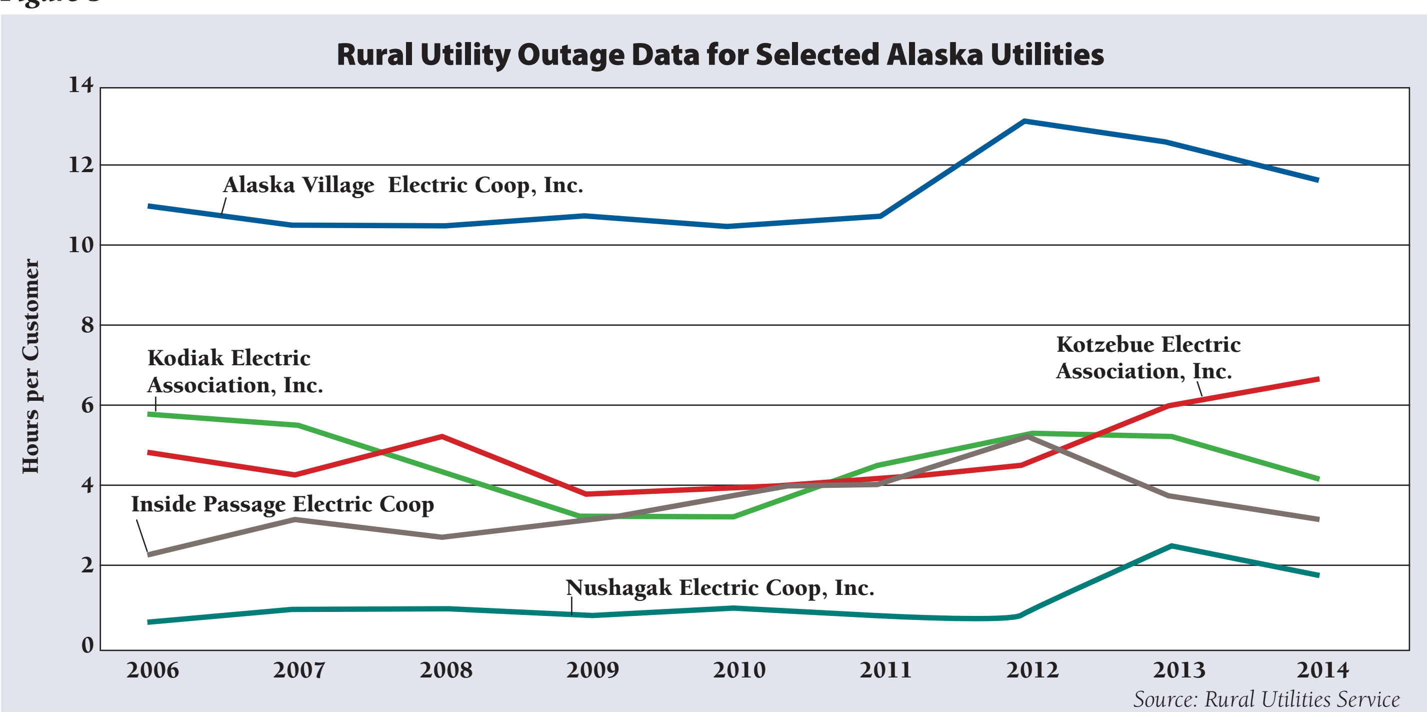
State and national policymakers are at a critical juncture where aging current infrastructure, challenging fiscal realities, and emerging technological opportunities meet. These realities will likely require fundamental changes at the state level, and we have used this report as a tool for identifying such changes. But federal agencies can also help to provide a bridge. As such, this report is designed to inform the U.S. DOE's work in Alaska over the rest of this decade and beyond.

- **The challenge of integrating existing systems and emerging technologies**

This report comes at a time in which the energy industry is rapidly changing. Concerns about climate change impacts and the role of greenhouse gases (GHGs) in changing the climate are leading to a reconsideration of the reliance on fossil fuels in the generation mix. However, deploying alternative resources, like wind and solar, comes with its own set of challenges, including cost questions and how to integrate these intermittent resources into existing, outdated power systems.

Many of the power distribution systems in Alaska's rural communities are at least 40 years old. Power generation facilities are relatively newer, but still average 21 years old.[6] The existing power infrastructure—which is based on well-understood, mature technologies (e.g., diesel)—is being reconsidered in light of emerging generation and storage technologies. Another challenge, as noted earlier, is the issue of deferred maintenance and power system interruptions. There is also a general lack of consistent and standardized information on energy/electricity system usage

Figure 3



Source: Rural Utilities Service

and long-term performance. Reported information about line losses, for example, appears highly unreliable, as some systems report sales levels that exceed actual production. Data reporting requirements for the PCE program provide the best information available, but even a casual review reveals serious concerns about how the data are collected and/or reported to government agencies.

After a decade of volatile fuel prices on global markets, Alaska's rural villages seem ready to transition to more sustainable technologies.[7] However, some utility managers are concerned that given the issues outlined above, the technical challenges and lifecycle costs of these emerging technologies are much higher than many community members fully appreciate. For example, the installation costs of a wind generator in Alaska are estimated to be approximately $10 per watt, or roughly two to three times the costs of similar systems in the Lower 48.[8] Similar cost differentials have been reported for solar photovoltaic (PV) systems. The installed costs of solar in rural Alaska typically range from $5.50 to $7.50 per watt depending on the type of systems and whether all costs are included,[9] compared with an estimated $2.70 per watt for residential-scale installations and $1.50 for utility-scale installations in most of the lower 48.[10]

Figure 4

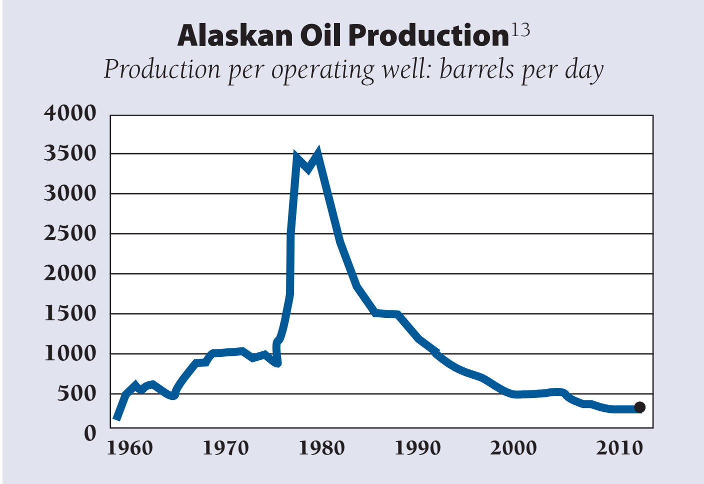
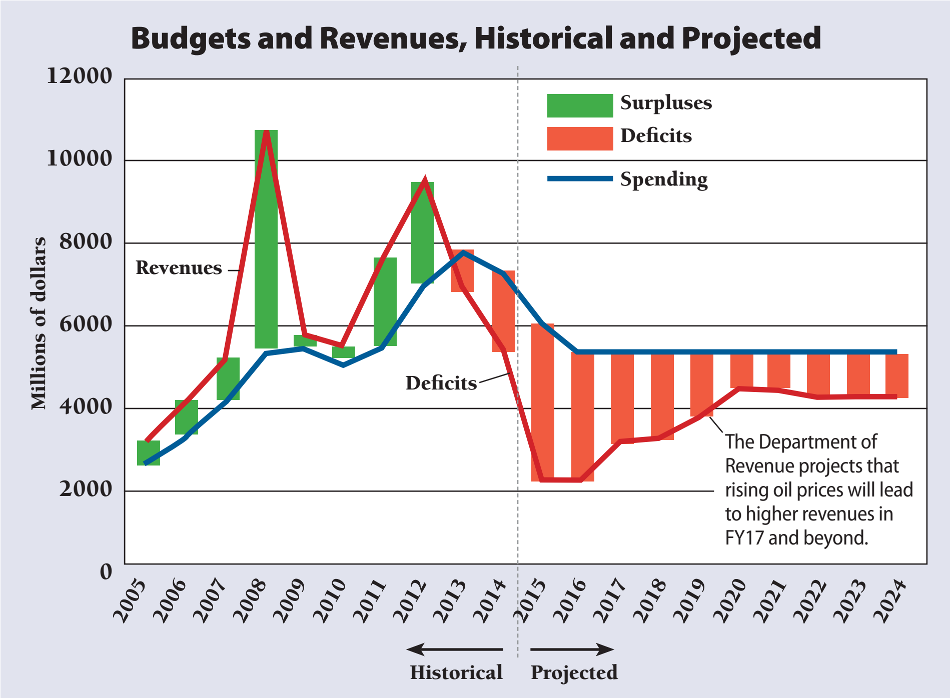


Figure 5



- **Declining state budgets**

Nearly 90 percent of Alaska's unrestricted budget funds can be attributed to state revenue from oil production.[11] Yet significant declines in production, coupled with significant declines in prevailing world oil prices, puts that funding at risk over the long term. Figure 4 shows the longer-term trend in declining oil production. Figure 5 shows historic and future budgets and expected revenues. Note that even if oil prices (and therefore revenues) rise again beyond 2016, as this projection suggests, Alaska would continue to operate at a deficit.[12] A number of federal and state agencies, including the DOE, Denali Commission, the Rural Utilities Service, and others have recently announced an influx of assistance targeted at improving rural utility infrastructure and performance. Yet these initiatives do not address the larger issue of Alaska's dwindling state revenue over the long term.

- **Fuel prices and their effect on rural Alaska**

For Alaska's rural utilities, (over)reliance on diesel generation systems poses a financial risk regardless of the price of oil. If the price of oil remains low, then the Alaska state budget—and therefore the revenues that fund state electricity/energy assistance programs—will suffer (see Figure 5). On the other hand, if the price of oil remains high, then these communities pay increased fuel costs for transportation, heating, and electricity. This no-win situation for rural Alaska communities opens the door to alternative energy solutions.

- **Guiding the DOE Office of Indian Energy's *Ten-Year Renewable Energy Plan***

  The U.S. DOE's Office of Indian Energy, in partnership with Lawrence Berkeley National Laboratory (LBNL) and the Regulatory Assistance Project (RAP), intends to use this report to inform DOE's *Ten-Year Renewable Energy Plan*. DOE assembled a team to provide an impartial, outside perspective on the energy needs of rural communities, particularly with regard to electricity generation and distribution. This perspective is intended, by design, to provide a fresh and objective evaluation of the challenges facing Alaska's rural communities. The team also has relevant experience from outside of Alaska and the United States, evaluating sustainable alternatives for islanded and remote power/energy systems.

- **U.S. chairmanship of Arctic Council**

  The Arctic Council is a high-level intergovernmental body that oversees the management of issues facing local populations and indigenous peoples. The eight member states are Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States.[14] In 2015, the United States assumed the leadership of the Arctic Council, with Secretary of State John Kerry serving in that role from 2015 until 2017. Among other things, the Council is focusing on communities impacted by climate change: "The Arctic Council's work on energy and water security seeks to improve economic and living conditions in the region by pursuing innovative technologies to mitigate the significant challenges faced by remote Arctic communities."[15] U.S. leadership of the council will shine a spotlight on rural Alaska communities, where the impacts of climate change are already affecting the performance of community infrastructure—including power and energy systems.

Who Is the Audience?

The findings from this report are applicable to a wide audience, but it is primarily aimed at policymakers at all levels of government, rural electric utility management, and other relevant stakeholders in rural electric/energy systems. The best solutions to Alaska village utilities' challenges will involve a cooperative, and ideally seamless, interaction among local, state, and federal government officials. Alaska Native Regional Corporations and private companies can also provide solutions and are therefore key audiences.

Given the common issues faced in many Arctic communities in Alaska and beyond, we hope that stakeholders around the world will read and find relevant pathways identified in this report. The report, is, however, tailored for the Alaska situation.

Key Questions Considered

This report focuses on answering three key questions:

(1) What is the current state of energy and electricity in rural Alaska?

A massive public commitment to electrify rural Alaska communities produced the systems that now exist in villages throughout the state. The prevalent technology at that time ensured that diesel would be the fuel of choice, and Alaska's oil wealth fueled the economic support to keep systems running. However, oil prices and production have become more expensive and volatile, and Alaska's residents cannot afford to assume that these systems can be supported at current levels. Meanwhile, rural isolation and lack of scale (see Section II-A of this report), among other issues, have posed challenges for the operation of village utilities while new options exist for consideration.

(2) What are the cost-effective technical solutions and alternatives to current sources of heat, transport fuel, and generation for rural regions of Alaska?

Energy efficiency programs, explored in detail in this report, are a least-cost solution for most if not all of the communities visited by the research team. These programs must be well-designed and address the unique challenges of rural villages. Energy prices send strong price signals that motivate energy-efficient investment, but most housing in the communities studied was built before oil and electricity prices rose sharply, which means that modern remedies and modern policy approaches are needed. Renewable energy sources, including solar, wind, hydro, biomass, and geothermal, can complement or replace diesel fuel as its price grows more unpredictable. Systems will need technical upgrades to better integrate these resources. Improved remote communications can help utilities better monitor performance and maintenance needs.

(3) What are the most promising policy pathways forward?

The research team found that in many cases, Alaska is already taking steps toward the policies needed to adapt rural systems to future needs and realities. Those efforts should continue and expand. Regionalization efforts, improvements to access to capital, improving access to information, human resource/workforce development, and better incentives are among the concepts explored in Section II of this report.

The following text box presents guiding principles the team applied to its study of rural Alaska energy systems:

Guiding Principles Applied Throughout this Analysis

Take a holistic view of community energy
Because there is little distinction between a community's energy challenges associated with electric generation and those related to transport and heating, solutions should endeavor to integrate all three.

Identify opportunities to streamline and coordinate policies
Having been developed over time, some electricity sector policies with certain redundant features could benefit from improved coordination and simplification.

Align financial incentives for positive outcomes
Community and utility incentives should positively align, where possible, to provide the most value for rural utility customers, and align with state and community objectives for sustainable resources.

Encourage least-cost solutions over the long term
The state and other funding sources should encourage communities and utilities to develop energy system solutions that result in the lowest lifecycle cost, including those related to long-term capital, operations and maintenance, and fuel.

Implement solutions incrementally
Build upon successful programs being implemented by existing institutions.

Highlight solutions that encourage continued community self-sufficiency
Promote solutions that can build upon community self-sufficiency.

Encourage "no-regrets" solutions
Encourage solutions that benefit communities regardless of the source or amount of financial resources.

Research Method

Over the past 12 months, we employed a number of methods to collect information about rural Alaska's energy systems, including:

1. Reviewing recently published papers, reports, and presentations

We evaluated reports, memoranda, and presentations from research organizations, the state of Alaska, the U.S. Departments of Energy and State, rural utilities, and materials presented at conferences.

2. Participating in meetings with key research and policymaking organizations

We met with principals and staff from organizations including the AEA, the Regulatory Commission of Alaska (RCA), AVEC, Institute of Social and Economic Research (ISER), the Alaska Center for Energy and Power, WH Pacific, Marsh Creek, Intelligent Energy Systems, and the Cold Climate Housing Research Center (CCHRC).

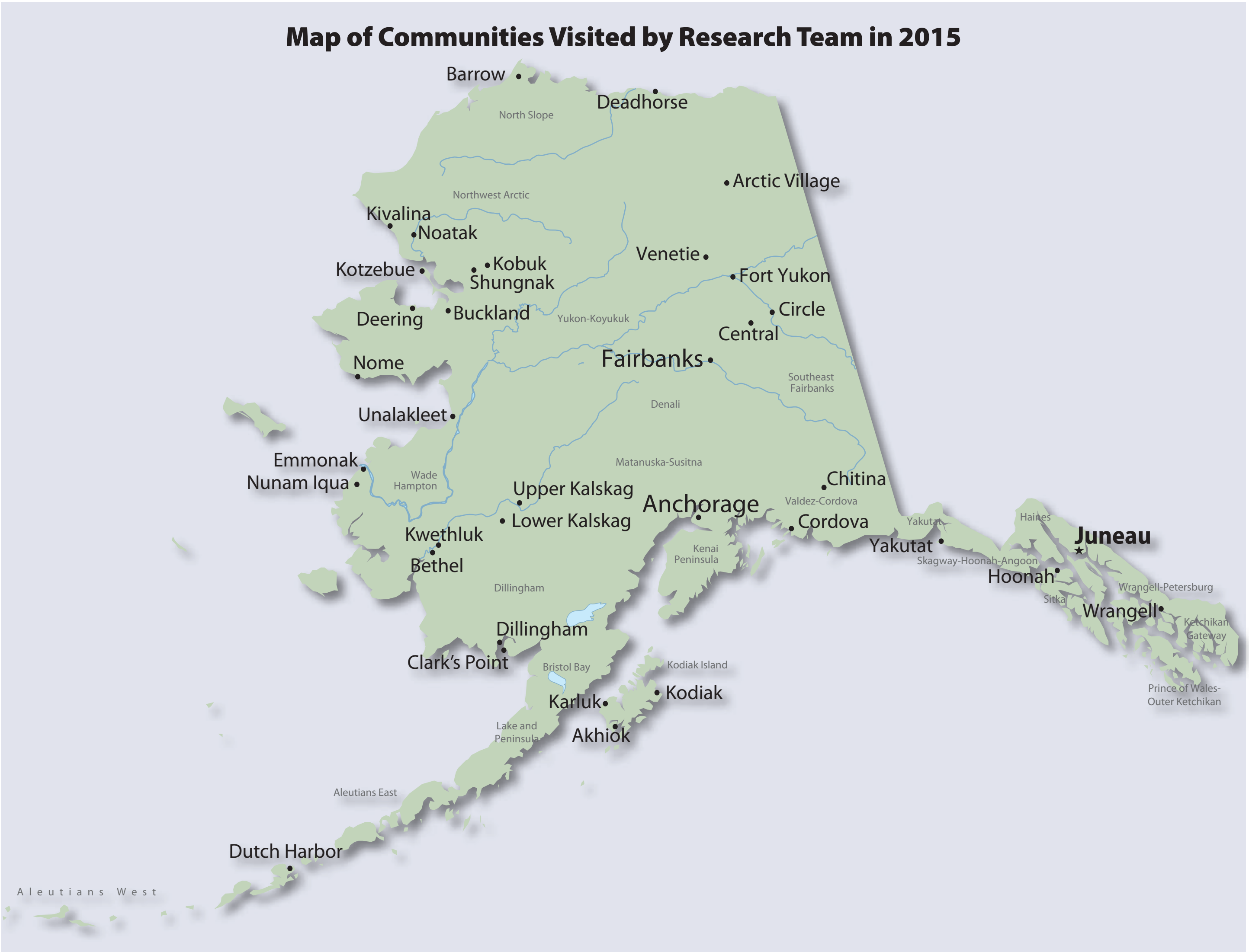
3. Conducting field visits and interviews in 34 rural Alaska communities

Prior to traveling, our team reviewed community profiles available through research portals run by the AEA and the Alaska Department of Commerce, Community, and Economic Development (ADCCED). We met with rural Alaska communities during trips between April and October 2015.[16] (See Figure 6.)

Field interviews explored the following topics:

- Community energy challenges
- Community energy successes
- Electric system reliability
- Long-range planning
- Financial health and related challenges
- Near-term capital plans
- Role of independent power and third-party assistance
- Diesel generator performance
- Maintenance and standards
- Experience with renewables
- Experience and access to energy efficiency
- Human resource capacity and gaps
- Waste heat and secondary loads
- Environmental and utility regulation
- Household heating

Figure 6



Report Structure

Sustainable Energy Solutions for Rural Alaska has three parts. Section I provides a high-level overview of the current environment in which many rural Alaskan utilities operate. Section II is a review of rural utilities' options to lower their costs and improve reliability and service quality. Section III is a summary of our recommendations.

Notes

1 Alaska Energy Authority (AEA), (2014). *Power Cost Equalization, Statistical Data by Community.* Retrieved from http://www.akenergyauthority.org/Content/Programs/PCE/Documents/FY14PCEStatisticalRptByComtAmended.pdf.

2 Kohler, M. (2015, July 15). Written Testimony on Microgrids, Submitted to the United States Senate Committee on Energy and Natural Resources. Retrieved from http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=67adbde2-9646-44c8-adca-2358148085f3. For comparison, Edison Electric Institute (EEI) financial reports indicate gross power plant in service at $1,212 billion for roughly 101 million customers in the lower 48, or roughly $12,000 per customer. Net plant is closer to $8,000 per customer. See EEI. (2014). *Industry Financial Performance.* Retrieved from http://www.eei.org/resourcesandmedia/industrydataanalysis/industryfinancialanalysis/finreview/Documents/FinancialReview_2014_02_IndustryFinPerf.pdf.

3 Regulated utilities in rural Alaska, which represent a small minority of the systems, do file notices of major outages with the regulator.

4 The information that is available comes from the filed reports of the regulated rural utilities. Because these are largely the larger private systems, and not generally associated with challenges to community health and safety, they are of limited value for this analysis. The information that is available is therefore from published accounts or from interviews done during the community visits.

5 Among the efforts highlighted in news releases from the White House were the following: (1) A $4 million Alaskan Communities Energy Efficiency Competition, funded by the U.S. Department of Energy (DOE); (2) $8 million in High Energy Cost Grants administered by the Denali Commission, including $1.5 million from the U.S. Department of Agriculture's Rural Utilities Service to improve infrastructure and $15.5 million in grants to support bulk fuel facilities and rural power system upgrades/power generation; (3) in Kodiak, a public-private partnership to deploy energy storage and hit a 99%+ renewables target, and (4) in Igiugig, money for investment in biomimic wind turbines. For more, see https://www.whitehouse.gov/the-press-office/2015/09/02/fact-sheet-president-obama-announces-new-investments-combat-climate.

6 See data from Form EIA-863, P*etroleum Product Sales Identification Survey.* Retrieved from http://www.eia.gov.

7 A review of the regional energy plans reveals a great deal of interest in alternatives. This may be most pronounced in the Kodiak Regional Energy Plan: see http://www.kodiakenergy.org/wp-content/uploads/Kodiak-REP-Phase-II-Vol-I-Resource-Inventory-Outreach.pdf. Kodiak now relies on diesel for only 6 percent of its electricity generation.

8 This compares to installed project costs in the Lower 48 as reported by LBNL at about $3 per Watt. See: http://eetd.lbl.gov/sites/all/files/lbnl-188167_presentation.pdf

9 Personal communications with David Pelunis-Messier, September 25, 2015, and Robert Bensin, October 2, 2015.

10 Personal communications with Bloomberg New Energy Finance, November 16, 2015.

11 Unrestricted oil fund revenue pertains to the roughly $2.2 billion that the state receives and uses to pay for, among other things, the operation of state government. Restricted sources of funds are about $7.4 billion, but the state has considerably less discretion in how the funds are used. Of the $2.2 billion in discretionary funds, approximately 90 percent of those funds have been from oil revenues from 2005 through 2014. Knapp, G., Institute of Social and Economic Research (ISER), 2015.

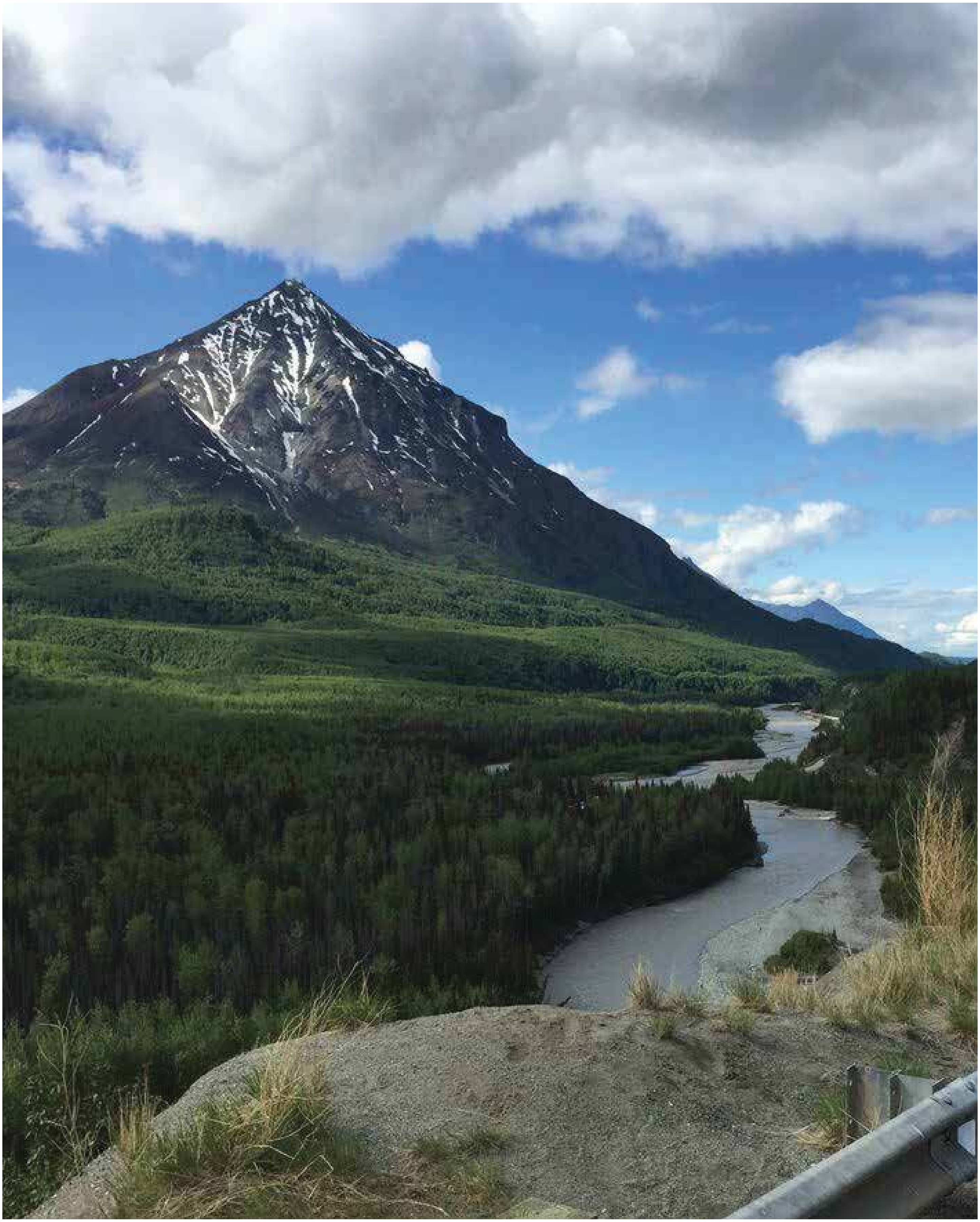
12 Knapp, 2015.

13 ISER, 2014.

14 For more about the Arctic Council, see: http://www.arctic-council.org/index.php/en/.

15 Arctic Council. (2015). *About the United States Chairmanship.* Retrieved from http://www.arctic-council.org/images/PDF_attachments/US_Chairmanship/Chairmanship_Brochure_2_page_public.pdf

16 In addition to the map showing the communities visited, the team also developed a Facebook page to help increase local awareness of the project. See: 2015 U.S. Department of Energy Rural Alaska Utility Study, retrieved from https://www.facebook.com/DOERuralAlaskaStudy.



I. Energy and Electricity in Rural Alaska

Factors Affecting the Utility Sector: Challenges of Distance and Size

Rural Alaska has been described as a "world away" from the state's urban economy.[17] To appreciate these differences, it is important to recognize some of the factors like size and remoteness that make Alaska so unusual. As illustrated in Figure 7, when superimposed on the lower 48 states, Alaska stretches, east to west, from Florida to California and, north to south, from Canada to Texas.[18]

Roughly, 200 communities exist in the high-cost, rural regions of Alaska.[19] Their average population is 471, although populations vary from 13 (Healy Lake) to 6,182 (Bethel).[20] Only seven of these communities have more than 2,000 people. Three of the communities visited, Akhiok, Clark's Point, and Karluk, have populations below 100 and fewer than 35 utility customers.

More than 70 percent of Alaska is inaccessible by road, resulting in a lack of access to affordable fuel and other supplies. [21]

In the absence of roads, Alaskans use alternate forms of transportation in certain seasons when available, although usually at high cost. Frozen landscape provides some intercommunity travel during colder months for the far northern communities. River passage in the summer provides some access for food and fuel deliveries. Coastal communities are accessible by ferry or barge. Otherwise, jets and small airplanes provide expensive access.

Figure 7

Alaska Superimposed on Lower 48 U.S. States

The research team arrives in Shungnak in April 2015.

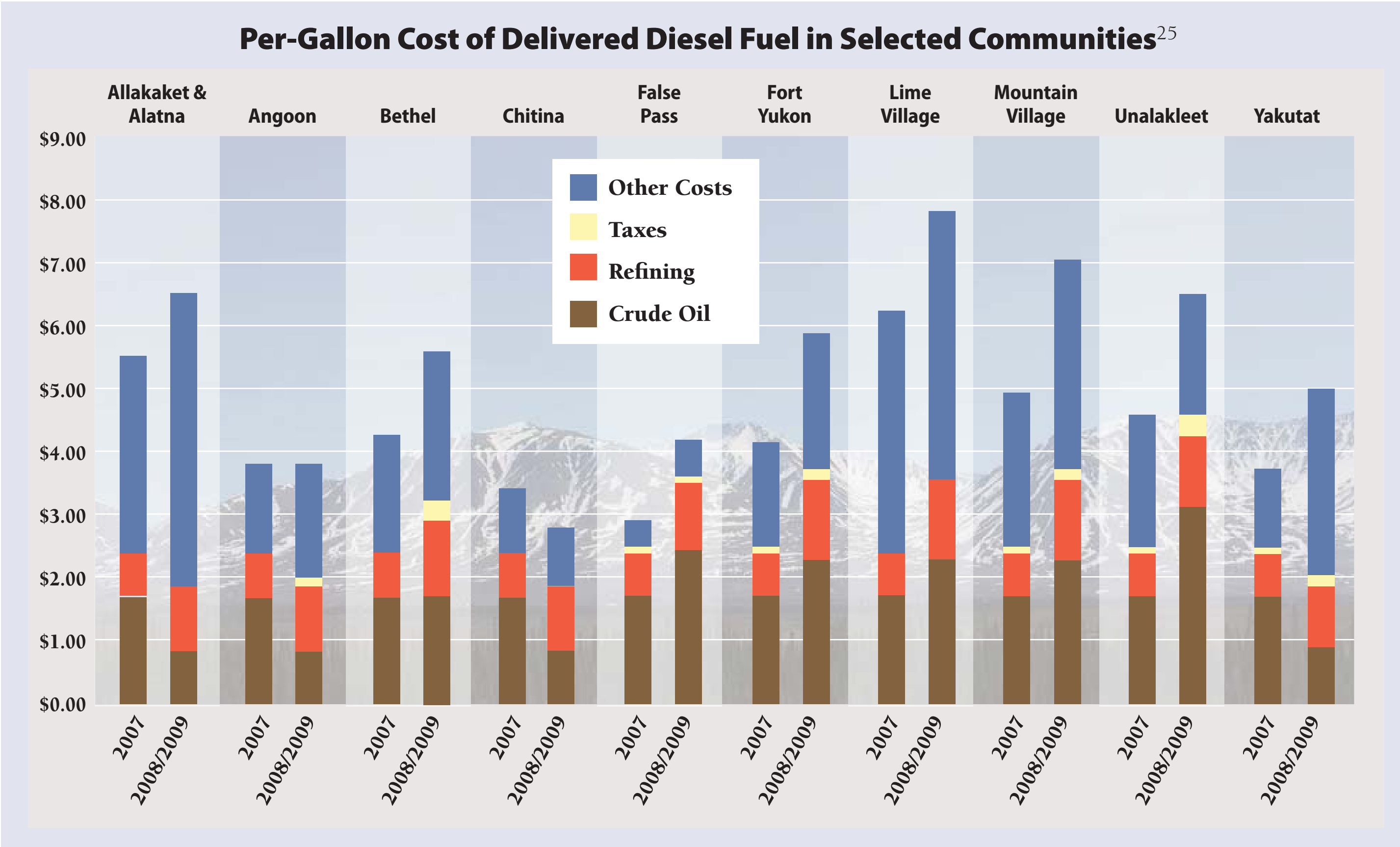
Communities in areas that are not served by road experience very high costs of producing electricity, usually by diesel, due to high transportation costs and high diesel prices. These high costs must be recovered from the limited number of customers with limited disposable income associated with generally low economic development.

Power Cost Equalization Program Guide, 2014

Most rural communities can communicate via internet, although the character of communications varies around the state. Railbelt and other larger communities usually experience reasonably high-speed communications at affordable rates, but more remote communities typically experience slower data speeds and rely on a single isolated provider of services with an accompanying risk of higher prices.[22]

Rural communities in Alaska rely on fuel oil for heating homes and for generating electricity.[23] "Communities in areas that are not served by road experience very high costs of producing electricity, usually by diesel, due to high transportation costs and high diesel prices."[24] (See,

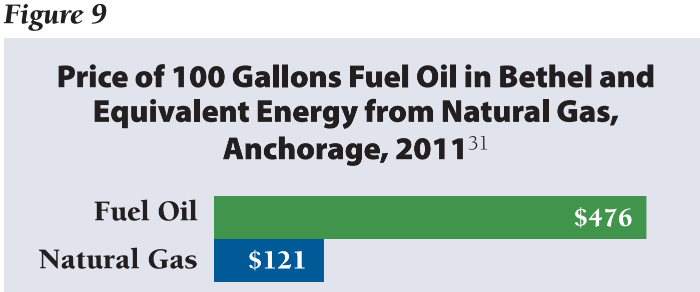
Figure 8



e.g., Fig. 9). Diesel generators produce about 89 percent of electricity in Alaska's rural communities, and power plants use about half of the fuel stored in most villages.[26] Of all the generation produced in PCE-eligible communities in 2011, only 11 percent (34 MW out of 309) came from alternative resources like wind and hydro; the rest was diesel-generated.[27] Most of the fuel oil used by Alaskans is tanked in from the lower 48, or from Alaskan refineries located in Valdez, North Pole, and Nikiski.[28]

Fuel oil is far more expensive than the natural gas that is accessible by pipeline and used elsewhere in Alaska for most energy needs, including electricity generation.[29] Considering the cost of equivalent amounts of energy,

Figure 9



fuel oil can be nearly four times more expensive. This is illustrated in Figure 10 where, in 2011, 100 gallons of fuel oil purchased in Bethel cost $476 while the same amount of natural gas purchased in the Anchorage region cost $121.[30]

In addition to geographic barriers, and the high cost of fuel, rural communities recover costs from a small number of customers with limited incomes. Some rural Alaska households spend as much as 47 percent of their income on energy, an amount five times greater than that spent by the state's urban households.[32] Figure 11 illustrates that these populations are located in rural jurisdictions. In many instances, rural Alaskans pay a rate that "can be three to five times higher than the average kWh rate of 14.06 cents (2014) in Anchorage, Fairbanks or Juneau."[33] Despite the PCE Program, Alaska's program to reduce the cost of electricity for rural Alaskans, electric bills continue to be higher in rural communities than in urban areas.[34]

Among the communities visited, Venetie, Noatak, and Arctic Village are among the highest electricity-cost communities in the state. Because they are remote from navigable waterways, and rely on regular fuel deliveries by air, the fuel costs associated with making electricity in these communities

Figure 10

Illustrative Fuel Costs in Electric Rates

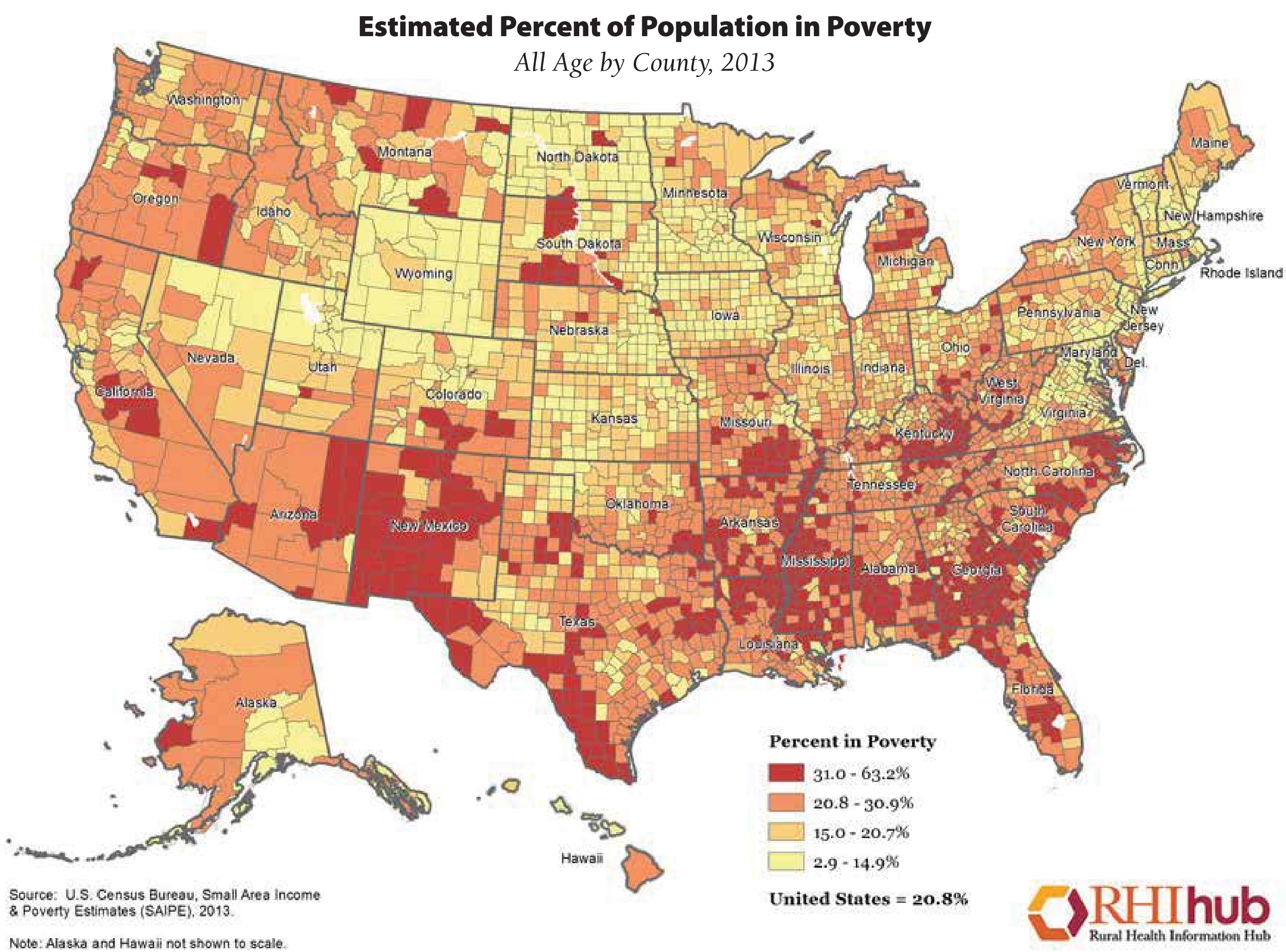
	Base	Fuel	Total
Venetie	$0.20	$0.75	$0.95/Kwh
Noatak	$0.23	$0.55	$0.78/KWh
Arctic Village	$0.16	$0.70	$0.86/KWh
PCE Base Rate			$0.1406/KWh

is very high. In 2014, average fuel costs alone for these communities ranged from 55 to 75 cents per kWh.[35] As illustrated in Figure 10, these high-cost communities face electricity rates that are five to six times higher than the PCE base rate, i.e., the administratively established benchmark rate based on average rates in Anchorage, Fairbanks, and Juneau.

Rural Alaskan communities are typically geographically isolated in northern latitudes, and so are their electric systems. Not only do rural Alaskan utilities face many of the typical challenges shared by all US utilities—including having to provide safe and reliable service at just and reasonable rates—they have to perform these functions under difficult environmental and economic conditions that include remoteness, inaccessibility and especially high costs. Furthermore, unlike the rest of the United States where millions of customers are connected to regionally interconnected systems, Alaska's rural systems are isolated and small, making them vulnerable.

These geographic and other factors contribute to the manner in which Alaska's rural utilities have developed, and shape the challenges and limitations that these utilities face every day. What follows is further discussion of other relevant factors that policymakers will need to weigh as they consider how best to support Alaska's rural electric utilities in the 21st century.

Figure 11



Availability of Objective Information

Information on Alaska's utility sector has become available in recent years. Credit for this is due to the AEA, the RCA, ISER, and some of the larger and rural cooperative systems.

Still, there is a stark absence of information available on smaller independent systems. In the current environment, it is difficult to effectively characterize the performance of specific utilities, except based on cost and price. Most of these systems are exempt from regulation except for the limited annual filing requirements of the PCE program.[36] The information provided through the PCE filings raises a number of concerns, including such things as negative line losses and generation conversion efficiencies. Furthermore, much of the utility costs are not included in the PCE filings. Taken together, the available data does not provide a full picture of rural utility operations.

As discussed further in Part II the need for information on utility performance is a key to empowering utility management and community leaders. In the absence of basic information, systems are unable to engage in meaningful planning and overall utility system improvement.

However, with adequate data, utilities will have objective references to benchmark their performance with regard the most important measures, including, for example, reliability, cost, financial performance, and access capital. This list could also be expanded to include system performance data that would enable greater adoption of emerging technologies—e.g., renewable resources and remote metering—and meaningful resource planning to achieve long-term objectives.

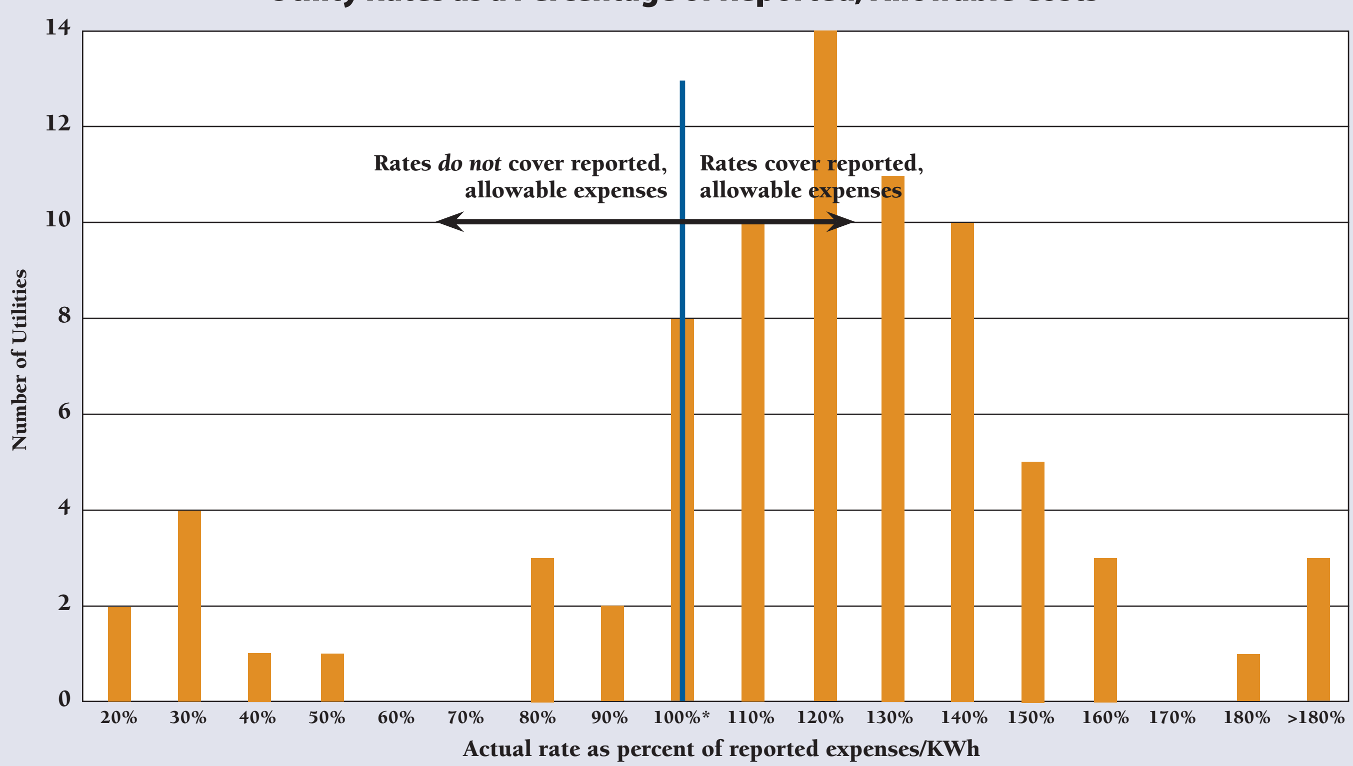
System Reliability

In Alaskan communities, electric system reliability is not just a matter of convenience or productivity; it is a matter of public health and safety. Utility systems must operate effectively under Alaska's often-extreme weather conditions.[37]

Reliability data for rural systems is limited, but according to one of the larger cooperatives, most outages reported are generally system-wide, and typically associated with the

Figure 12

Utility Rates as a Percentage of Reported, Allowable Costs



** Note: Baseline (1) on X-axis means the rate covers the allowable costs.*

Source: AEA

performance of diesel generators.[38] Interviews indicated that there are generally about 20 distressed utility systems that are at persistent risk of catastrophic failure related to inadequate system maintenance.

Workforce Development

Running a utility company requires a broad array of personnel with various abilities including technical, managerial and financial expertise.[39] Because of remoteness and small size of communities, many rural Alaskan utilities struggle to fully meet their workforce needs and develop necessary expertise.

The state of Alaska and federal government, through DOE and the Denali Commission, currently provide significant technical assistance to rural Alaskan utilities and support for workforce development. These programs (discussed more fully in Section II) provide a strong foundation on which to build and improve training opportunities for rural utility staff, managers and community leaders. Utility managers in the some of the larger communities emphasized the larger role that well-formed on-the-job training plays in molding an effective workforce. Based on interviews and anecdotal evidence, we briefly list some of the important gaps in training that remain:

Aging and Inadequate Infrastructure

- The quality and age of distribution plant varies across all utilities and needs constant attention.[40]

Renewables Integration Challenges

- Many utilities demonstrate promise in displacing diesel generation with locally sourced renewable resources; these utilities need support in integrating these resources into their existing systems, including new technology and skills.

Limited Capital Planning

- Many systems lack strategic resource plans or standard capital plans and budgets for sound investment.

Inadequate Cost Recovery [41]

- Because many utilities have difficulty training and retaining qualified staff, this could have a direct effect on a utility's ability to price services, maintain accounts, and participate in state assistance and grant programs.

Inadequate Bill-Keeping and Accounting [42]

- Some systems fail to recover in rates sufficient revenues for anything beyond immediate costs of utility operations, threatening system reliability, and longer-term financial sustainability of the utility, a concern compounded by constraints on state assistance.[43]

Limited Business and Resource Planning [44]

- Utilities would benefit from support for business planning, and developing and designing their systems to effectively integrate renewable resources.

Engagement with Community and Tribal Leaders

- Some well-trained and capable utility system managers could benefit from support in clarifying relationships with community leaders and tribal organizations that oversee the utility.

In addition to building upon the well-established state and federal programs to improve workforce performance of rural utility systems, Alaska also has a significant pool of skilled and experienced utility practitioners whose expertise could be of great value if it were shared with others. These experts could be part of workforce improvement efforts to address various training challenges, and help managers and staff from neighboring utilities become more effective in their jobs.

Capital Needs

All utilities, including those in Alaska, are "capital intensive," and require large amounts of investment because utility infrastructure deteriorates with age and operation and inevitably fails, requiring overhaul or replacement.[45] Capital expenditures typically include such things as the regular replacement of existing "plant," i.e., infrastructure such as generators, poles, and wires, as well as system improvements, both routine and major.[46] They could include investment in innovative and emerging energy technologies that are beginning to see significant influence in rural Alaska. The capital needs of utilities may also include access to ready capital through either a credit facility or a capital reserve.[47]

Failure to undertake these investments can create operational problems for utility systems and increase the risk of turning power system assets into liabilities.[48] Moreover, neglect or underfunding inevitably results in existing infrastructure becoming less reliable, inefficient,

The Rural Power System Upgrade Program

The AEA's Rural Power System Upgrade Program (RPSU) provides communities with capital to undertake powerhouse and electrical distribution system upgrades. These include powerhouse upgrades or replacements, line extensions, and other repairs to generation and distribution systems.

The RPSU has provided significant support to Alaska's rural utilities, completing 51 capital projects at a cost of over $100 million between 2000 and 2011. By June 2015, the RPSU completed 75 projects and had 28 underway.

and potentially unsafe.

Alaska's utilities rely heavily on the state and federal government for the capital required to maintain and improve their systems. The AEA's Rural Power System Upgrade Program (RPSU) (see text box), combined with the work of the Denali Commission, currently provides many rural utilities with much-needed capital through grants to undertake powerhouse and electrical distribution system upgrades.[49] Alaska's larger communities and cooperatives have ready access to capital through federal government agencies such as the Rural Utilities Service or private sources (local banks), but smaller independent utilities have fewer options, often limited to fuel loans from the state and fuel dealers.[50]

Underinvestment in infrastructure is a significant concern in rural Alaska, especially due to economic limitations faced by Alaska's small utilities. Many operate with distribution plant that was first put in service during the 1970s and 1980s, much of which has reached the end of its useful life. Many rural systems experience high line losses and poor conversion efficiencies due to lack of investment in newer plant.

On the basis of interviews with various rural utilities, there appear to be several basic reasons for their lack of access to capital. The first have to do with utilities themselves. There is not widespread recognition that borrowing and investing in the power system is needed. Many utilities may avoid borrowing and thus underinvest in their system as a matter of fiscal prudence; utility managers do not want to go into debt and don't see the need to. Also, utilities may not be able to establish their creditworthiness due to the various fiscal and managerial challenges they face. Another reason that utilities don't seek out capital is that they prefer to access grant monies from state and federal government.

Failure to pursue private capital, including capital from Alaska Regional Corporations, as an alternative or in addition to existing public grants and loans may only contribute to a pattern that sometimes swings between periods of underinvestment and overcapitalization.

Focusing on Rural Utility System Needs: Understanding the "Tier" System

Rural Alaska utility systems do not fit neatly into a single category and broad-brush characterizations of the various aspects of their service are not especially helpful. However, some groupings make sense, because most of these systems face common challenges and opportunities.

One part of the challenge that utilities face is simply recognizing the need for capital investment and keeping up with the routine replacements and system improvements, i.e., having a capital plan.

All rural utility systems need to deliver reliable service, respond to state utility regulation (even non-regulated utilities are subject to some oversight through the PCE program), engage in system planning, and human resources management. Utilities face similar governance and financial performance challenges. Many rural utilities have difficulty investing in end-use energy efficiency. These categories include:

- Reliability,
- Capital Planning and Strategic Planning,
- Management,
- Workforce Development,
- Governance,
- Financial Performance, and
- System Efficiency.

Given these common challenges and characteristics, we categorized rural Alaska utilities into the following four tiers (see Figure 13 below):

Each category of utility system has its own set of relevant

Figure 13

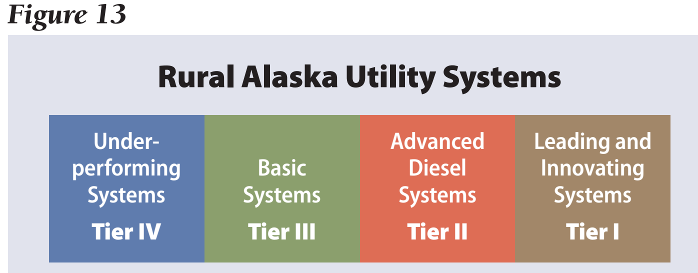


Figure 14

Reliability and Underperforming (Tier IV) Systems

	Attributes	Goals for System Improvement
Reliability	• Semi-annual major system outage with implications for community health and safety. • Inadequate vegetative maintenance.	• Upgrade or rebuild aging facilities. • Maintain facilities to manufacturer specifications. • Where applicable – implement plan for vegetative management. • Establish distribution response plan (equipment, service contract, personnel). • Upgrade and modernize fuel storage facilities.

"attributes." While not an exhaustive list, the attributes are objective factors that help illustrate these various challenges. For example, as shown below in Figure 14, the "reliability" attributes for underperforming (Tier IV) systems include annual or biennial system failures, and inadequate vegetative management.

Likewise, each category of utility system has its own "goals for system improvement" that identify steps that could be taken to address a given challenge. Again, using reliability as an example, goals for improvement of an underperforming Tier IV system include such things as upgrading or rebuilding aging facilities, better maintenance, and development of a distribution response plan to codify best practices for system maintenance.

How is the Tiered Approach Used in the Paper?

The purpose of categorizing utilities here is to illustrate general trends in the manner in which rural Alaskan utility systems operate, including typical struggles they face, and solutions they might employ. This approach is not intended to illustrate any actual utility system, and should not be construed in that way. In fact, it would not be surprising for an actual utility to see itself illustrated in multiple tiers. For example, a specific utility may have "generally high levels of system reliability"—an attribute of leading and innovating (Tier I) systems—while also needing to develop a "vegetative management plan," an attribute of Underperforming Tier IV systems. A complete version of this matrix is located in the Appendix.

Notes

17 This observation about rural Alaska is found in Coyne, A., and Hopfinger, T. (2011, November). *Crude Awakening: Money, Mavericks, and Mayhem in Alaska.* Nation Books.

18 In addition to its immensity, Alaska has extensive mountain ranges, glacier fields, and permafrost. The state is also known for extreme winter (and summer) temperatures. Furthermore, due to its latitude, the length of the day changes widely over the course of the year; north of the Arctic Circle, winter brings 24-hour darkness and summer 24-hour daylight. All these extremes make building roads and facilitation of other forms of transportation difficult.

19 We refer generally to the Power Cost Equalization Program-eligible communities as the rural high-cost communities, distinct from many communities in the southeast and Railbelt. Certain communities are remote microgrids, but enjoy the benefits of low-cost hydro and therefore do not meet the definition of high-cost as defined by the PCE program eligibility requirements.

20 Based on the sample of 175 PCE communities that appear in the AEA's *Power Cost Equalization, Statistical Data by Community,* amended in March 2015. There is no clustering of size in the wide range of community populations, but the largest 7 communities are significantly larger than the other 168.

21 Ibid.

22 Communications capabilities have only recently included cellular and Internet. Rural internet service is slow and problematic by Anchorage and Fairbanks standards. For a detailed discussion of the challenges and opportunities associated with broadband communications, see Hudson, H. (2014, March 28). *Broadband Issues and Opportunities for Alaska.* ISER. Retrieved from http://www.iser.uaa.alaska.edu/Publications/presentations/2014_03_28BroadbandIssuesAndOpportunitiesForAK.pdf.

23 For a details of utility generation information by community, visit the Energy Data Gateway: https://akenergygateway.alaska.edu/. See also ISER (2014, April). *Electricity in Alaska: A Growing and Changing Picture.* Research Summary No. 74. Retrieved from http://www.iser.uaa.alaska.edu/Publications/2014_04-RS-ElectricityInAlaska.pdf.

24 AEA. (2014, July). *Power Cost Equalization Program Guide* [updated version], p. 5. Retrieved from http://www.akenergyauthority.org/Content/Programs/PCE/Documents/PCEProgramGuideJuly292014EDITS.pdf.

25 Colt, S., Fay, G., Saylor, B., Szymoniak, N., and Wilson, M. (2009, January). *Study of the Components of Delivered Fuel Costs in Alaska.* ISER. Retrieved from http://www.iser.uaa.alaska.edu/Publications/fuelpricedeliveredupdate.pdf. Notes: Other costs include transportation, storage and retailer markup. The “refining” component is calculated as the difference between the OPIS wholesale rack price (measured in Anchorage) and the EIA reported U.S. crude price. Sources: U.S. Energy Information Administration, Weekly United States Spot Price FOB Weighted by Estimated Import Volume (dollars per Barrel), http://tonto.eia.doe.gov/dnav/pet/hist/wtotusaw.htm; Oil Price Information Service, Wholesale Rack Prices for Anchorage, 1987-2009.

26 See Federal Register. (2015, May 29). Denali Commission Fiscal Year 2015 Draft Work Plan. Volume 80, Number 103, p. 30667, http://www.gpo.gov/fdsys/pkg/FR-2015-05-29/html/2015-13010.htm; U.S. Arctic Research Commission. *Report on the Goals and Objectives for Arctic Research 2015–2016, for the US Arctic Research Program Plan;* and Commonwealth North. (2012, February). *Energy for a Sustainable Alaska: the Rural Conundrum.* Retrieved from http://www.alaskapower.org/pdf/CommonwealthN_FINAL.pdf.

27 On an energy basis, only about 8 percent of the GWh energy produced by PCE-eligible communities was produced by wind and hydro, the remainder by internal combustion engines, predominantly oil-fueled. ISER, 2014. Nuiqsut on the North Slope has natural gas and is eligible for the PCE, but residential rates are below the PCE floor and therefore residential customers do not receive PCE payments (community facilities do receive a small amount of support). Personal communication with Jed Drolet, AEA.

28 AEA, 2013.

29 Fuel oil is not only more expensive than other fuels available in more populated Alaskan communities; as noted, it is difficult to transport.

30 Goldsmith, S., Pathan, S., and Wiltse, N. (2012, May). *The Snapshot: The Home Energy Rebate Program.* ISER and the Cold Climate Housing Research Center (CCHRC). Retrieved from http://cchrc.org/docs/snapshots/HERP_snapshot.pdf.

31 Figure adapted from Goldsmith et al., based on ISER calculations, with data from UAF Cooperative Extension Service and ENSTAR Natural Gas, assumes 100 gallons fuel oil has 14 MMBtus energy, which equals the energy content of 14 Mcf of natural gas, priced in 2011 at $8.63/Mcf.

32 See AEA. *Rural Power System Upgrade Program.* Retrieved from http://www.akenergyauthority.org/Programs/RPSU; and Alaska Alaska Federation of Natives. (2012, May). Alaska Energy Brief. Retrieved from http://www.nativefederation.org/wp-content/uploads/2012/10/2012-afn-cap-alaska-day-brief.pdf.

33 AEA, PCE update, 2014: “Alaskans in small remote rural places that rely on fuel oil had the most expensive electricity—with prices from roughly 30 cents to more than $1 per kilowatt-hour in 2011.” Also see: Fay et al. (2013, December). *Alaska Energy Statistics 1960-2011, Final Report*. ISER for AEA.Retrieved from http://iser.uaa.alaska.edu/Publications/2013_12-AlaskaEnergyStatistics2011Report_Final_2014-04-30.pdf.

34 Fay et al, 2013.

35 AEA, Statistical Report of Power Cost Equalization Program, Fiscal Year 2014, March 2015.

36 The list of exemptions from regulatory oversight of the RCA are many, but include communities that have less than $500,000 in total revenues (AS 40.05.711). This exemption alone exempts most of the smallest systems. Other exemptions relate to the public ownership character of the utility.

37 Weather variation is particularly extreme in communities such as Fort Yukon. Extended periods from -50 to -60 degrees F are common. Fort Yukon also reports the highest temperature ever recorded in Alaska, 100 degrees F.

38 Kohler, 2015: According to one of the larger cooperatives, “systems typically consist of a stand-alone power plant with three or four generators. Sizing is carefully done so as to operate the most efficient generator to meet the needs of the day and the season. Redundancy is determined based upon having adequate capacity when the largest generator is down for maintenance and another fails unexpectedly.”

39 See, e.g., Denali Commission. (2012, April). *Status of Rural Alaska Management Training 2012 Summary Report.* Retrieved from https://www.denali.gov/images/Training_Documents/Rural_Manager_Training_Study_findings_April_2012.pdf.

40 Losses over 10 percent are common and represent an inappropriately high level, even for the large systems, but wholly unacceptable for small systems in cold climates. The RCA assumes a maximum limit on line losses of 12 percent in determining PCE subsidies.

41 Utility rates should be set to recover all historic costs, including timely loan repayment obligations, a fair return on investment, and such things as routine maintenance, brush clearing, and costs of predictable system failures.

42 Established recordkeeping, personnel, operations, and maintenance practices are critical to the health of a utility.

43 In certain cases, it appears that rates are inadequate to recover even the costs of operations, resulting in growing or sustained high debt levels originally due to operating costs associated with fuel. In certain, instances revenues from utility operations are used for community priorities entirely unrelated to the utility.

44 This is a complex and relatively new area with technical challenges requiring management expertise and support to implement. Even for larger systems in the rest of the United States, the challenges associated with renewable integration are significant. Some emerging practices by Alaska's rural utilities reflect innovations that could both inform the aspirations of other rural systems, and emerging practices in even interconnected regions.

45 Capital intensity is one of the hallmarks of an electric utility. See Bonbright, Danielsen, and Kamerschen. (1988). *Principles of Public Utility Rates,* 2nd ed. Public Utilities Reports, Inc.

46 Routine replacement and improvements are typically financed in utility rates while major capital projects require additional financing. See, e.g., Mann, C. (1999, December). Financing Mechanisms for Capital Improvements for Regulated Water Utilities. National Regulatory Research Institute (NRRI) 99-16. Retrieved from http://www.ipu.msu.edu/library/pdfs/nrri/Mann-Capital-Improvements-99-16-Dec-99.pdf.

47 A cash reserve or capital reserve fund can be used to accumulate funds for future capital purchases, major maintenance, or for predictable, but infrequent and irregular events that require significant capital. The fund can accumulate surplus cash or be structured as a formal budget account for dedicated placement in a bank account not to be used except for prescribed purposes. To repeat, it is critically important that the use of these funds are narrowly defined and that this be sanctioned and then respected by both utility managers and the board, community leaders, tribal leadership, or owners that approved or established the reserve.

48 For example, Tier IV and III utilities operate at high levels of system losses (in the 15-20 percent range). See note 108, describing RCA practice or imputing only 12 percent loss for all PCE recipient utilities.

49 The Denali Commission has invested more than $1 billion in rural infrastructure to date. Cooperative utilities have access and sometimes rely heavily on federal sources of low-cost lending through the Rural Utilities Service. The service administers loans and loan guarantees to finance the construction or improvement of electric distribution, transmission and generation facilities in rural areas. Retrieved from http://www.rd.usda.gov/about-rd/agencies/rural-utilities-service. The state also provides capital through low-interest loans. Loans for power projects are available under AS §42.45.010, Power Project Fund.

50 Municipalities can finance through the state's Municipal Bond Bank, and cooperative utilities can borrow from such sources as the RUS, the National Cooperative Services Corporation, and the National Rural Utilities Cooperative Finance Corporation.

II. Analysis and Options

A. Solutions to Achieve Scale

A Challenge of Remoteness

Because of their remoteness and size, Alaska's rural utilities do not enjoy the "scale economies" of larger utilities—in other words, the cost advantage of being larger that results in lower cost per kWh of electricity produced. The absence of scale is the key factor in most aspects of service delivery in rural Alaskan communities, and a primary reason that electricity costs are high and reliability is poor.

The limited opportunity to interconnect with other electric systems compounds the challenge.[51] A distance of 10 to 15 miles represents the boundaries of sound and economic investment in interconnection. Although physical interconnection may not be possible, utilities can still pool resources in other areas like management, maintenance, fuel purchases, bookkeeping, and training. Most of these services, if performed at scale, could improve system performance.

In many instances, state and federal programs are able to provide needed scale. Where they have, they have generally performed well. For example, the AEA trains operators to ensure that utility staff can maintain power plants at code-compliant levels, and bookkeepers can meet PCE program filing requirements, training that no individual utility could afford. Where programs have been unable to reach, however, gaps persist and costs escalate, as do threats to service quality and public health and safety.

The challenge boils down to finding ways to build upon and improve the self-reliance of Alaska's small communities, and reduce the persistent reliance on state and federal supports.

Alaska's smallest communities, such as Karluk on the tip of Kodiak Island, struggle with high costs because of remote location and a lack of scale economies.

Over time, budget realities mean that state and federal assistance may diminish, requiring alternative approaches that will help rural utilities achieve scale. The state can help develop a path of greater self-reliance for rural communities, as the following examples illustrate, through an appropriate mix of regulatory oversight, financial incentives and other strategies.

Organizational Models

One possible path for individual communities to consider would be to organize with other similarly situated rural utilities in a way, for example, that would increase their fuel buying power or their ability to train and mobilize staff. This is the strategy adopted by various cooperatives, regional corporations, and certain municipalities, and provides an approach that could be beneficial to small rural utilities. Alaska could explore new techniques to encourage its independent utilities to band together in ways that create greater scale and cooperation in service delivery.

An important initial step in this effort could be for the RCA to draw upon its existing authority to further encourage utilities to improve their performance. As explored later in this paper in the discussion of the PCE formula, the RCA could direct utilities to develop key performance measures through its cost-control authority over the program.[52]

Bulk Fuel Buying

There was universal agreement by all the communities visited by the authors that diesel costs are a burden. Buying fuel in bulk is business as usual for a number of organizations in Alaska, and a potential strategy that communities might consider to lower their diesel fuel costs.

The AVEC systems purchase diesel for their systems as a whole and then differentiate the price based on the costs of delivery. The Norton Sound Economic Development Corporation functions as a fuel aggregator for the independent utilities in the Bering Straits Region.

Small utility systems could explore opportunities to coordinate fuel purchases and shipments with neighboring mining operations and fish processing facilities. Communities that are far apart by land but lie along the same commonly traveled air or water transportation routes could make similar agreements, reducing shipping costs.

Coupled with training and an effort to identify reasonable approaches to the collection of performance data related to key measures, the RCA could better position utilities for taking steps to realize greater scale. For example, helping utilities to appreciate the financial value of lowering their line losses could help utilities recognize their level of performance and to improve upon it.[53]

There are a number of remarkable examples of well-managed and maintained independent rural systems in Alaska.[54] Those utilities that find they are unable to keep performance standards at the needed levels, however, should seek out ways of banding together to create economies of scale.

Alaskans are familiar with organizations that are potential models for rural utilities to consider.

- **Cooperatives and Regional Systems:** Roughly half of Alaska's rural communities participate in rural cooperatives such as AVEC or the Inside Passage Electric Cooperative. Alaska Power and Telephone (AP&T), a regulated investor-owned system, serves high-cost rural communities. Due to the relative size of these providers, they are able to offer many of the services associated with larger investor-owned utilities in a professional and well-managed environment. Despite these advantages, some communities expressed concern over a lack of connection between the cooperative's management and the community itself, a concern related to fears that local control will be lost. For communities concerned about this, other options listed below may be preferable.

- **Regional Corporations:** The initial 12 organizations created by the Alaska Native Claims Settlement Act (ANCSA) are financially stable and many have substantial experience with energy issues. They are ideally suited to help village utilities develop and maintain economies of scale, particularly with regard to access to capital, technical expertise, and longer-range planning. Assistance here can range from playing the role of a convener to taking a more active role in ownership and project provision to rural systems as independent power producers.

- **Neighboring Utilities:** Rural communities develop economies of scale by coordinating with neighboring communities. Many already exchange services; Kotzebue Electric Association (KEA), for example, is owner and operator of the City of Buckland utility, and also provides services to the Ipnatchiaq Electric Company as needed. North Slope Borough aggregates services for several nearby villages. While the communities don't need to be as closely linked as KEA and its nearby communities, neighboring systems can be in close communications and improve awareness of third-party service providers.

- **Third-Party Service Providers:** Firms available for contract work can provide small systems with significant support, including billing and metering services, system planning, design, and other engineering services. The state of Alaska has already fostered the development of a third-party service community through use of public funding. An ad hoc group, the Regional Alaska Maintenance Partnership (RAMP), is advancing a variation of this approach. RAMP (see Section II-D for more information) seeks to connect rural facilities owners with local workforces to provide maintenance services.[55]

- **Joint Action Agencies (JAAs):** JAAs are formed by participants, often municipalities or cooperatives, to provide reliable and competitively priced energy or energy related services.[56] JAAs can function as a regional power authority, for example, by creating services optionally available to member systems through a wholesale buyer and service provider. JAAs members typically have the freedom to participate fully or partially, depending on the nature of services that the JAA provides.

Realizing greater scale is necessary for most small independent systems to perform at acceptable levels. In the event that this does not happen, and the struggles of the utility continue to jeopardize a community's well-being, there may be a role for the state, via the RCA, to control or manage the transfer of operation of poorly performing systems. One model for doing so would involve the establishment of a "provider of last resort" (see text box).

Provider of Last Resort

Under this approach, RCA or AEA could work with the community to identify a qualified distribution system operator through a competitive process. This could be done through an auction process and could secure bids to provide system improvements necessary for sustainable services at reasonable rates. One value of this approach is that it could combine community support with elements of competition to foster innovative solutions at the community level.

Conclusions

The small electric systems in rural Alaska are among the most expensive in the United States to run. In fact, if the full costs of grants and supports were included in the rates customers pay, at least in their current form, many of the small independent systems would prove to be unsustainable. Addressing their needs will not be easy. But as the picture for state and federal government support shifts in the future, local cooperation and use of new organizational models could begin to provide the scale that is crucial to controlling costs and improving performance.

B. Improving Long-Range Planning and Resource Decisions[57]

An Uneven Landscape

Long-range planning is critical to utility management. It allows managers to evaluate the benefits of long-term commitments, a key advantage in a business characterized by long-lived assets. Planning allows the identification of projects that are feasible, have sound economics, enjoy community support, and ultimately are bankable from the standpoint of potential investors and project developers.[58]

Regional planning can create a critical mass of engagement necessary to help ensure that a wide range of energy options is considered and that there is a

Utility Resource Plans

Utility resource planning in most U.S. jurisdictions is an analysis to identify a utility's least-cost path over time. It is also a public process involving the participation of local stakeholders. These efforts are sometimes called "least-cost integrated resource plans" or simply "integrated resource planning" (IRP) when the scope of the resource decisions include demand-side considerations.

IRPs typically include scenario planning and consideration of uncertainty. IRPs are also typically high-level plans frequently with time horizons of 20 years that look at a broad array of resource choices, although they may include specific project-related analysis in the near term (i.e., 1-5 years).

healthy exchange of diverse perspectives in narrowing the potential solutions. It also promises to reinforce the role of organizations such as regional native corporations or cooperatives to play a stronger role in helping to raise capital for projects that potentially benefit multiple communities. Integrated Resource Plans (IRP) were developed for the Railbelt region in 2010 and for the Southeastern region in 2012.[59]

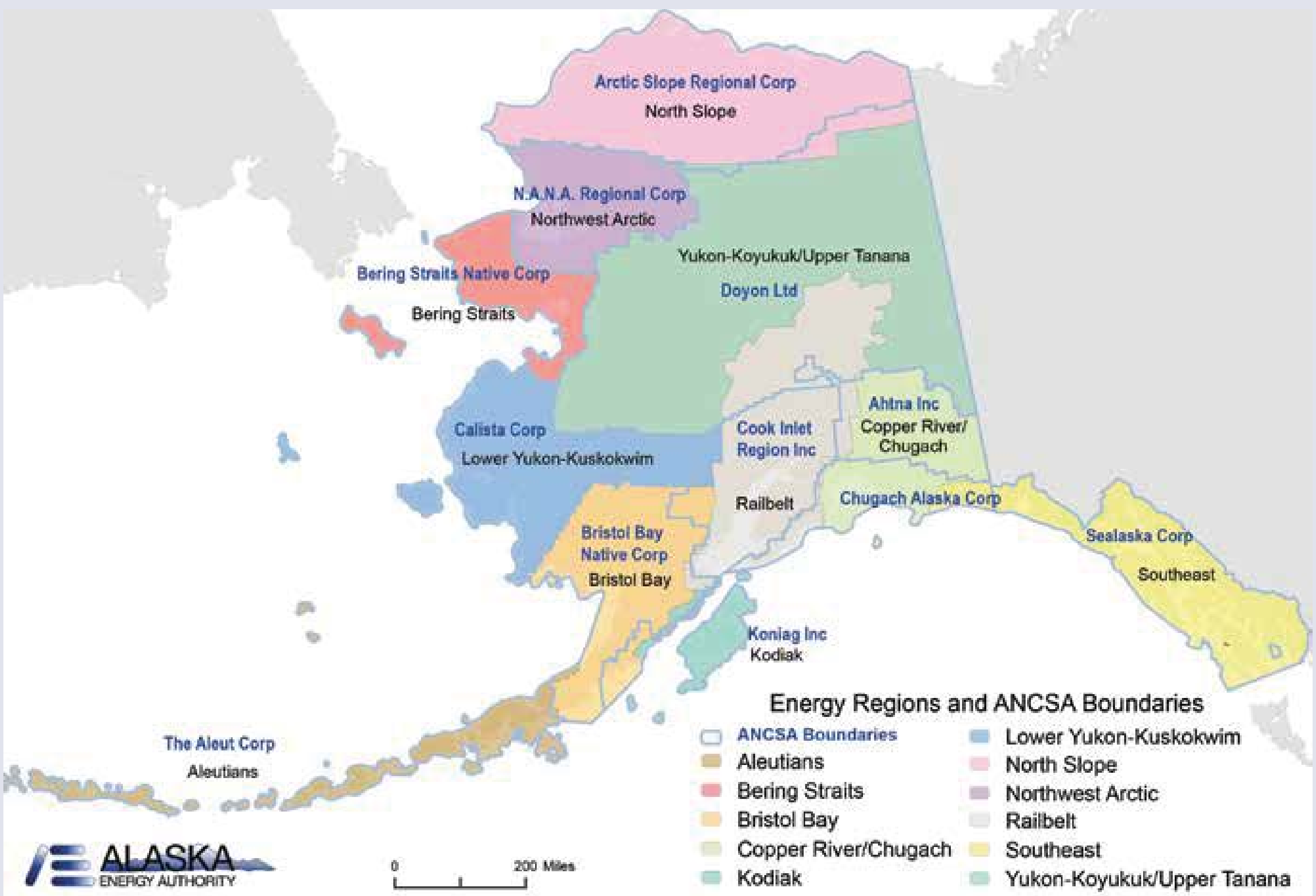
For most of the state's high-cost rural systems, however, planning occurs in the context of the grant-making process which are organized around (1) powerhouse upgrades, (2) improvements to the distribution system, and (3) upgrades to the tank farms that are an integral part of electric utility service.[60] Furthermore, it is often difficult for system managers occupied with many pressing near-term matters to step back and engage in planning. Rather than looking broadly at alternatives (including supply-side and demand-side) and their relative cost-effectiveness, the consideration of alternatives is typically led by project developers and guided by the terms of the grant. Interviews with utilities and local experts reveal that, apart from the grant-making context, little resource or even capital planning is actually taking place at the community level in much of rural Alaska. This may be beginning to change, however, with the AEA-led Regional Energy Planning initiatives.

Regional Energy Planning

The AEA has led an effort to work with all regions of Alaska on long-range energy planning. Based on the list of organizations and individuals participating, regional engagement appears to be strong. The goal is to use a community-based approach to determine the energy priorities and formulate concrete, implementable and fundable plan to achieve those priorities. Efforts are designed to reduce the long-term costs of power and the dependence on fossil fuels. Phase I of these efforts included the development of inventories and community profiles.[61] Phase II involves a dialogue with community and regional

Figure 15

Regional Energy Planning



leaders and other key stakeholders about their priorities. (See Figure 10).

The Southeast and the Railbelt regions prepared energy plans more along the lines of traditional electric utility resource plans that focus on the electric sector. But for rural regions, the regional planning efforts consider all forms of end-user energy needs, including electricity generation and heating. The advantage to this approach is that it captures the emerging areas of overlap between energy demands. The traditional distinctions between electricity, heating, and transportation are breaking down with new forms of electric heating (air source heat pumps and ceramic heating stoves), and the adoption of electric vehicles. These plans are focused on specific projects:[62]

1. **Aleutian & Pribilof Islands:** Diesel efficiency, heat recovery, weatherization and energy efficiency, and wind-diesel integration
2. **Copper River:** Transmission, energy efficiency and conservation, biomass, natural gas, and wind and solar
3. **Interior:** Energy efficiency/energy efficiency for new construction, biomass
4. **Northwest Arctic:** Wind, solar PV on water and sewer facilities
5. **Southeast:** Energy efficiency and conservation, new hydro

Planning efforts of the state and regions provide a framework for prioritizing community and regional projects. The efforts also highlight the importance and benefits of standards that can be implemented on a community or regional basis, as it appears is occurring in the interior region. The next challenge will be to translate them into action. For most of the high cost rural systems, planning is a product of the grant-making process of AEA and the Denali Commission.

According to drafts of the plans, the process has involved these key factors:

- Broad focus on both energy and electricity;
- Attempts to identify specific projects rather than directional categories of resources;
- Community involvement has been part of the process; and
- Economic criteria appear to be an integral part of the analysis.

Interviews with utility managers in the communities suggest that efforts like this are likely to lead to actual development.

START

The START program is a cooperative effort between DOE's Office of Indian Energy, the Denali Commission, and NREL. It is a federally sponsored adjunct to AEA's regional planning efforts. The program is a competitive technical assistance opportunity aimed at (i) reducing the cost and use of energy for rural Alaska consumers and communities, (ii) increasing local capacity, energy efficiency, and conservation through training and public education, and (iii) increasing renewable energy deployment and financing opportunities for communities and utilities.

Key Next Steps

Some plans have observed that, as the state's fiscal situation tightens, capital investment made in rural communities by the state will become more challenging. The best investments, e.g., energy efficiency and waste heat recovery, are going to be those that can withstand the test of time.[63]

A critical next step in the planning process is for communities to pick up where the state-led process has left off. To foster this, there are a number of options available to AEA and its partners. Some of these will require an ongoing role for AEA and, more appropriately, relevant regional entities, including regional native corporations, boroughs, and regional government associations. They will facilitate engagement of the communities in the next steps on their own.

Federal government partners will also have a role in encouraging community participation in regional efforts through targeted funding. The AEA and its federal government partners will also likely play a role in helping to support future regional planning efforts. The DOE's Strategic Technical Assistance Response Team (START) program (see text box) can help implement strategies outlined in the Regional Energy Plans. Six communities visited by the research team—Arctic Village, Venetie, Kwethluk, Shungnak, Hoonah, and Yakutat—were among the 16 groups that START assisted in 2015 with community energy planning or clean energy projects.[64]

Communities will be able to take steps forward with assistance like that provided by the START. To the extent that funds are available, AEA can work with state partners to integrate regional plans into community efforts and next steps. Establishing a schedule and plans for future updates of the current plans will help to ensure that the cycle will continue.

Conclusions

Long-range planning can set the stage for community involvement in their energy choices, and regional planning is a cornerstone of Alaska's efforts to reduce dependence on diesel energy for heating and generation. Through the Regional Energy Planning process, the state appears to be achieving some success in identifying regions' priorities. The next challenges will be to move these efforts toward implementation at the community level and toward sustainable regional planning.

The planning efforts underway in Alaska will be helpful to all categories of rural utilities. Underperforming (Tier IV) and basic (Tier III) systems should pursue greater engagement at the community and regional level in the creation of long-range resource plans, and the state efforts underway will support this. For example, they need help in articulating longer-term goals for themselves (Tier IV) and in identifying consulting resources (Tier III).

Advanced diesel (Tier II) and leading and innovative (Tier I) systems will also benefit. With planning support, advanced diesel (Tier II) systems will be better able to identify ways to reduce their dependence on diesel fuel and adopt locally sourced alternatives. Likewise, leading and innovative (Tier I) systems can use help from regional planning support to plan across their systems and expand operational control of both the demand and supply side of their systems.

C. Meeting Rural Utility Capital Requirements

The Finance Challenge: Getting the House in Order

As noted in Section I, all utilities require large amounts of investment because utility infrastructure deteriorates with age and operation. With respect to capital planning and financial performance, key requisites to accessing capital, Alaska's roughly 100 rural utilities face two general challenges.

First, utility managers, owners, and community leaders simply need to recognize the need for timely investment and capital investment planning.[65] This is important to both ensure that utility system investment keeps pace with system needs, but also that systems are in a position to invest in cleaner and cheaper resources where possible.

Utility managers have to improve their practices to secure better credit standing with potential lenders, demonstrating that capital would be well placed and could be repaid.[66] For example, Alaska's underperforming (Tier IV) and basic (Tier III) systems experience significant customer payment arrearages and are often underpaid for the recovered waste heat they provide the community. In response, they would need to improve the pattern of customer payment, maintain better financial records, and be sure to use funds in a manner consistent with accepted standards of financial and accounting performance. Lenders condition loans assuming such standards.[67]

The financing challenge specific to Alaska's rural utilities lies in meeting their need for capital financing at a time when the flow of capital from relied-upon sources is diminishing.

This discipline could be encouraged by Alaska's utility regulator, the RCA. It already requires that certain standards of accounting are met in order for utilities to receive PCE support. The RCA could build on these initial steps.

The RCA could also help utilities to recognize that they have the means to fund reasonable borrowing. Regulated utilities are able to modify their base rates by taking advantage of provisions in state law regarding the Simplified Rate Filing (SRF) process.[68] This process allows utilities to modify rates as frequently as quarterly, as long as the modifications do not exceed "a cumulative 20 percent in any three-year period or a cumulative eight percent in a twelve-month period."[69] This would allow utilities to reflect changes in capital costs in their rates in a timelier manner. Of course, non-regulated communities would need to secure similar flexibility from relevant oversight boards at the cooperative or within the community.

More for the Money

The second part of the access-to-capital challenge is that historical support for relied-upon sources such as grant capital from state and federal sources may be diminishing. Because providing grant capital to rural utilities is likely to become a challenge and subject to even greater political pressure for the state as its budgets tighten, Alaska should consider strategies to optimize the manner in which it provides support to rural utilities. This could involve a shift from one-time subsidies and grants to the use of tools such as loans, revolving loan funds, and even insurance products that would make the most of the amount of energy produced (or energy saved) for every dollar of public funds made available. Interviews suggest that this idea has gained acceptance and is already occurring.

Ongoing Grant Assistance

Some form of grant assistance will likely extend into the indefinite future for some of the smallest systems that are in the greatest distress. The combination of small community size, low volumes of generation, and low income will continue to require policymakers to take steps to ensure that standards of public health and safety are met. We recommend that future funders explore avenues for of assistance that extend the reach of available grant capital through assistance that is scaled to the need. We also recommend that grant funding be better targeted in ways that prioritize need. This may require complementary technical assistance.

A Bank for the "Small Guys"

The "green bank" concept provides another model for moving a state away from direct support of energy projects to more strategic and cost-effective use of state funds. This approach encourages "a shift from one-time subsidies and grants toward market-catalyzing financial tools."[70]

A green bank provides low-cost, long-term financing support to clean energy projects by leveraging public funding to attract private investment "so that each public dollar supports multiple dollars of private investment."[71] For example, Connecticut's Green Bank—formally known as the Clean Energy Finance and Investment Authority (CEFIA)—has produced $300 million in investment since its founding in 2011.[72] The State of New York developed a similar institution that has produced $1 billion for energy projects, 30 percent of which comes from state revenues and 70 percent from the private sector.[73]

Funding for green banks comes from public sources. Existing energy efficiency funds were repurposed in Connecticut, and in New York, Regional Greenhouse Gas Initiative (carbon auction allowance revenues) funds provided initial capital. Relying on authority similar to the authority exercised by Alaska's Municipal Bond Bank Authority, the State of Hawaii funded its green bank by issuing bonds to private investors.[74]

Private Capital and ANCSA

Reductions in available state funds will inevitably require rural utility systems to consider new sources of private capital, either traditional debt or equity capital. Private capital can be accessed through traditional banks and lending institutions. Private equity capital can be accessed through regional corporations or tribal village corporations. Other forms of private equity capital can be accessed through traditional investor-owned systems, such as the 30 or so high-cost utilities that are owned by AP&T and regulated by the RCA. AP&T report that they have formed innovative partnerships with ANCSA corporations such as Haida Corporation and Tanacross, Inc., to support development of clean energy on ANCSA lands, opening markets to participation by indigenous entities and supporting increased self-determination.

Conclusions

Access to affordable capital is critical to a properly functioning electric utility. Today, many of Alaska's rural utilities tend to be heavily dependent on a diminishing stream of grant funding and they will need to become familiar with various practices that could improve their access to capital and their willingness to borrow when circumstances warrant. Underperforming (Tier IV) and basic (Tier III) systems can strengthen their practices to make themselves more likely to be able to access private capital. Strengthening financial performance includes such things as improving record keeping, cutting down on bill arrearages, and ensuring that rates cover system costs with a return or margin for future investment. The state of Alaska and its partners can also take steps to help these utilities attract private capital.

D. Developing Workforce Capacity and Utility Management

Human Resource Challenges

Utility administration requires a broad business and technical skill set that rural utilities sometimes struggle to acquire. Tier IV and Tier III systems often fall short in keeping plants operating reliably and securing access to capital, and there are gaps in the skills of managers and governing bodies of these systems. Tier II and Tier I utilities lack expertise in developing viable renewable projects and, once implemented, in integrating them into their systems. These utilities could also benefit from support in business planning.

As mentioned, the state of Alaska and the federal government, through DOE and the Denali Commission, currently provide significant technical assistance to rural Alaskan utilities. However, some important gaps remain, as outlined in Section I. They include concerns of aging and inadequate infrastructure; the challenges of integrating renewables; limited capital planning; skills and training gaps; inadequate cost recovery; inadequate bill-keeping and accounting; limited business and resource planning; and the need for further engagement with community and tribal leaders.

Existing Training Programs

The State of Alaska

The AEA and ADCCED have developed numerous training opportunities, including courses, materials, and outreach, to Alaskans in support of their energy projects and infrastructure.

Power Plant Operation: The AEA provides entry-level and advanced training courses for power plant operators to help ensure that rural utility staff have the essential skills to operate their power plants.

Bulk Fuel Operator Training: The AEA offers a course to ensure safe operation and maintenance of bulk fuel storage facilities because most rural communities rely on petroleum-based fuels like diesel to power electrical generators.

Hydro Generation Training: The AEA provides training for certified power plant operators whose systems have incorporated hydro generation facilities.

Utility Clerk Training: The AEA trains utility system clerks on reporting requirements related to the PCE program, RCA programs, and the state's bulk-fuel loan application process.[75]

Circuit Rider: The AEA's Circuit Rider Program provides rural system operators free technical assistance to improve power system safety, efficiency, and reliability, and to help reduce the risk and severity of emergency conditions.

Utility Management and Community Leaders:[76] The Rural Alaska Maintenance Partnership (RAMP) is an ad hoc group that meets on a monthly basis to advance a shared vision of establishing a network of third-party service providers. The group recognizes that an inadvertent lack of maintenance of rural facilities is occurring due to a lack of training, communication and coordination. RAMP further believes that there is opportunity to connect rural facilities owners (private, public, state and federal) with local workforces through a "shared maintenance delivery enterprise." The focus is on building maintenance, but could be extended to include assistance in maintaining infrastructure and utilities.

The Alaska Rural Manager Initiative (ARMI) project is a parallel effort to RAMP. ARMI's project goals are to design relevant training programs for tribal administrators, utility managers, and municipal managers and to improve access to management training. ARMI was developed to better understand rural manager and rural manager education challenges. As such, ARMI provides an important initial step in addressing the challenges associated with rural management training.[77]

"As the market continues to grow the human resource and knowledge base that helps Alaska to successfully develop renewable energy projects and resources will become an increasingly valuable asset and driver of economic development."

Alaska Energy Authority Renewable Energy Grant Recommendation Program

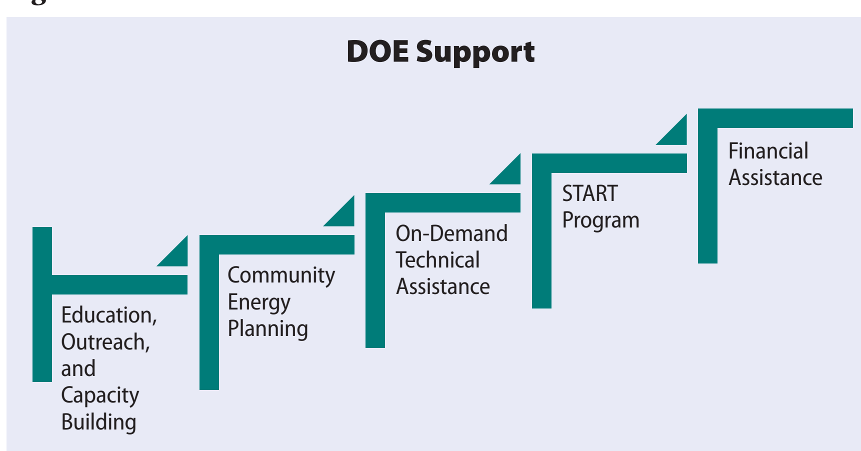
RUBA: Although directed at rural water and wastewater utilities, the ADCCED's Rural Utility Business Advisor (RUBA) Program provides a strong model for power utility training.[78] (See text box.)

U.S. Department of Energy

The DOE, in cooperation with the Denali Commission, provides rural utility operators in Alaska native villages with resources, technical assistance, skills, and analytical tools needed to develop sustainable energy strategies, and implement workable solutions to energy challenges.[79] Figure 16 illustrates the spectrum of support that DOE makes available, including assistance in capacity building.

DOE provides direct support for education and capacity

Figure 16



building in the form of webinars, workshops, and trainings on renewable energy project development and financing. These include:

- Alaska Workshop Presentations
- Energy Resource Library
- Renewable Energy Course Curriculum for Tribes
- Tribal Renewable Energy Webinar Series
- Renewable Energy Project Development Workshops

DOE also indirectly builds capacity through its support for specific energy project development.[80] DOE further supports training and capacity building through its provision of "On-Demand Technical Assistance" to native villages and regional and village corporations.[81] DOE's START Alaska Program, which provides native villages with community-based technical support to develop energy and infrastructure projects, also has a training and capacity-building component.

Building Skills, Building Networks

Training and technical assistance represent promising and low-cost avenues for improving the performance of rural utility systems. The current state and federal programs described above are a solid foundation on which to build and improve training opportunities for rural utility staff and community leaders.

The RUBA Program

The ADCCED's Rural Utility Business Advisor (RUBA) Program was designed to "increase managerial and financial capacity" of Alaska's rural water and wastewater utilities. RUBA takes the following approach to assisting communities:

- Identify communities with sanitation management issues
- Visit community for fact-finding;
- Create an assessment identifying strengths and weaknesses;
- Develop a proposed work plan;
- Present the assessment and work plan to the community;
- Finalize the work plan with the community's council and agree on responsibilities;
- Provide technical assistance on-site;
- Assess progress and adjust work plan if necessary;
- Present eight management courses

It provides both one-on-one and small group trainings in the community and also utility management classes for utility staff and elected officials in various hub communities.

A mentor could be someone who successfully developed a renewable project, a tariff for electric vehicles, or simply a successful grant proposal. A mentor may be familiar with pricing excess diesel generator heat or someone willing to explain the PCE reporting process.

For example, AEA's Utility Clerk Training program could be expanded to further deliver accounting and recording-keeping training to Tier III and IV utilities, enabling managers to be more effective in their work, including interaction with community leaders, other utilities, outside experts, and government. The state could also expand basic human resources training to utility managers, to ensure that policies, procedures, and hiring processes at Tier III and IV systems are more effective in retaining capable staff. Some utility managers also highlighted the need for better training of line workers.

The state of Alaska could also consider providing assistance to Tier I and II systems facing their own human resources and management challenges. This includes the need for better business plans to create scale in purchasing, management, and operations.

Such efforts could work in conjunction with regional training centers to provide supplemental workforce development in close proximity to the community. Alaska has an established network of such centers throughout the state that could be used selectively to supplement the power plant operator facilities located at the Alaska Vocational Training Center in Seward.

RUBA (see text box) provides an encouraging model for similar support to rural electricity utilities.[82] All but one of the 52 water and wastewater utilities in communities served by the RUBA program reported significant declines in service interruptions and improvements in service reliability. Forty-six of 52 either implemented new accounting systems or improved existing ones.[83]

DOE could also expand support to managers in business planning and strategic energy planning through various programs such as START and its On-Demand Technical Assistance Programs. Building upon its current project-based offerings, DOE could provide Tier I and II systems with support in developing business plans and thinking strategically about their futures.

It should be recognized that training for Alaskan utility systems need not necessarily come from state- or DOE-sponsored programs. The School of Management at the University of Alaska, for example, provides online courses emphasizing practitioner-oriented instruction and a focus on materials relevant and applicable to a work environment.[84] With online access and professional staff, the University of Alaska could develop and deliver a curriculum that could be supported by the state and DOE.

In addition to the state university system, there are also private contractors who may be suitable to use for discrete training purposes.[85] Finally, expertise may be available in neighboring communities at no charge. Utility managers could benefit from this less formal engagement.

Mentoring Programs: Tapping Experience

Alaska has a significant pool of skilled and experienced utility practitioners whose expertise could be of great value if shared with others. This pool can be tapped to address the workforce challenges many communities face. Recognized experts could serve as peer reviewers or mentors to managers and staff from neighboring utilities, helping them learn and become more effective in their jobs.

A potential mentor could be someone who successfully developed a renewable project, a charging program for electric vehicles, or simply a successful grant proposal. A mentor may be familiar with pricing excess diesel generator heat or someone willing to explain the PCE reporting process.

The state and DOE could take advantage of this "human resource" by simply providing utility managers with better access to each other. A mentoring network could be a natural expansion of the existing Circuit Rider program, for example, which provides support in person or via phone or e-email.

State agencies could use their experience and contacts to identify possible mentors. Mentoring could also become a regular feature of the Alaska Rural Energy Conference, as well as of DOE's regional renewable energy workshops.[86]

Peer Exchanges: Identifying Grid Modernization Leaders

A topic related to the mentoring exchange is leveraging peer exchanges in another way. A number of local, state, regional, and national organizations—including tribal governments and national laboratories—are undertaking efforts to push the boundaries on what is possible in a small number of rural Alaska communities. These organizations are advocating for, designing, installing, and testing hybrid wind-diesel systems, wood-fired boilers, solar water heaters, electric vehicles, smart grids, and other emerging technologies.

Yet a large number of rural Alaska communities do not have the institutional, financial, and/or human resource capacity to be able to incorporate these advanced technologies and fundamentally transform the grid today—let alone keep the lights on with existing power infrastructure. Perhaps more importantly, policymakers and planners do not have the information they need to determine if a rural Alaska community can realistically incorporate and maintain advanced energy technologies over the long run.

A peer exchange program could be a first step in tackling those problems. The program would be comprised of both regional energy experts ("ambassadors") and a network of local utility managers ("buddy systems"). The peer exchange program would be tasked with (1) identifying villages where the utility's finances and staff are working well and (2) prioritizing a list of technologies that could be installed and maintained there. Participants could visit various villages to gather information and make these decisions. Members of the peer exchange would participate in twice-yearly workshops, contribute to a scoping study to identify metrics used to determine communities' metrics to install and maintain advanced energy systems, and share information into an online system used to track up-and-coming utilities.

Combining Workforce Development with Workforce Retention

Beyond training and peer development, employee retention is key to maintaining workforce capacity and performance. AP&T reports that the utility has managed to retain a capable workforce and maintain utility plant to high standards through incentive models, an employee-owned corporate structure, and other innovative staffing solutions. The utility suggests that these workforce development/retention solutions could be used as a replicable model.

Conclusions

Alaskans have always relied on their neighbors to help get things done. Beyond useful expansions of the current workforce training opportunities, the state can put this natural cooperation to work for rural utilities through mentoring and peer exchanges. Managers and staff will be able to share experiences, help each other troubleshoot, and together figure out what works and what does not in Alaska's unique landscape.

E. Expanding End-Use Energy Efficiency and Conservation

The Efficiency Challenge and Current Efforts

In 2010, lawmakers established an Alaska state energy policy (House Bill 306) that includes the goal of reducing per capita energy use in the state by 15 percent by 2020.[87] Alaska has achieved considerable success with existing programs operated through the Alaska Housing Finance Corporation (AHFC) and AEA. (See Figures 12 and 13 below).

The main challenge for rural Alaska is to improve the energy performance of existing housing and commercial and public buildings. Roughly 85 to 90 percent of existing homes in rural areas are in need of major retrofits.[88] Funding for existing programs is in decline and further threatened at a time when more effective and ambitious efforts should be scaling up.[89]

High costs appear to provide impetus for some energy efficiency initiatives at the community level. Highly efficient LED street lighting, for example, is relatively common in the communities visited. And, as noted earlier, most residents limit their use of electricity. But despite the high costs of energy and the heavy burden on homes and businesses, Alaska has not fully embraced policy initiatives common to most states, at least not statewide. In light of the pending fiscal challenges, Alaska should consider additional options that ideally rely less on state funding.[90] State and federal money can serve as a bridge to the establishment of more sustainable sources.

The federal and state governments offer various residential efficiency programs, most of which are administered by the AHFC. The AEA focuses energy efficiency initiatives on commercial buildings, public buildings, industrial facilities, and electrical efficiency. The Regional Housing Authorities and RuralCAP, the Tanana Chiefs Conference, the North Slope Borough, and certain development corporations help to oversee and deliver weatherization and household energy efficiency services. The programs include:

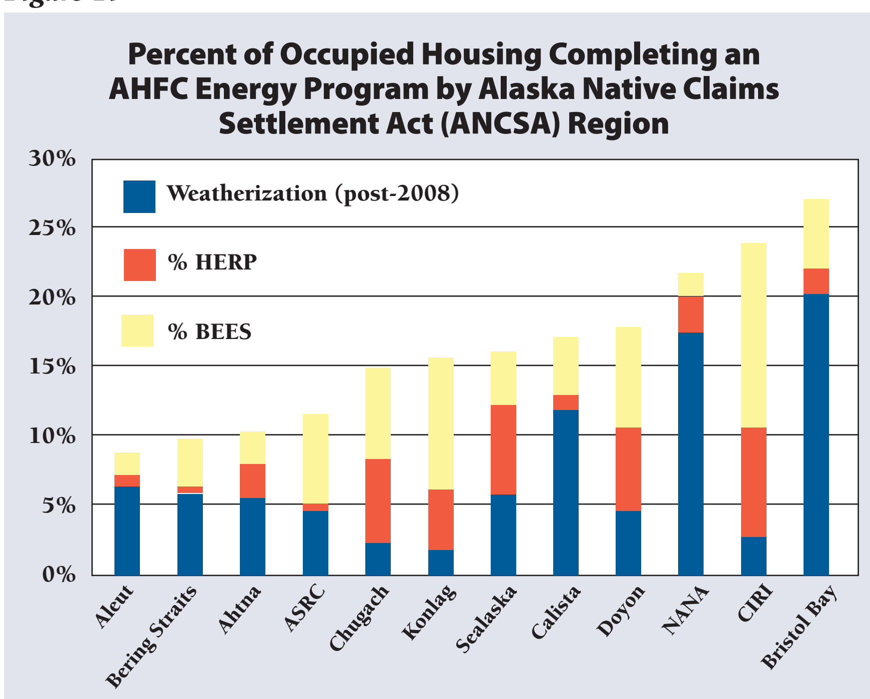
- *Weatherization Program* that provides free energy efficiency improvements to income-eligible houses;[91]
- *Home Energy Rebate Program* that offers payments of up to $10,000 for qualifying energy efficiency improvements at existing homes;[92]
- *New Home Rebate Program* that provides different levels of payment based on a building's qualifications;[93]
- *Energy Efficiency Interest Rate Reduction Program* that promotes energy efficiency in new or remodeled homes through interest rate reductions;[94] and
- *Second Mortgage for Energy Conservation Program* that provides borrowers with financing to make improvements on owner-occupied properties.[95]

The CCHRC (see "Technology Solutions" for more detail) provides a variety of technical assistance, including managing and analyzing data; energy modeling; calculating economic analyses of building, retrofit, and energy projects; and making policy recommendations to agencies and officials.

Figure 17 illustrates the amount of Alaska's existing housing that has benefitted from the Weatherization Program and Home Energy Rebate Program, as well as the state's Building Energy Efficiency Standard.

The AEA also helps to coordinate the activities of the Alaska Energy Efficiency Partnership, a group of 20 organizations and individuals from around the state that that meet regularly to create collaborative opportunities

Figure 17



among energy efficiency professionals and interested parties.[96] The partnership was responsible for a set of comprehensive state recommendations related to energy efficiency policy reforms in 2012.[97]

The federal and state governments support efficiency programs for public structures such as schools and municipal buildings through the Efficiency Revolving Loan Fund.[98] They have also supported energy efficiency audits and improvements to community buildings, primarily in rural areas, through the Village Energy Efficiency Program (VEEP) (see Figure 18).[99]

The federal government and the state of Alaska provide investment support for efficiency in commercial buildings. Loans through the Alternative Energy Conservation Loan Fund may be used to purchase, construct, and install alternative energy conservation improvements in commercial buildings. The Commercial Building Energy Audit Program, administered by AEA, also supports audits for privately owned commercial buildings.[100]

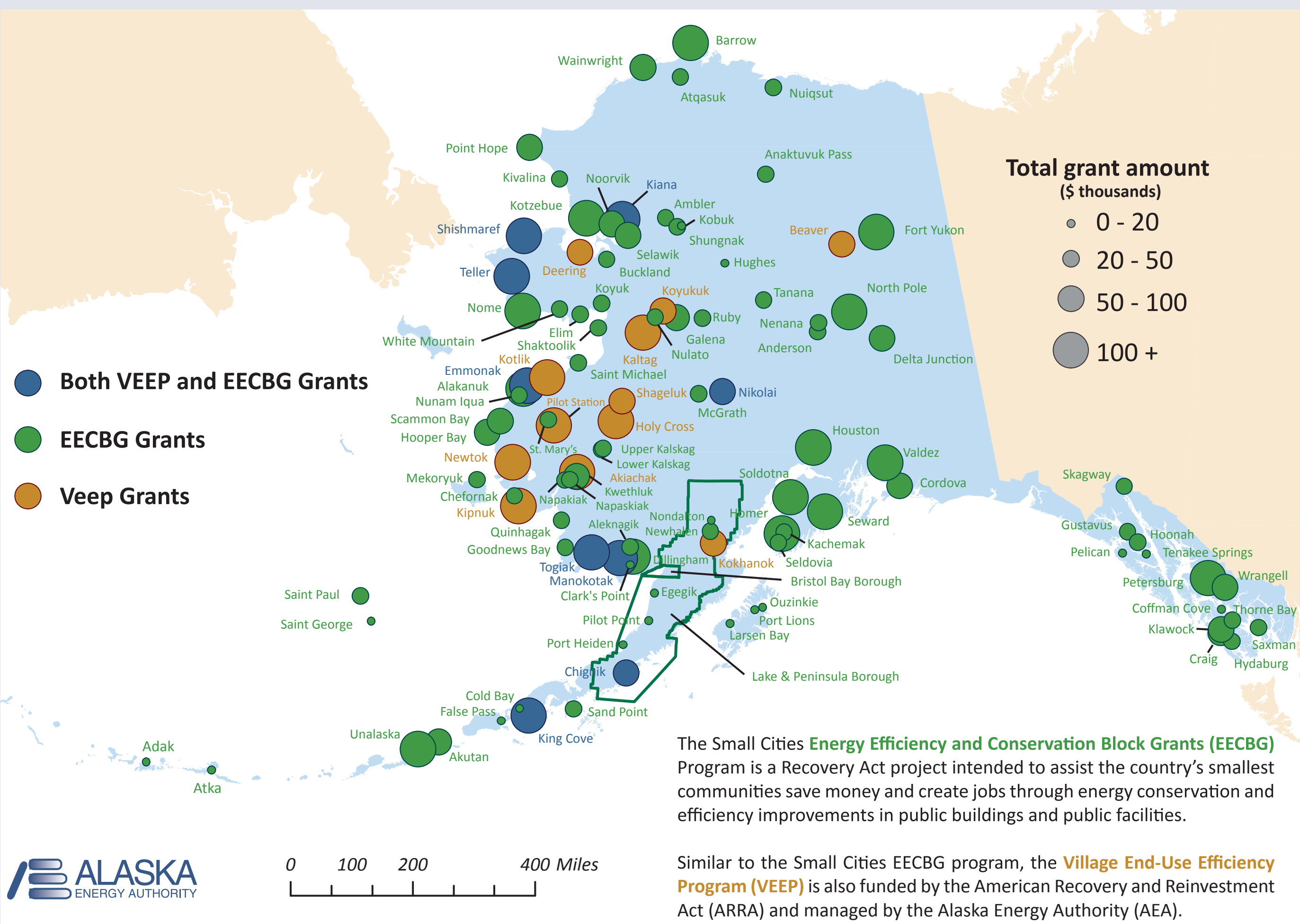
Improving the Energy Performance of Housing

The challenge for rural Alaska continues to be energy performance improvements to existing housing, commercial, and public buildings. Housing energy costs are 1.5 to 4 times higher than the U.S. average.[101] As illustrated by Figure 17, the percentage of occupied housing that has completed an efficiency program is very low, ranging from 8-28 percent. Rural areas tend to be lower-income and so qualify for weatherization programs, but fail to participate in the Home Energy Rebate Program. Among the reasons cited for the low level of participation is the required contribution from those that participate. In Alaska's cities

Figure 18

Energy Efficiency and Conservation Recovery Act Funds at the Alaska Energy Authority

2010-2012



and suburbs, higher-income households are better able to provide their share of the upfront costs of the retrofits.[102]

Judging from the research team's visits and the audits performed, there is considerable potential for improving the efficiency of public buildings. Likewise, given that the vast majority of homes in the state were built during the 1970s and 1980s, current improvement options are far above the standards of construction at that time.[103]

Efficiency Options

Utility Efficiency Programs

U.S. energy efficiency policy objectives have traditionally been met through a combination of avenues. Electric utilities play a big part, investing heavily in electricity load management and driving consumer acceptance of efficiency goals. Some jurisdictions establish energy efficiency obligations on all energy service providers.[104]

Energy efficiency efforts typically have the fastest payback opportunities of any energy investment, and are an engine of job creation and economic growth. More than one percent of electric utility revenues in the United States are now spent on efficiency programs.[105]

A key lesson from decades of energy efficiency experience is that utility programs are valuable. They provide energy decision-makers with the freedom to make choices and an opportunity to invest in a system that is superior to the one they currently have. Specifically, programs provide:

- Initial awareness of energy efficiency opportunities and options;
- Greater familiarity with the various choices;
- Appreciation of the feasibility of making a specific choice including any installation and adaptation issues; and
- Help in executing the choice.

Unlike almost all other U.S. states, Alaska's utilities seldom invest in end-use energy efficiency.[106] There are exceptions, however. Golden Valley Electric Association (GVEA), which serves communities in the Fairbanks area and beyond in Alaska's Interior, offers rebates to builders for residential and commercial energy efficiency improvements. GVEA made more than $3 million in direct program expenditures. At least one utility manager visited indicated his willingness to make investments that would benefit community members and the municipality, even if it does not yield financial benefits to the utility.

Extending Obligations to Fuel Service and Delivery Providers

As state funds become less reliable, Alaska could rely more heavily on energy service providers as a source of either direct efficiency investment or funds for such investment. This could be done via a system benefits charge, a mandatory charge collected from all users by energy providers only for purposes of program funding. Funds could be used by community organizations or by a heating utility—a provider that would act similarly to a traditional gas or electric utility but focusing only on thermal efficiency, which is the greatest challenge for energy efficiency efforts in Alaska.

Building Codes

The economic case for adopting building codes in Alaska is likely the strongest in the country. While the state's housing stock is the nation's most energy-intensive,[107] Alaska is one of only five states without a mandatory statewide energy efficiency building code obligation for either residential or commercial structures.[108]

Energy-efficient new construction, compared with retrofitting existing buildings, is nearly always the most cost-effective way to improve energy performance.[109] Because Alaska is a home rule state, its municipalities and regional governments could adopt their own building codes.

Labeling and Time of Sale Requirements

The purpose of mandatory labeling is to disclose the energy use associated with a building. This will help a buyer determine the value of the property being purchased or leased. Alaska requires disclosure of "utility data" at the time of sale.[110] Labeling requirements could apply to new buildings and to identify buildings that have met state building standards, or could be extended further to address even higher standards. Villages, municipalities, and regional governments could adopt their own requirements. However, it may be more effective if the state first creates guidelines that can later be adopted as a community standard at the village level.

Leveraging the Market for Energy Efficiency Services

In parts of the United States, there are active markets for energy service companies, also known as ESCOs. These companies provide energy management services, such as efficiency installation and maintenance, for a fixed payment or payment tied to the savings at the facility where the investments occur. In 2011–2012, Alaska engaged an ESCO to deliver energy efficiency services to rural communities as part of the VEEP.[111] Ameresco provided energy efficiency services to 14 villages in the state—including two communities visited by the research team, Fort Yukon and Emmonak—focusing on block grants available through the American Recovery and Reinvestment Act (ARRA). The program demonstrated the effectiveness of aggregating community projects to attract the attention and capital investment of an ESCO.[112] A widely recognized challenge related to the ESCO model in rural Alaska is associated with building maintenance. A cornerstone of the ESCO model is well-maintained buildings. An effort to address current challenges with building maintenance is the focus of the ad hoc RAMP initiative discussed in Section II-D.

Public Purpose Energy Service Company (PPESCO)

Another approach that may have relevance in rural Alaska is the establishment of one or more organizations that have broader energy mandates than a traditional commercial ESCO. A PPESCO is a third-party organization tasked with achieving deep efficiency savings in community or public purpose buildings, but which otherwise functions like a traditional ESCO and receive repayment based on a share of savings. The PPESCO is also distinct in that they target smaller community buildings than a traditional ESCO. Ideally, the PPESCO concept could draw investors from native corporations, boroughs, or economic development organizations that have ongoing connections to the community and the projects to ensure that they are properly maintained over time. AEA reports that it is trying out the PPESCO model through a partnership with Nuvista Light and Electric Cooperative to pilot an aggregated non-residential building retrofit project that is financed rather than funded through grants.

Centralized Delivery of Services

Among a list of recommendation of the Alaska Energy Efficiency Partnership in 2012 was the establishment of a single statewide energy efficiency utility and the establishment of binding targets.[113] As the previous description illustrates, Alaska has many organizations with responsibilities for energy efficiency programs. The concept of a single statewide efficiency organization was pioneered by the state of Vermont, which launched its Efficiency Vermont program in 2000, and the approach has been adopted in a variety of jurisdictions in the United States and Canada. The concept is to centralize the expertise within the state around a single organization whose mission is to focus the goal of improving the state's end-use energy efficiency performance, thereby improving the performance and overhead of programs.[114]

Conclusions

The state of Alaska has established ambitious efficiency targets for 2020, but the existing commitment to energy efficiency is largely reliant on currently available funds. The state should consider strategies to move away from overreliance on the state general fund for this purpose and greater emphasis on utilities to deliver energy efficiency, as well as consolidating and streamlining of programs.

F. Improving Power System Efficiency

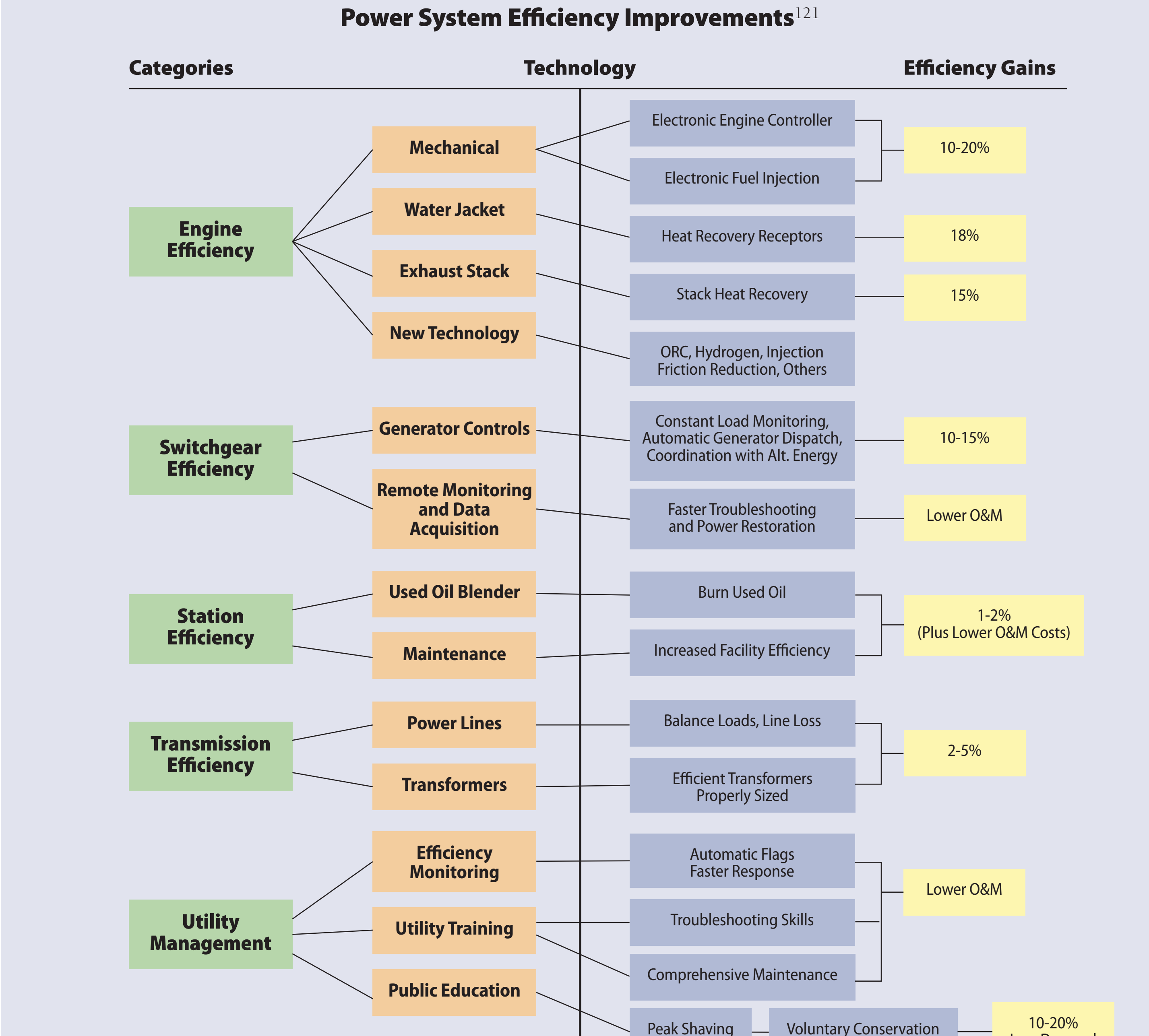
Targeting System Losses

Ninety-one percent of utility generation in Alaska's high-cost communities is diesel-fired.[115] Underperforming (Tier IV) and basic (Tier III) systems experience low efficiency performance characterized by poor fuel-conversion efficiency and heavy "line losses," i.e., wasted electricity due to distribution or transmission system inefficiencies.[116] The most cost-effective and readily addressable solutions for these systems requires improvement of the generation fuel efficiency and system efficiency.[117] Figure 19, a chart developed by the University of Alaska at Fairbanks' Alaska Center for Energy and Power (ACEP), illustrates the various approaches across a utility system that could improve system efficiency.

ACEP reports that the conversion efficiency of diesel generation depends largely on a generator's size and age.[118] The deployment of larger and newer diesel technology in rural utilities has produced systems that are 20-30 percent more efficient per gallon of diesel.[119] Controls on generation and help in managing system operations have further improved performance by 10 to 15 percent.[120] Reliable generation controls also benefit advanced diesel (Tier II), and leading and innovating (Tier I) systems as well. As these systems endeavor to move away from diesel and accommodate greater penetration of renewable resource in their systems, they have an even greater need to be able to control their diesel resources.

Line losses are highly variable among Alaska's rural communities. Underperforming (Tier IV) systems

Figure 19



Source: ACEP

experience line losses exceeding 15 percent while basic (Tier III) systems are in the 10 percent range, and advance diesel (Tier II) systems are closer to 5 percent losses.[122] There are many cost-effective opportunities for improvement. The discussion below considers strategies that Alaska can use to continue to improve power plant efficiency.

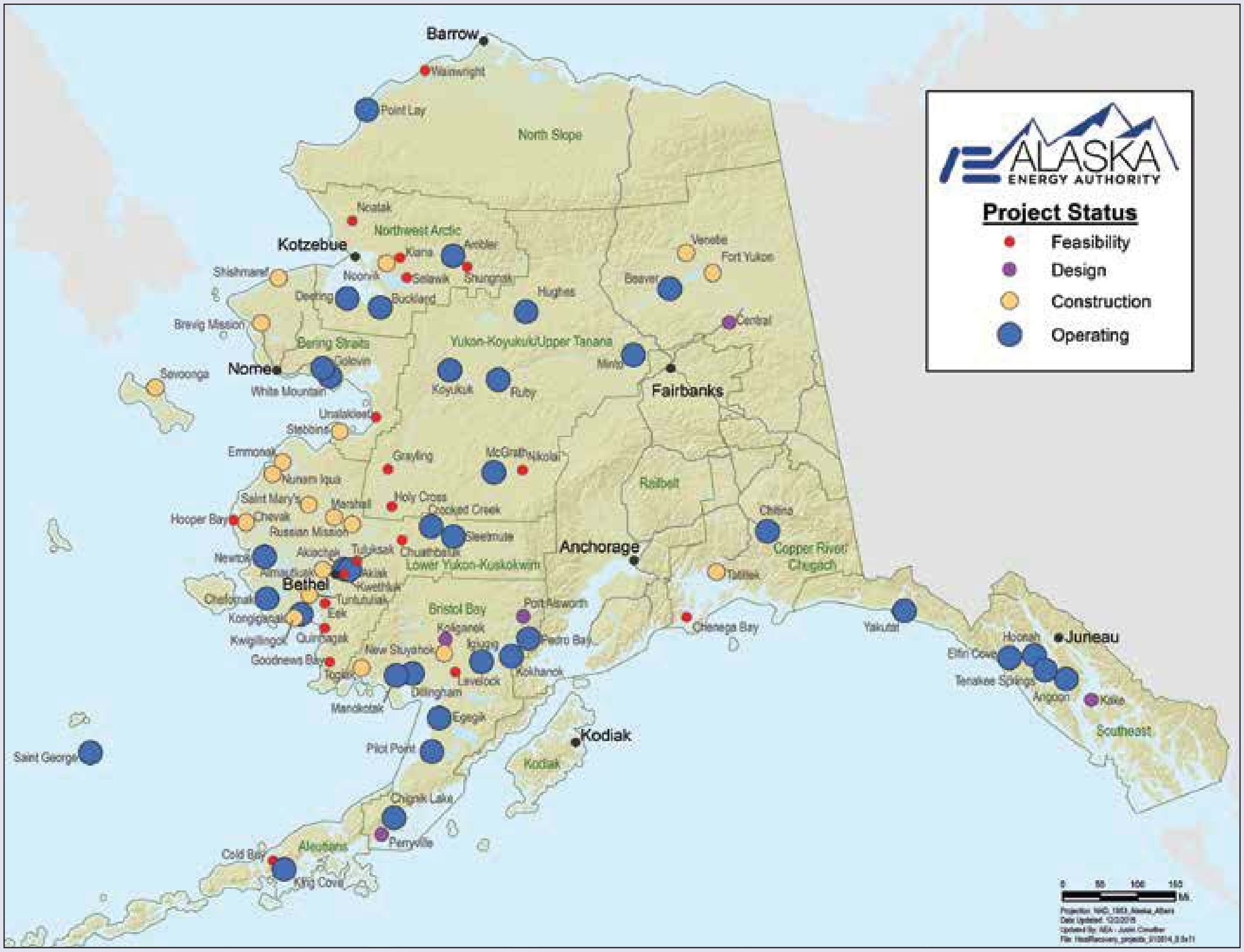
Figure 19 on the next page identifies diesel system improvements that could affect overall performance and efficiency, highlighting parts of the system, potential technologies and efficiency gains.

Options for Improvement

Utility systems can increase their performance and efficiency in a number of ways, including improving utility generation and generation heat recovery, taking advantage of flexible loads, and, where feasible, interconnecting with other systems. Distribution system improvements are also promising. While some line losses on an AC system are inevitable, capital improvements can reduce them cost-effectively, and avoid otherwise wasted fuel. When these types of investments appear financially sound and grant

Figure 20

AEA's Diesel Heat Recovery Program[123]



capital is unavailable, they may deserve commitment of ratepayer capital.

The state's Rural Power System Upgrade (RPSU) program demonstrates the state's emphasis on and recognition of the value it sees in improving system efficiency. The RPSU program provides communities with capital to upgrade their powerhouses and distribution systems, including line extensions, and other generation and distribution repairs.[124] Under the current circumstances, many of these improvements are critical to the well-being of rural communities, and as funding from traditional sources becomes scarcer, the state could explore ways to leverage community funds and outside capital to encourage these types of investments.

Because power-system upgrades are long lived, it is

Dan Winters, manager of Unalaska's municipal utility, monitors a generator from recaptured (waste) heat.

A ceramic stove made by Steffes is among the popular models used in Alaska. Customers with these stoves can be valuable to utilities looking to better manage their loads.

The Alaska Affordable Energy Strategy

The Alaska Affordable Energy Strategy (AkAES) is a requirement of the 2014 Alaska gasline legislation that requires the development of infrastructure that will deliver affordable energy to areas in the state that will not have direct access to a North Slope natural gas pipeline. AEA is tasked with identifying the most cost-effective means of generating, delivering, receiving, and storing energy for the targeted communities. The plan and any associated recommendations for legislation are due to the Alaska Legislature by Jan. 1, 2017.

General areas of inquiry include end-use efficiency; changes to generation, transmission, and distribution; improvements for transportation of fuel and energy infrastructure; management and ownership improvements; and a manner to directly underwrite energy costs. Recommendations from the effort may include improvements to current state programs; new assistance, loan, or grant programs; and new regulations or statutory requirements.

important that systems incorporate controls that can effectively integrate variable renewable energy sources. With regard to system efficiency, the difference between basic (Tier III) diesel systems and advanced diesel (Tier II) systems lies in their ability to accommodate distributed resources (see Glossary). In the absence of effective controls, systems that add more renewable resources run the risk of having to curtail these resources due to the system's lack of flexibility and service quality (including voltage levels). Incorporating controls changes that. For example, the new powerhouse in Emmonak can complement the performance of the village's 400 kW of wind power.

The AEA also manages a Heat Recovery Program to encourage utilities to utilize recovered heat from power plants to reduce the cost of energy (see Figure 20).[125] The payback on these systems is very quick, typically three to five years.

Innovative use of flexible thermal loads presents utilities with another opportunity to improve system efficiency, move away from diesel generation, enhance diesel performance, and save customers money. Not only can more effective use of waste heat improve system efficiencies, its use can also lower power costs by giving a utility an additional product to sell. Ten to twenty percent of the heat content of the oil used for generation can be readily captured and used by neighboring buildings, including public spaces, for space and water heating needs further avoiding diesel consumption. Waste heat can even be used to further generate electricity.

Communities in this study such as Unalakleet rely on secondary loads (see Glossary) such as community water heating to help capture the full value of their wind resources, even when loads are otherwise low. Unalaska produces additional electricity from the waste heat produced by its generators.

Others, such as Kobuk and Deering in the Northwest Arctic Borough, match solar with community water. Ceramic electric thermal stoves, being adopted by homeowners in various rural communities, are another way to capture this potential. Utilities could offer lower off-peak rates that would encourage the use of these stoves, which could then be heated at night with wind power.

Storage systems more generally, including both thermal and battery storage, provide great potential for system efficiency by allowing more effective integration of renewable resources. Kodiak relies on a combination of lead acid batteries and flywheel technology to buffer the variable wind loads on system frequency and voltage levels. One of the emerging technology fund projects if focused on trials of lithium ion technologies in rural communities. TDX has a project on Saint Paul Island that relies on extensive use of thermal hot water storage and flywheel technology.

There are other ways for utilities to accommodate and take full advantage of variable energy resources like wind and solar. Innovation can be spurred by the Emerging Technology Fund, but scarce capital from the state going forward may require communities to take the lead in implementing the solutions described above.

Conclusions

Improvements to utility powerhouse and distribution systems will prove pivotal in allowing communities to reduce their reliance on diesel fuel, and effectively integrate alternative forms of power generation. Recapture of waste heat and reduction of line losses offer potential for quick payback opportunities, whether financed with grants or ratepayer capital, and can provide further energy benefits to the community.

The opportunities for improving the efficiency and capture of these resources depend on the ability of utilities to engage in meaningful capital planning, to strengthen the capacity of community leadership and utility management, and to gain access to the necessary expertise.

In the meantime, the state will need to find ways to stretch available financial resources through the targeting of grants and loan supports. The DOE can help communities to identify and implement options through the START program, and AEA can help communities through continued use of the Circuit Rider program.

G. A More Effective Power Cost Equalization Program

In 1984, the Alaska Legislature created the Power Cost Equalization (PCE) program to provide rate subsidies and support for investment in utility performance. The PCE represents one of the few tools available to regulators and administrators to encourage steady improvements in utility performance. Coupled with technical assistance to communities, it can offer a potential path toward improving performance even among the smallest and most distressed utility systems.

The PCE was designed to provide some level of fairness to the rural communities that faced costs three to five times higher than those paid in Anchorage, Fairbanks, or Juneau, and were unable to benefit from large power projects such as the Four Dam Pool, Bradley Lake, and the Alaska Intertie that serve more populated areas of the state.[126] The funds come from the authorized uses of the roughly $1 billion PCE Endowment Fund, which was in turn funded through legislative appropriations. Today approximately 83,000 Alaskans, living in more than 190 participating communities, receive some benefits from the PCE program.[127]

The RCA sets the PCE rate subsidy under the PCE program, and the AEA administers it.[128] The RCA evaluates utility eligibility and utility cost, and ensures compliance with statutes and regulations.[129] The AEA authorizes payment to utilities, determines eligibility of customers, and provides training and assistance to utilities.[130]

The PCE program is a subsidy that decreases the price of electricity observed by consumers. Lower prices typically translate into greater demand. However, the structure of the PCE subsidy for electric power bills still leaves these consumers with a strong signal to manage their energy use.

The program has consumption limits, meaning that it subsidizes energy use up to a certain limit.[131] Residential customers receive a credit on the initial 500 kWhs they consume each month, and community facilities receive a per-month credit determined by multiplying 70 kWhs times the community population.[132] (See text box.)

The PCE program also has the effect of delivering to participating communities a certain amount of regulatory oversight by the RCA. The RCA requires each participating utility to provide financial, production and consumption information in an annual report to help in the calculation of the utility's annual rate subsidy. Standards set by the RCA limit PCE to cost recovery of only portions of the system that meet standards of performance efficiency. For example, distribution losses greater than 12 percent are not eligible for cost recovery through the PCE mechanism. Relying on its PCE-related cost-control authority, the RCA could, set a similar limit for allowable recovery indexed to arrearages.[133]

Funds at Risk

In the early 1990s, the Legislature authorized the creation of an Endowment Fund for the PCE that was

PCE Rate Example:

For a customer that consumes less than 550 kWh, the effective rate for each kWh consumed is 18.36 cents per kWh ($1.00/kWh - $0.8164/kWh) for the first 500 kWh and $1.00 for each after the first 50. The total bill is then (500 x 0.1836) + (50 x 1.00) = $141.80.

originally capitalized from several sources including proceeds from the sale of the Four Dam Pool projects and funds from the Constitutional Budget Reserve. Until recently, it was also supplemented with general funds.[134] During tight fiscal times, funds such as these become at risk of reappropriation. State revenues from oil extraction were down by 80 percent in fiscal 2015, from the $2.6 billion collected last year to $524 million.[135]

In addition to potential funding challenges, rural communities continue to face the cost pressures that the PCE program was designed to address, including rising fuel prices. However, while the PCE program has been successful in subsidizing the limited use of energy and in imposing a measure of business discipline on many utilities, it could be better tailored to create incentives for communities to pursue lower-cost and more sustainable local resources. These improvements could also be aligned in ways that would enable the state of Alaska to support better utility business practices, and would be justified under current law.

Revisiting PCE Implementation

Alaska is currently considering certain changes to the PCE program.[136] If decision-makers take steps to modify the PCE, they should also consider other potentially constructive reforms.[137]

As discussed below and in Section II-B, above, while the PCE program has been successful in supporting the limited use of energy (up to 500 kWh) and imposing a measure of business discipline on many utilities (due to basic reporting requirements), it could be better tailored to create incentives for communities to pursue lower-cost and more sustainable local resources. These improvements could also be aligned in ways that would enable the RCA and state of Alaska to support better utility business practices. (See Section II-C, above.)

A more effective PCE support program could provide incentives for PCE communities to invest in lower cost and more sustainable local resources, by using a portion of the program funds for something other than direct subsidies of customer's electricity rates.

In drafting the PCE statute, the Alaska Legislature provided for both a rate subsidy and support for investment in improved utility performance. According to its enabling statute, AS 42.45.180, the purpose of the PCE program is twofold:

(1) *equalizing power cost* per kilowatt-hour statewide at a cost close to or equal to the mean of the cost per kilowatt-hour in Anchorage, Fairbanks, and Juneau *by paying money* from the fund *to* eligible electric *utilities* in the state; and

(2) *making grants to eligible utilities* under AS 42.45.180 *to improve* the *performance* of the utility."[138]

The AEA is authorized to make grants (not exceeding 75 percent of the cost of the project[139]) for "a small power project that will reduce the cost of generating or transmitting power to the customers of the utility."[140] A "small power project" is defined as:

> *"a new or modified project that will either generate, store, or conserve no more than 1.5 megawatts of power or provide a metering system, transmission system, distribution system, or bulk fuel storage facility that has an estimated cost of less than $3,000,000."*[141]

[I]nvestment in energy efficiency and end-use measures could reduce demand growth in PCE communities by nearly one-half.

"Nightmute Final Report Lighting & Weatherization Measures 2008 – 2009," Geoff Butler, Alaska Building Science Network, AEA (2010).

Though the PCE program has successfully encouraged households to use energy prudently, its formulaic approach to bill payment has also been criticized for not better aligning with state and strategic objectives for sustainable energy resources that serve state and community interests in a more diverse base of resources that reduce risk.[142] When rural utilities look to build community support for alternatives that improve utility performance, such as renewable energy, this could be a challenge because residential customers would see little impact on their electricity rates and bills. Consequently, community support for resource alternatives could languish.[143] Reformulating the PCE could reward investments in sustainable alternatives to oil-fired generation while also reducing the rates that consumers see.

One approach would be to shift the emphasis of the program from a pure dollar-for-dollar pass-through to an initiative that can serve as a source of investment in cost-effective alternatives. In this way, the fund would provide positive returns to communities that participate well in excess of the current pass-through. For such a change to occur smoothly, however, the changes would need to be made clear and carefully structured. An approach here might be, for example, to establish a base amount that works like the current PCE and then supplement with additional PCE funds based on performance in relation to defined metrics and awards.[144]

Using PCE funds to improve rural system performance enables PCE communities to invest in lower-cost and more sustainable resources such as energy efficiency, renewables, interconnection, or line loss reduction, all improvements consistent with the full intent of the Legislature to "reduce the cost of generating or transmitting power to the customers of the utility."[145]

Conclusions

The PCE program helps provide some level of fairness to the rural communities that do not benefit from the large power projects serving more populated areas of the state. In developing the PCE law, the Alaska Legislature provided for rate subsidies and support for investment in improved utility performance.

Additionally, the PCE represents one of the few tools available to regulators and administrators to encourage steady improvements in the performance of rural utilities. Coupled with technical assistance to communities, it can offer a potential path toward improving performance even among the smallest and most distressed utility systems.

Determining the cost-effectiveness of current PCE investments and potential investments in lower-cost and more sustainable resources—energy efficiency, renewables, and interconnection or line loss reduction—would be consistent with the Legislature's intent of the PCE statute and potentially more cost-effective long-term use of limited PCE dollars.

H. Fostering Measures and Standards of Performance

The Oversight Gap

The RCA provides regulatory oversight of larger rural systems. The smallest communities, approximately 100 in number, are virtually exempt from this oversight and less likely to take advantage of the RCA's expertise and help.

Utility operations can only work when a utility's management, board, and community leaders have sufficient information to help gauge their utility's performance. The authors saw only limited evidence that independent rural utilities were empowered in this way.

Setting Useful Benchmarks

Currently small utilities provide financial, production and consumption information in their reports to the RCA to help in the calculation of the utility's PCE rate subsidy.[146] Ideally, utilities should be able to track and benchmark their performance on a more meaningful basis relative to other systems in at least the following categories:

- Reliability,
- System losses,
- Service quality,
- Conversion efficiency and effective use of energy from generation, and
- Financial performance.

Much of this information is available for comparison in PCE reports from the RCA and the AEA, but data quality and accessibility of this information can make it a challenge to effectively employ.

The information would be most valuable if it were tracked over time so self-improvement can be assessed and, perhaps, benchmarked against standards being met by other similar communities, and eventually even larger Railbelt systems. Furthermore, utilities should track their progress implementing community objectives (e.g., investment in renewables and energy efficiency).[147]

Relying on its PCE rate-setting authority, the RCA could direct utilities to produce this needed information related to key performance measures.[148] Today, in order to qualify for PCE support, utilities are required to "make every reasonable effort to minimize administrative, operating, and overhead costs, including using the best available technology consistent with sound utility management practices."[149] Furthermore, in reviewing PCE applications, the RCA is authorized to "require the elimination of unnecessary operating expenses."[150]

In order to ensure that utilities have, in fact, minimized administrative, operating, and overhead costs, the RCA could require them to submit data related to key performance measures. With this information, the RCA could also ensure that the PCE is not supporting unnecessary expenses associated with operations of substandard systems. Among the information relevant to such determinations would be the following:

(1) forward-looking business, maintenance, or capital plans;

(2) maintenance and operational performance such as maintaining and retaining records of plant maintenance, along with associated standards of performance;

(3) output-based performance measures such as plant or distribution system failures and outages, power quality, system losses, arrearages, credit ratings or creditworthiness, financial performance measures (net

income or excessive debt), quality of reporting, and even indicators of customer satisfaction.

This effort would need to be coupled with training and an effort to identify reasonable approaches to the collection of key measures. This additional oversight and support from the RCA would create more incentive for PCE communities to invest in lower-cost and more sustainable local resources.

Conclusions

It would be worthwhile for Alaska to establish reasonable oversight of small rural utilities in order to help them develop standards of performance for the benefit of their customers. Requiring these utilities to produce the minimal performance data suggested here would create an incentive for PCE communities to invest in lower-cost and more sustainable local resources.

While an exemption from regulation might appear advantageous—when it comes to the availability of performance data—it actually puts smaller rural utilities at a disadvantage. Performance measures justify programs, costs, and demonstrate accountability. Considering the prominence that performance data provides larger utilities seeking grant funding, Alaska's small utilities are nearly invisible.

Underperforming (Tier IV) and basic diesel (Tier III) systems struggle in part because oversight authority is sometimes blurred. Making rural utilities provide reasonable performance data as part of the annual PCE filing process will help start discussions with utility managers and community leaders, reaching out to neighbors for ideas, and agreeing on basic principles and set lines of authority. While advanced diesel (Tier II) systems and leading and innovating (Tier I) systems should already have oversight mechanisms in place, they can still benefit from ongoing stakeholder engagement to ensure that performance remains solid.

While it is beyond the scope of this effort to recommend specific measures beyond the categories listed above, those measures are best developed in a collaborative manner with sensitivity to customers in rural communities, and after consideration of proposals by experts at the AEA.

The Alaska Center for Energy and Power

ACEP is an applied energy research program based at the University of Alaska-Fairbanks that focuses on testing how to integrate innovations in rural, isolated power grids that currently rely on diesel.

Its test facilities in Fairbanks allow ACEP to simulate the operations of village loads and equipment when renewables are integrated, aiming to find out whether solutions that operate well in milder conditions also work in the weather extremes of rural Alaska. Their work can help communities make smarter decisions about technology investment.

The Cold Climate Housing Research Center

The CCHRC is a nonprofit corporation based in Fairbanks created to facilitate the development, use, and testing of energy-efficient, durable, healthy, and cost-effective building technologies for people living in cold climates.

Included in the portfolio of service offerings is research on (1) sustainable communities, (2) building science, and (3) policy research related to energy efficiency in buildings in Alaska. The CCHRC has received two Emerging Energy Technology Fund grants for heat pump demonstration projects.

I. Technology Solutions

Steps Toward Innovation

Technology can help overcome the barriers of distance and scale that rural utility systems face. It can help them better integrate renewables and communicate data to customers and managers, among other key functions. The weather-related challenges across the state have fostered a spirit of experimentation that organizations such as ACEP and the CCHRC seek to tap (see text box for details).

AEA's Emerging Energy Technology Fund has made two rounds of funding awards (in 2012 and 2013) to date. The fund is designed to advance technologies that are approaching commercial potential and have not been previously deployed in Alaska. Utilities, third-party providers, research organizations and others have won support for projects ranging from cold-climate wind turbine testing in the Northwest Arctic Borough to Saint Paul Island's demonstration of flywheel technology.[151]

Beyond innovations such as ceramic stoves that help manage thermal load and powerhouse improvements (see "Power System Efficiency"), new technology on the customer side of the meter is helping utilities better manage their billing and financial performance. Forty-three communities have installed Marsh Creek's "pay-as-you go" meters, allowing customers to better understand the connection between consumption and bills. Communities visited by the research team such as Arctic Village reported that the meters were a success, and in at least one community, Clark's Point, this installation helped bill collection improve to the point that the utility was able to restore its eligibility for the PCE.

In Clark's Point, a tiny fishing community in the Bristol Bay region, the village utility has improved bill collection with a system of prepaid meters and cards.

Battery technology, combined with flexibility of storage loads, can also reduce dependence on diesel generation by providing a better match with variable energy resources. In 2015, to support its wind generation, Kodiak Electric added 2 MW of flywheel technology to its system to help reduce frequency fluctuations and the wear and tear on the 3 MW of battery storage. (Diesel-off is now the norm in Kodiak as it approaches 100 percent renewable energy.) As noted earlier, Unalaska has three 50 kW waste heat recapture generators that take waste heat and turn it into additional generation, and the city is planning an "inline" hydro generator that allows it to capture the working energy from their potable water as it comes off the neighboring storage sites. Cordova and Unalaska boast underground distribution systems with high levels of reliability. Electric vehicle adoption is only beginning in Alaska, as it is elsewhere in the United States, but communities such as Juneau (see next section) have made strides here too.

Conclusions

Innovation requires investment, and the efforts outlined here are no exception to this. Some communities may struggle to find funding for these efforts beyond traditional grants. But the use of innovations such as prepaid meters can demonstrate to third-party providers that utilities are serious about getting their financial houses in order, and therefore are good investments. Our suggestion of pooling resources with regional neighbors to make other improvements and attract capital applies here as well.

The establishment of an online information clearinghouse for energy technology in Alaska appears to have promise. One utility executive suggested that there would be merit for utility staff simply in gaining familiarity with the new technologies that are becoming available in the state. Such a clearinghouse would also allow staff to share news and tips beyond their communities.

J. Fostering Local Renewable Energy Solutions

Fuel for the Future

Alaska has a renewables goal of 50 percent of its energy mix by 2025.[152] The AEA Renewables Atlas provides an overview of the resources that have been deployed to date in the state and the available resource potential of each

Solar panels are positioned to capture the low angle of the sun in Noatak (left) and Nome.

The research team examines a wood boiler system in Kobuk.

region.[153] Even small communities have set ambitious targets; Saint Paul (population 453) is aiming for 80 percent renewables for both electricity and heat by 2020. Communities in the Kodiak Electric Association are already almost 100 percent renewables.[154] The addition of 9 MW of wind on Pillar Mountain brought it forward from levels that already reflected heavy levels of renewables (about 75 percent). Juneau and Cordova also provide their communities with a significant amount of energy from renewable resources.

Many of the rural communities visited listed "going diesel off" as part of their community or utility vision. This is already occurring in some hydro-rich communities like Kodiak and Cordova, as well as much more remote locations such as Saint Paul.

There was no shortage of enthusiasm for these new options among members of the community and village leaders that we visited. But that enthusiasm was at times tempered time by the sobering realities of local resource assessments and the economic and integration challenges that are often cited by utility managers. The costs of wind in rural Alaska is reported to be above $10 per watt installed. This compares to an installed cost of approximately $1.70 per watt in as an average cost in the lower 48,[155] where jurisdictions are able to take advantage of scale (e.g., larger turbines on wind farms) and proximity to manufacturing, and do not have the unusual logistical challenges of placing relatively small wind turbines in remote locations and with soft or unreliable soil conditions.

The Renewables Challenge: Making It Work

The options and opportunities around renewable energy are many. Utility-scale wind projects are now widespread. AVEC alone has 10 wind systems across the 56 communities that it serves, and another five under development. Utility development of wind increases the likelihood that the utility will design the system to accommodate renewables. Utility-owned projects require good planning efforts and building local support for the commitments (even cost-effective projects may stall in the face of competing demands for capital). Alternative energy solutions are also being adapted for thermal needs, such as community building heat or heat for water and sewer; in Kobuk, the Alaska Native Tribal Health Consortium sponsored a pilot project using biomass boilers that replaced 3,000 gallons of diesel with harvested cord wood for community heating.

There are four broadly framed challenges typically faced by rural communities in relation to renewables. They are: (1) the initial identification and screening of renewable technologies; (2) integration of variable energy technologies; (3) the cost and cost-effectiveness of the technologies; and (4) the implications for the financial health of utilities. Options for each are included in the discussion that follows.

Identification of Renewable Potential: Identification of renewables appropriate for the community can be achieved in one of three ways. First, the utility can identify these opportunities and screen and include them in their own planning processes. This can be achieved by working with vendors, but may be best achieved through regional planning efforts. Efforts are underway at the regional level to identify appropriate technologies suitable to each region, and rural utilities can build on these efforts.

Second, the utility can allow and enable its customers to develop customer-sited resources such as rooftop solar panels. Typically, these are fostered through either net metering or a standard offer price for electricity that flows to the utility. Net metering exists in a number of communities in the Northwest Arctic Borough and in the Upper Tanana. Rules for compensation are usually accompanied by rules for interconnection so that customers can be fully informed of the costs and benefits of self-

Independent Power Producers (IPPs)

Roughly 38 percent of the electricity in the United States is now provided by third-party providers known as IPPs. Increasingly, IPPs are providers of renewable energy, with about 15 percent of generation coming from renewable sources. These providers typically offer service at rates approved through formal regulation or through individual contract negotiations. A recent decision by the RCA provides these utilities with the rights to a price for renewable energy that is at the avoided costs of service for what would otherwise be paid by the utility to cover incremental costs. The entry of competitive providers holds promise for stabilizing rates, and, with time, the opportunity to see further reductions in the cost of service.

providing their energy.

Third, the utility can establish rules for interconnection and compensation from third parties, typically independent power producers (IPPs) that provide services on larger scales (see textbox). Here again, the utility can establish clear rules for interconnection and compensation, that compensation be based either on cost or value to the utility. These rules should ideally be established regionally or statewide in order to attract sufficient third-party interest.

Members of the IPP community recognize the central importance that standards and regulations play in helping to overcome barriers. The recent RCA ruling in Docket R-13-002 is recognized as a landmark decision[156] that could substantially improve opportunities for non-utility power by increasing the scope of "avoided costs" (i.e., utility value) that are recognized in value attached to power sold to utilities. However, the reach of the RCA is limited; it regulates only a small fraction of high-cost rural utilities in Alaska (beyond certification and PCE determinations). This leaves room for these utilities to move forward independent of formal regulatory oversight. Rural utilities can encourage IPP entry by establishing an open-door policy and creating a common framework for interconnection and compensation that encourages engagement. One of the concerns raised by the IPP community is the potential for regulatory overreach. Federal requirements for qualifying facilities under the Federal Power Act exempt IPPs from

Cordova Electric Cooperative

Cordova Electric Cooperative serves 1,566 consumers, with 78 miles of underground distribution plant and one substation. CEC has 18 MW of generation capacity: one diesel plant (10.8 MW) and two hydroelectric plants, one 1.25 MW, and another 6 MW.

Between its two existing hydro facilities, in 2014 CEC was able to provide 72 percent of its energy from renewable resources. According to CEC, its hydro projects saved over $3,300,000 in diesel fuel costs in 2014. CEC reports that customer "bills would have been 42 percent higher without the hydro projects." According to the CEC CEO, its hydro generation is "vitally important to Cordova's energy security." This is energy that is generated in Cordova and is not subject to market fluctuations and [diesel] barge logistics.

In a joint effort with the City of Cordova, CEC is exploring ways of integrating large amounts of renewable energy into its generation portfolio. "Energy storage will help us continue reducing our diesel fuel use and get more out of our existing hydros."

Workers dig to bury power lines in Cordova.

state oversight in order to reduce barriers to participation. However, IPPs that do not qualify or come under the Act may be subject to greater state regulation.[157]

IPP power has been slow to materialize in Alaska, which is one of only four US states where less than five percent of electricity is generated by IPPs.[158] Nationally, independent power accounts for 39 percent of generation and the vast majority of power from non-hydro renewables. Opportunities for both self-generation and third-party provision of generation through IPPs can be enhanced through standardized arrangements for interconnection, information exchange, competitive solicitations, and compensation arrangements (i.e., standard contracts and power purchase agreements).

Integration: Utilities in rural Alaska are already pursuing three key strategies that are helping with the integration of renewable energy and reducing the curtailment of loads:

- ***Plan and Invest in Diesel Powerhouse Integration:*** First, most systems in rural Alaska will need to effectively integrate renewable resources with diesel, as AVEC is doing with its wind-diesel hybrids. As noted, earlier, improvements to the powerhouse are long-lived investments. Genset technology and powerhouse controls must be adequate to handle the needs of small systems. Rural communities with viable renewable resource potential and potential granting agencies should include these improvements in their strategic and capital plans. This will require a standing offer of technical assistance.
- ***Match Renewables to Flexible Secondary Loads:*** Perhaps the most cost-effective avenue for enabling integration is through effective use of available secondary loads, which can receive electricity delivery at varying times of the day and can limit the need for solar or wind curtailment. Water and sewage systems are common secondary loads used by Unalakleet and a number of communities in the Northwest Arctic Borough. Ceramic stoves, discussed earlier, are being installed by third-party providers such as the Chaninik Group in four communities on or near Kuskokwim Bay, and Chaninik offers incentives such as a 10-cent-per-kWh discount rate in exchange for giving the utility some measure of control over loads. Secondary load use can also be fostered through discounted rentals and customer credits that are common in other regions.
- ***Add Flexible Storage:*** Flexible storage includes traditional lead-acid batteries and advanced lithium-ion batteries. It also includes flywheel technologies. Flexible storage serves as a potential accompaniment to powerhouse improvements that, if well-situated, can help to deliver high power system quality and cost-effective integration with the diesel generators.

Cost of Renewables: Various factors explored above affect the cost of renewables, at least for certain categories of them. More experience, better knowledge exchange, and scale are required to reduce the costs of logistics and distribution. Better exchange of information about community experience with renewables can be improved through effective use of communications and social media. Continued investment in near-commercial technologies will also be needed. Scale efficiency can improve with the size of markets, buying pools, and the establishment of greater volume to remote communities. Strategies for improvements here include those addressed above under recommendations, but this is a topic left for more detailed examination by potential vendors. Scale can also be addressed by creating state and regional targets for renewables. Growth can also be fostered by listening to the needs of developers. Solar developers, for example, indicate that among their needs is information on customer loads (daily load shapes). Information of this sort could potentially be shared with appropriate customer privacy protections, but may require investments in advanced meters and utility meter data management systems (MDMS) that most, if not all, rural utilities still lack. Of course, subsidies can serve as a bridge to accelerate the adoption of these technologies. We recommend effective use of targeted grants and supports for technologies that are close to commercial potential.

Financial Impacts on Utilities: A utility may lose revenues if more customers install self-generation, or if the costs of integration or curtailment of renewables are not effectively incorporated into consideration or compensation. Financial impacts can be addressed either in the terms and conditions related to compensation or payment (e.g., whether to allow net metering or simply engage in a buy-all sell-all arrangement) or through the framework for adjusting rates and recovering costs. If a utility allows net metering, it should consider the establishment of a revenue assurance mechanism to ensure recovery of costs that do not vary with sales (most nonfuel costs). A revenue assurance mechanism will also improve the financial health of the utility, along with its creditworthiness.

Conclusions

Rural utilities seeking to deploy renewable resources face multiple challenges. First, cost-effective resource alternatives must be available. Second, either the resource must be flexible or the system must allow for the flexibility to accommodate higher levels of renewables. Third, the systems and rate design elements must be in place to effectively integrate the renewables at high levels of system reliability at a reasonable cost.[159]

Removing barriers and incentivizing greater investment in renewable energy will contribute to the ability of rural Alaskan utilities to move beyond their reliance on diesel fuel and build cleaner, locally sourced resources. With continued state support, rural utilities will be able to identify their renewables potential, determine its cost-effectiveness and financial impact, and determine how best to integrate these resources into their systems while maintaining standards of performance.

Notes

51 Twenty-five villages have interconnected. But even interconnection does not fully address the issues associated with scale economies; interconnecting villages sometimes maintain duplicate facilities as insurance against a downed line.

52 See AS 42.45.130: Cost Minimization.

53 The RCA also imposes a line-loss standard of 12 percent on utility systems receiving PCE support. This establishes a number for how much fuel would have been used or how many kWh of electricity would have been sold if the utility had met the standard. If the standard is not met, then a utility's fuel expense is calculated as if it had met the standard, potentially causing the utility to lose money. Enforcing these provisions encourages utilities with line-loss rates that are higher than 12 percent to become more efficient by reducing their line losses. See Cox, B., and Knudsen-Latta, C., *Power Cost Equalization Basics,* RCA presentation.

54 Though sometimes as few as one or two individuals are shouldering the weight of the utility's success or failure, which means that some of these systems may prove fragile in the future, they can continue to do well under current models as long as they have the needed technological support.

55 See *Regional Alaska Maintenance Partnership,* flier from 2012. Participants include AEA, AVEC, the AHFC, the Denali Commission, RuralCAP, Associations of Housing Authorities, Alaska Native Tribal Health Consortium, and various state agencies and education and training institutions.

56 While most are formed to provide power, some joint action agencies are formed to provide natural gas, electric transmission, or telecommunications services. See Moody's Investors Services. (2012, October 12). *US Municipal Joint Action Agencies.* Retrieved from http://www.publicpower.org/files/JointActionWorkshop/jaa%20methodology.pdf.

57 See: EIA, Form 860, Schedule 3 Generator Data, 2013. Retrieved from http://www.eia.gov/electricity/data/eia860/; AEA. *Rural Power Upgrade Program.* Retrieved from http://www.akenergyauthority.org/Programs/RPSU; and AEA. (2013). *Draft Aleutian & Pribilof Islands Regional Energy Plan - Phase 1 Resource Inventory.* Retrieved from http://www.aleutiansenergy.org/wp-content/uploads/downloads/2014/02/YCE%20DRAFT%20NOVEMBER%208%202013.pdf.

58 Potentially including the grant-making agencies in the state, including AEA and AHFC, but could also include utilities, communities, and third parties.

59 See AEA, *Regional Energy Planning,* retrieved from http://www.akenergyauthority.org/Policy/RegionalPlanning.

60 See AEA, *Rural Power Upgrade Program*.

61 Kodiak Regional Energy Plan. (2015, March). *Volume I: Resource Inventory and Priorities.* Retrieved from http://www.kodiakenergy.org/wp-content/uploads/Kodiak-REP-Phase-II-Vol-I-Resource-Inventory-Outreach.pdf

62 Ibid.

63 AEA. (2013). *Aleutian & Pribilof Islands Regional Energy Plan.*

64 US DOE Office of Indian Energy. *START Program.* Retrieved from http://www.energy.gov/indianenergy/resources/start-program.

65 Beecher, J. (2001). Statement on behalf of the H2O coalition before the Senate Environment and Public Works Committee. Retrieved from http://www.epw.senate.gov/107th/bee_0327.htm. "The real risk today may be in the potential for a 'responsiveness gap,' that is, the gap between awareness and knowledge about an issue or problem and taking the actions necessary to address the problem and avoid or mitigate deleterious effects."

66 Tier IV utilities, for example, have high arrearages and periodically operate at a loss. Inadequate management

may also result in incomplete records related to personnel, operations, maintenance, planning, and billing.

67 See Appendix A, "Financial Performance" and "Capital Planning."

68 Fourteen regulated utilities serve PCE eligible rural communities.

69 Pickett, M. (2008, December 8). *Electric Utility Regulation in Alaska,* p. 3. RCA. Rate adjustments under SFR regulations are in addition to purchased and fuel cost rate adjustments (AS 42.05.381(e) and 3 AAC 48.700).

70 Ibid. For example, loan guarantees or loan-loss reserves.

71 Coalition for Green Capital. *What is a Green Bank?* Retrieved from http://www.coalitionforgreencapital.com/green-banks1.html.

72 OnPoint. (2014, November 20). *Coalition for Green Capital's Hundt says green banks can help states comply with EPA power plant rule.* Interview with Reed Hundt. Retrieved from http://www.eenews.net/tv/videos/1900/transcript; Connecticut Green Bank, http://www.ctcleanenergy.com/Home/tabid/36/Default.aspx; and Copithorne, B. (2014, May). *Connecticut's Green Bank Gives Commercial PACE a $24 Million Boost.* Retrieved from http://blogs.edf.org/energyexchange/2014/05/28/connecticuts-green-bank-gives-commercial-pace-a-24-million-boost/.

73 See note 71.

74 See: Hawaii Green Infrastructure Authority GEMS Financing Program, retrieved from http://energy.hawaii.gov/testbeds-initiatives/gems. Hawaii raised capital for its bank relying on authority similar to the authority exercised by Alaska's Municipal Bond Bank. The Alaska Bond Bank supports municipalities by purchasing their bonds and then selling its own bonds in the national market. "Because the bond bank is able to receive a bond rating better than most small municipalities, it can borrow money at a lower interest rate, then pass the savings on to Alaskan cities."

75 In 2013, AEA offered three PCE training classes for utility clerks, and continues to offer the courses. PCE training provides utility clerks with essential technical knowledge in order to help ensure continued participation in the program. AEA indicates that it has determined that additional training is needed for utility managers, and that they would benefit from a better understanding of ratemaking and general business management. A key purpose of this additional training would be to ensure that utilities have accurate rates and reports to assist utilities to fully participate in the benefits of the PCE Program. For more, see: https://www.omb.alaska.gov/ombfiles/15_budget/DCCED/Proposed/comp2602.pdf.

76 A useful reference point for the training needs of rural community managers is a survey commissioned by the Denali Commission. See *Three Star Enterprises, Status of Rural Alaska Management Training 2012, Summary Report,* retrieved from https://www.denali.gov/images/Training_Documents/Rural_Manager_Training_Study_findings_April_2012.pdf.

77 ARMI comprises statewide educators, rural manager employers, and other stakeholders that understand the education needs, challenges, gaps, and opportunities of rural managers.

78 The RUBA program is detailed at https://www.commerce.alaska.gov/web/dcra/RuralUtilityBusinessAdvisorProgramRUBA.aspx.

79 See: http://www.energy.gov/indianenergy/resources/alaska-native-villages.

80 The positive effect on human resource capacity associated with individual project development was noted in a recent AEA study: "As the market continues to grow the human resource and knowledge base that helps Alaska to successfully develop renewable energy projects and resources will become an increasingly valuable asset and driver of economic development." Vermont Energy Investment Corporation. *Alaska Energy Authority Renewable Energy Grant Recommendation Program Impact Evaluation Report,* Volume 2, Vermont Energy Investment Corporation, Alaska Center for Energy and Power, January 22, 2013, page 12. http://alaskarenewableenergy.org/wp-content/uploads/2013/07/Alaska-Energy-Authority-Grant-Recommendation.pdf.

81 In this context, DOE provides a broad array of its resources, including the Offices of Indian and Tribal Energy, the national laboratories, the Federal Energy Regulatory Commission (FERC), Federal Power Administrations.

82 Results from a 10-question, closed-ended survey administered to 52 communities served by the RUBA program during the year 2000, provided by Michael Black, Alaska DCED, April 2001.

83 Colt, S., et al. (2003, July). *Sustainable Utilities in Rural Alaska: Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, and Solid Waste.* Final Report, Part A: Overview. ISER.

84 See University of Alaska Southeast's business administration course offerings at http://www.uas.alaska.edu/som/business.html.

85 See, e.g., Marsh Creek LLC, a company that advertises various utility support and training services including development of PCE reports to AEA, RCA annual reports, monthly customer billings and ledgers, DOE annual EIN reports, rate analyses, utility manager training, utility clerk training, and fuel farm management. Retrieved from http://marshcreekllc.com/services/energy-systems/village-power.html.

86 U.S. DOE. (2015, February 5). *DOE to Host Three Alaska*

Native Village Renewable Energy Project Development Workshops in March. Retrieved from http://www.energy.gov/indianenergy/articles/doe-host-three-alaska-native-village-renewable-energy-project-development.

87 House Bill 306.

88 AHFC. 2014 Alaska Housing Assessment. Retrieved from https://www.ahfc.us/efficiency/research-information-center/housing-assessment/.

89 Libensen, S. (2014, December 31). Commentary: Cuts to Energy Efficiency will Cost Alaska. *Anchorage Daily News.* Retrieved from http://www.adn.com/article/20141231/cuts-energy-efficiency-programs-will-cost-alaska.

90 Ibid.

91 Weatherization funds come from the U.S. DOE and AHFC. See: https://ahfc.us/pros/grants/service-assistance-grants/weatherization-programs/#sthash.LLF6jKLO.dpuf.

92 The Home Energy Rebate Program is funded by the state of Alaska. See: https://www.ahfc.us/efficiency/energy-programs/home-energy-rebate/#sthash.gUibts6t.dpuf.

93 The New Home Rebate Program is also funded by the state of Alaska. See guidelines at: https://www.ahfc.us/files/2813/7367/3759/New_Home_Construction_Rebate_guidelines.pdf.

94 The Alaska Building Energy Efficiency Standard (BEES) was established in 1992. All residential buildings constructed after 1992 must incorporate BEES if AHFC or other state assistance is involved in the purchase of the property. It currently affects about 25 percent of new homes.

95 Renewable Energy Alaska Project (REAP). *State and Federal Programs.* Retrieved from http://alaskarenewableenergy.org/energy-efficiency/energy-efficiency-resources/.

96 For more about the Alaska Energy Efficiency Partnership, see http://www.akenergyefficiency.org/.

97 CCHRC. (2012). *Energy Efficiency Policy Recommendations for Alaska.* Report for AEA. Retrieved from http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf.

98 AHFC. *Energy Efficiency Revolving Loan Fund (AEERLP) for Public Facilities.* Retrieved from https://www.ahfc.us/efficiency/energy-programs/energy-efficiency-revolving-loan-fund-aeerlp/.

99 Ibid. Starting in 2005, 51 villages received funding support from the Denali Commission. Between 2010 and 2012, 21 villages received support through ARRA funding.

100 There appears (as of September 2015) to be no current funding for this program. See http://www.akenergyauthority.org/Efficiency/CommercialAudit.

101 On average, Alaskans are burdened with energy costs that are higher than the rest of the nation. Annual residential energy costs in Alaska Range from approximately 50 percent higher than the national "cold"/"very cold" climate average in the CIRI ANCSA region to nearly four times as high in the Doyon region. When viewed on a per-square-foot basis, some areas of Alaska stand out even more for their high energy costs. In the NANA region, average households spend $9.15 per square foot annually for home energy, which is more than nine times higher than the $0.97-per-square-foot national cold climate average." As noted in the comprehensive report from the AHFC, *2014 Alaska Housing Finance Assessment,* retrieved from https://www.ahfc.us/efficiency/research-information-center/housing-assessment/.

102 Goldsmith el al, 2012.

103 However, training centers in construction trades may contribute to the challenge for new home construction. Houses built in technical centers are reported to be designed using methods that are now decades old. Personal communication with former building auditor in Bethel, Alaska, May 2015.

104 Lees, E. (2012). *Best Practices in Designing and Implementing Energy Efficiency Obligation Schemes,* Executive Summary. Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6477.

105 American Council for an Energy-Efficient Economy (ACEEE), 2014; Consortium for Energy Efficiency (CEE), 2014.

106 ACEEE, *2014 State Scorecard.*

107 AHFC, *2014 Alaska Housing Finance Assessment.*

108 ACEEE, *2014 State Scorecard.*

109 Wasserman, N., and Neme, C. (2012, October. *Policies to Achieve Greater Energy Efficiency.* Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6161.

110 ACEEE, *2014 State Scorecard;* see also AS.34.70.101.

111 AEA, 2012.

112 For information on ESCOs, see Stuart, E., Goldman, C., Larsen, P., and Gilligan, D. (2014). *The U.S. ESCO Industry: Recent Trends, Current Size and Remaining Market Potential.* Retrieved from http://aceee.org/files/proceedings/2014/data/papers/3-319.pdf.

113 See *Renewable Energy Atlas of Alaska,* retrieved from http://alaskarenewableenergy.org/wp-content/uploads/2009/04/2013-RE-Atlas-of-Alaska-FINAL.pdf.

114 Neme and Wasserman, 2012.

115 AEA. (2015, March). *Statistical Report of Power Cost Equalization Program, Fiscal Year 2014.* For fiscal year 2014, 391.5 GWhs were produced by utilities from diesel generation. Other sources provided 50.5 GWhs of utility generation.

Purchased power was 55.1 GWhs.

116 Line losses are inversely tied to distance, and so will increase for some for the more rural and dispersed areas.

117 See Appendix A, "System Efficiency"; and Alaska Center for Energy and Power (ACEP). Alaska Energy Wiki. Retrieved from http://energy-alaska.com/.

118 Effective maintenance is also a key factor, and many larger cooperative systems that maintain their systems to manufacturing specifications typically have more effective operating systems and better efficiencies.

119 ACEP, Alaska Energy Wiki.

120 ACEP reports that tighter control over the fuel systems has boosted the usable kWh per gallon of diesel. Efficiency improvements of 10–15 percent over the older engines have been achieved in over 25 rural powerhouses upgraded by AEA. http://energy-alaska.wikidot.com/diesel.

121 ACEP, Alaska Energy Wiki.

122 30 of the 43 community systems that reported line loss data from AVEC had line loss levels below 5%. AEA, Power Cost Equalization Statistical Report for Communities, March 2015, available at http://www.akenergyauthority.org/Programs/PCE

123 AEA has supported the development of more than 34 heat recovery systems since 2004. As of fall 2014, more than 30 Prefeasibility Studies were completed and 10 were in development. 18 projects were in design or under construction. See: http://www.akruralenergy.org/2014/An_Overview_of_Heat_Recovery_in_Alaska-Devany_Plentovich.pdf.

124 As of June 2015, it had completed 75 projects and had 28 more underway.

125 AEA conducts pre-feasibility studies for potential heating projects and provides technical support for project development with funding from the Alaska Native Tribal Health Consortium, Washington State University, and US Department of Energy.

126 Specifically, the Four Dam Pool utilities: Kodiak, Port Lions, Valdez, Petersburg, Wrangell and Ketchikan. See Fay, G., and Melendez, A. (2012, March). *All-Alaska Rate Electric Power Pricing Structure.* Technical Report to the Alaska Senate Finance Committee, p. 19. Retrieved from http://www.iser.uaa.alaska.edu/Publications/2012_03_14-All_AK_Rate.pdf.

127 Drolet, J. (2014, September 25). *Power Cost Equalization: AEA Perspective, Alaska Rural Energy Conference* [presentation], slide 4. Retrieved from http://www.akruralenergy.org/2014/PCE-AEA's_Perspective-Jed_Drolet.pdf.

128 The Alaska Legislature articulated the roles for the RCA and AEA under Alaska Statutes 42.45.100-180.

129 Drolet, 2014, slide 7.

130 Ibid. Seven percent of the PCE Endowment Fund's three-year monthly average market value may be appropriated to the PCE Rural Electric Capitalization Fund for annual PCE program costs.

131 The RCA also imposes a line-loss standard of 12 percent on utility systems receiving PCE support. If the standard is not met, then a utility's fuel expense is calculated as if it had met the standard. This establishes a number for how much fuel would have been used or how many kWh of electricity would have been sold if the utility met the standard. It also encourages utilities with line-loss rates that are higher than 12 percent to become more efficient by reducing their line losses. See Cox and Knudsen-Latta, Power Cost Equalization Basics.

132 E.g., water and sewer facilities.

133 AS 42.45.130. Cost Minimization.

134 The AEA reports that as of June 30, 2014, the PCE Endowment Fund balance was $977,867,367. AEA. (2014, July 29). *Power Cost Equalization Program Guide,* p. 2. Retrieved from http://www.akenergyauthority.org/Content/Programs/PCE/Documents/PCEProgramGuideJuly292014EDITS.pdf.

135 *Alaska Dispatch News.* (2015, January 8). Gov. Bill Walker: The hard truth about Alaska's oil revenue. Retrieved from. http://www.adn.com/article/20150108/gov-bill-walker-hard-truth-about-alaskas-oil-revenue. The revenue problem is further exacerbated by the State's agreement to offer tax credits to oil and gas companies to encourage their investment. Factoring in the tax credits due to the oil companies, Alaska's production tax is expected to generate negative returns to the state.

136 Drolet, 2014, slide 20: The "AEA has opened a file with the Department of Law to begin a second round of PCE regulations changes."

137 AEA is seeking further clarification of community facility requirements, including periodic eligibility recertification, and proration of community facility credits. It is also considering the topic of voluntary assignment of PCE benefits.

138 AS 42.45.100. Power Cost Equalization and Rural Electric Capitalization Fund. Retrieved from Alaska Legal Resources Center, http://www.touchngo.com/lglcntr/akstats/statutes/title42/chapter45/section100.htm.

139 AS 42.45.180 (a): "[W]here a utility has otherwise secured financing from sources other than the power cost equalization and rural electric capitalization fund."

140 AS 42.45.180 (a): Grants For Utility Improvements.

141 AS 42.45.180.3.

142 For example, see Kohler, M. (2010). *Renewable Energy,*

Efficiency, and Power Cost Equalization. Retrieved from http://avec.org/wp-content/uploads/2015/04/2011-01-Back-Page-Renewable-Energy-Efficiency-PCE.pdf.

143 Reference to this was made in the Aleutians and Pribilof Island Draft Regional Energy Plan. AEA, 2013, p. 3.

144 Structured in this way, it functions much like the US DOE State Energy Program (SEP), for which Congress annually appropriates a base amount and an additional competitive allocation.

145 AS 42.45.180 (a): Grants For Utility Improvements.

146 3 AAC 107.240. Reporting and Recordkeeping Requirements.

147 While planning efforts have become a significant part of community engagement in some regions, they should become part of effective utility engagement in every community that faces challenges with costs. (See Appendix A, "Planning.")

148 AS 42.05.711 and 42.05.712. Retrieved from http://www.legis.state.ak.us/basis/statutes.asp#42.05.711.

149 AS 42.45.130. Cost Minimization.

150 Ibid.

151 See AEA. *Overview of EETF Awards.* Retrieved from http://www.akenergyauthority.org/Content/Programs/EETF/Documents/EETFOverviewAwards021815.pdf.

152 In 2010, through House Bill 306, Alaska established goals to produce 50 percent of the state's electricity from renewable resources by 2025 and reduce energy use 15 percent per capita by 2020. AEA, 2013.

153 AEA Renewable Energy Atlas, 2013. Retrieved from http://www.akenergyauthority.org/Content/Publications/2013RenewableEnergyAtlasOfAlaska.pdf.

154 For more, see Kodiak Electric's website: http://www.kodiakelectric.com/energy.html.

155 LBNL, 2014 Wind Markets Report.

156 Alaska Independent Power Producers Association, peer review communication, December 31, 2015.

157 Ibid.

158 U.S. EIA.

159 But other communities such as those served by the Chaninik Wind Group in the southwest and some island communities with good wind resources (i.e., Saint Paul and Kodiak) are already moving forward to address the integration challenges of high levels or renewables in small communities.

III. Recommendations

The state of Alaska's emerging fiscal challenges are forcing a shift away from the current model of assistance to rural communities, which centers on grant capital delivered by the state and federal government. Tighter budgets will likely force support to be more focused when it is offered; when it is not, communities will need to leverage other sources of capital and assistance. Given the emergence of new categories of energy resources, enabled in part by advances in communications and technologies and the successful efforts to demonstrate and commercialize alternatives, the ability to expand electricity fuel sources beyond diesel is increasingly within reach. State and federal agencies and their strategic partners will likely serve as stewards of a new or emerging environment, one that places communities in a position of greater self-determination.

How will this shift take place? In fact, it has already begun. As state and federal program funds shrink, alternative sources of investment must replace them. The recommended path forward includes modifications to existing support, a shift in the role of government agencies, greater emphasis on cost-effectiveness and value, efforts to encourage closer cooperation among rural communities, finding new ways to empower utility managers and community leaders, and bolstering a sense of accountability in those most responsible for the utility system. The pace at which reforms are needed is an open question. Ideally, the transition should provide a reasonable path forward that communities can navigate smoothly, with clear expectations established for the future as the emerging realities unfold.

A list of more specific recommendations is provided below. The list includes 14 interrelated topics distilled from the analysis and options covered in Section II. The topics are grouped into four broad categories: (1) regional strategies to foster scale, (2) improvements to operations and planning, (3) strengthening incentives and accountability, and (4) strategies to strengthen innovation in service delivery.

In summary, we recommend the following:

Regionalization

1. **Strengthen Regional Institutions to Realize Scale**
2. **Institutionalize and Implement Regional Plans at the Community Level**

Operations/Planning

3. **Strengthen Capital Planning and Prudent Ratepayer Investment**
4. **Improve Access to Low-Cost Capital for Rural Utilities**
5. **Strengthen Investment in Workforce Development and Training**
6. **Strengthen Investment in Power System Efficiency**

Accountability/Incentives

7. **Establish Customer-Focused Standards of Service, Performance, and Accountability**
8. **Align Incentives with Performance Outcomes and Policy Objectives**
9. **Align Power Cost Equalization Formula Design with State Policy Objectives**

Fostering Innovation in Energy Delivery

10. **Strengthen Energy-Related Communications in Rural Communities**
11. **Accelerate Testing and Adoption of Emerging Technologies**
12. **Strengthen Delivery Through Third-Party Service Providers and Independent Power**
13. **Strengthen Commitment to Energy Efficiency**
14. **Enhance the Role for Cost-Effective Renewable Energy**

The larger categories serve to functionally organize our discussion. In terms of priority, however, we would highlight the recommendations below in particular:

No. 1, Strengthen Regional Institutions to Achieve Scale: *Regional institution building and cooperation* is needed to achieve scale while preserving the local control and capturing inherent regional opportunities for better service at lower costs.

No. 5, Strengthen Investment in Workforce Development and Training: *Increased workforce capacity,* especially among utility and community leaders, is needed to improve the collective ability to adopt new approaches to investment and management of utility systems.

No. 7 and No. 8, Improve Accountability and Align Financial Incentives: *Stronger accountability* will ensure that that focus of the utility and community leaders alike is properly placed on the standard of service received by utility customers. *Aligning incentives* ensures that when communities receive financial support, their incentives are relevant, understood, and inform choices made by consumers and community leaders in a manner that effectively serves consumer, community, and state objectives.

No. 12, Increase the Role for Independent Power Producers and Other Third-Party Service Providers: IPPs and third parties create opportunities to more rapidly harness and accelerate the adoption of innovation and new technologies, while increasing access to new sources of capital.

Further details of these recommendations, along with likely institutions that would implement them and the role that the DOE's Office of Indian Energy would play, are described below. The authors acknowledge that many of the recommendations here require funding during a period of tighter budgets, and that the discussion of proposed steps for state agencies (especially AEA and AHFC) and their strategic partners (see Glossary for a definition of this role) is high-level. We address these issues at the end of Section III.

Regionalization

Strengthen Regional Institutions to Realize Scale

Many rural utility systems are struggling in Alaska today. The challenge is most apparent among the smaller independent communities that lie beyond the electrical intertie spanning between Fairbanks and Anchorage. Even those that are working well often seem to do so by virtue of the talents and commitment of a few individuals or champions within the community, raising fundamental questions of sustainability. Over time, these communities will benefit from finding ways to band together to bolster standards of service and costs that sustainably serve community interests.

Many of the communities visited by the research team share a strong interest in local control that is consistent with Alaska native values of self-reliance. Beyond that, there are also strong signs of community interest in working more closely with regional organizations and neighbors who share common cultural identities, circumstances, and local resource potential. Close working relationships have emerged in some regions between interconnected communities, regional corporations that serve the communities, and utilities that exist in local hubs. These realities, bolstered by modern technology and communications, indicate the potential for better serving remote communities through regional cooperation, either formal or otherwise.

We recommend that independent utilities come together to foster scale to better address customer and community needs. Specific recommendations include the following:

- Online platforms or portals should be established to provide effective communications between neighboring systems and dedicated to collaboration among utility managers and staff. One goal would be to foster exchanges about successful experiences with third-party service providers.
- Alaska's rural utilities should work with regional organizations like economic development corporations, boroughs, and tribal corporations to increase access to capital, and realize scale and efficiency in bulk fuel and material purchases.
- Remote independent rural utilities should work to strengthen ties with regional hub utilities in order to formalize partnerships or ownership arrangements that capture efficiencies from scale.
- Alaska's rural utilities should explore options for joining an existing cooperative or organizing under

a regional corporation or cooperative, and achieving sufficient size to allow for workforce specialization and scale in purchasing.

Ideally, scale would be achieved through the establishment of or participation in organizations that have the legal standing necessary to create management efficiencies, allow some degree of labor specialization, and engage in contracts for purchases and services on behalf of members. Scale is only a means to an end. The objective here is reliable, high-quality service at affordable prices. However, communities that fail to take steps to deliver reasonable quality service should be held accountable to either the community or state. This is best achieved through mechanisms that educate, advise, inform, and broadly empower the utility managers and utility leaders, but may require more deliberate approaches if inadequate service persists. One approach offered would be to establish a provider of last resort option for communities that are unable (for reasons of size, remoteness, or distress) to foster effective regional partnerships.

DOE and its partners can help to foster closer cooperation through regional meetings and events designed to move communities closer on energy issues. This effort has already begun with the work of AEA, and some early efforts of boroughs and native corporations to foster the same through regional energy plans.

Institutionalize and Implement Regional Plans at the Community Level

Following on the concept of regional cooperation, regional planning is perhaps the first logical step toward community development of alternatives to diesel generation. The state of Alaska has made a significant commitment to rural communities by facilitating regional conversations about their energy future. Regional planning efforts appear to be particularly constructive when they build on historic and cultural connections or common challenges of climate and soil, with likely solutions that can be fostered through in-region intercommunity conversations. The challenge will be to implement the solutions identified and to institutionalize the planning efforts. We recommend the following:

- Community leaders and utility managers should build on the successes of the regional planning efforts to incorporate elements relevant to their community in their own capital plans.
- Boroughs and regional government organizations should help to ensure that the regional planning efforts initiated in recent years by the Northwest Arctic Borough, and current work by AEA with the region's governmental organizations, become an ongoing effort to foster regional cooperation and collaboration around resource options available to each region.

We recommend that state, regional organizations, and the DOE help to ensure that the value created by the effort of AEA, regional organizations, and government entities is captured in utility and community planning efforts for future implementation.

DOE's START program provides a firm foundation for work at the community level to implement regional energy plans.

Operations/Planning

Strengthen Capital Planning and Prudent Ratepayer Investment

Many rural communities are reluctant to invest ratepayer capital to benefit those ratepayers and the community. In an environment in which grant capital is widely available, this potentially represents sound practice. However, over time utility managers will need to invest in their systems as if they were business enterprises, regardless of the source of capital. Further, communities and utilities need to maintain financial health and creditworthiness to enable funds to be borrowed once the need becomes apparent. This is largely an issue related to capacity-building among management and community leaders, on which we have already recommended a greater emphasis. There is also a role for incentives and some form of effective oversight.

- Rural utilities should always establish capital plans that recognize the need for steady investment in plant and facilities independent of the availability of grant capital.
- Rural utilities should adhere to capital plans by investing in needed plant improvements with ratepayer capital even when grant capital is scarce.

Rural communities and their utilities will need to take the lead in developing capital plans that reflect the character of the timely investments necessary to support the system for best performance, whether sourced from grants or ratepayer funds. Prudent capital planning is needed to help move away from the boom-or-bust approach of the past, which made more sense when system infrastructure was being built with large, one-off capital grants. The DOE, AEA, Denali Commission, and their partners already play a constructive role in requiring training and planning in conjunction with grant awards. More capacity-building—i.e., training local officials and utility staff to make and execute capital plans and effectively maintain systems distinct from grant awards—may be needed to ensure an effective transition.

Improve Access to Low-Cost Capital for Rural Utilities

Independent rural utilities will need to increase their reliance on ratepayer-funded capital. Traditional grant funders, including state and federal government agencies, can help by offering innovative tools to improve access to capital. These might include establishing a "one-stop shop" Web portal or other technical support, offering low-cost loans with public capital, and securitizing available capital from private lenders to ensure the repayment of otherwise high-risk loans.

In order to improve rural utility investment practices and access to capital, it is recommended that the state of Alaska:

- Continue to use state funds to support capital improvements in rural utilities, while continuing to prioritize the investments that provide the greatest long-range returns, and commit capital in ways that extends its reach to more communities.
- Create online tools and technical assistance to aid communities that are interested in pursuing capital from grants or loans.
- Base award of grants and public loans on project feasibility, technical merit, and economic potential to ensure that the reach of available capital goes as far as possible. Capital grants and loans should be made by trained staff rather than through legislative award to help ensure that the capital is directed where it is most needed.
- Recognize that capital commitments are long-term and, as such, power plant upgrades should include control systems and other capabilities that ensure better and easier integration with renewable energy sources.
- Continue efforts to coordinate project planning among state, community, and federal partners. Over time, more communities should take the lead with respect to capital planning and seek sources from lending institutions or grantors to reflect community needs and priorities.
- Prioritize grants to communities that demonstrate effective routine capital planning, combined with professional management and maintenance of facilities.
- Move increasingly from a role of grantor to lender to extend rural utility access to low-cost capital.
- Leverage private capital and outside sources of capital by providing financial assurance (securitization) for loans.
- Encourage the aggregation of loans through appropriate instruments like the municipal bond bank or regional organizations able to carry credit ratings.
- Foster the development of low-cost alternative power from new sources, such as independent producers, to reduce the pressure on communities to rely on ratepayer capital (see "Strengthen Delivery Through Third-Party Service Providers).

As the entity that administers most grant capital to rural utilities, AEA will need to spearhead any reforms related to future capitalization by adjusting its working model accordingly. DOE and strategic partners can help to identify appropriate models from other jurisdictions that may be relevant to efforts aimed at creating lending instruments that combine public backing and otherwise private loans.

Strengthen Investment in Workforce Development and Training

The challenges that small community utilities face are often tied to fundamental issues related to human resource capacity. The AEA, Alaska Department of Commerce, Community, and Economic Development (DCCED), and U.S. DOE should continue to provide the numerous sound training and technical assistance opportunities they have developed, including courses, materials, and outreach to Alaskans in support of their energy projects and infrastructure. For example, strengthening and expanding skills training for powerhouse operators is an important next step. It should also be noted that state and community commitments will need to extend training well beyond technical staff. In many of the small communities visited for this study, no residents had the training needed to successfully serve as utility managers and bookkeepers. Further, to the extent that community leaders have a role in utility operations, rate-setting, and approval of capital plans and investments, it is critically important that they receive similar training. Effective capital planning and sound investment of ratepayer funds to reduce the cost of service is essential to prudent utility management to serve customers in the community. Individuals responsible for governance of the utility and the approval of loans and rates need adequate training to appreciate the value of these commitments to their ratepayers and the community. With respect to traditional technical staff, we recommend the following:

- The state should build on the successes of the current powerhouse operators' training by investing in more courses to enable better integration of renewables with advanced diesel systems.
- The state should expand opportunities for training bookkeepers and utility managers to better understand the standards of cost recovery that are allowable under the PCE program, and steps that utilities can take to include all prudent costs that are appropriately recovered in rates. Training here would ideally include oversight or involvement of appropriate staff at the RCA and AEA.

The body of this report examines many specific programs and efforts to strengthen human resource capacity. We recommend an emphasis on utility managers and community leaders, potentially modeled on the Rural Utility Business Advisers (RUBA) program. Another valuable training program focused on tribal administrators, utility managers, and municipal managers is the Alaska Rural Managers Initiative (ARMI) that is being led by the Denali Commission and a consortium of educators. ARMI is comprised of a group of statewide educators, rural manager employers, and other stakeholders who understand the educational needs of rural managers. The ARMI goal is to facilitate discussions of how to meet those needs accessibly for managers living in rural communities.

Access to training could be increased by further supporting regional training centers in larger hub communities. We also recommend formalizing effective peer-to-peer relationships, and sharing of experiences between communities. Strengthening relationships here may also foster over time more opportunities for realizing scale covered in our first two recommendations.

Human resource commitments extend well beyond the issue of operator training. Some communities simply fail to adequately pay their workers and thus have a hard time keeping people in these demanding positions, or the rates charged fail to capture the full cost of service and the managers do not have the training needed to confidently correct the situation.

AEA is appropriately in the center of power system training needs. Expanding programs and efforts around human resource development will require additional funding from general funds or grant assistance from partners. The DOE and strategic partners could potentially play a role in fostering the development of peer-to-peer relationships between rural communities. DOE should work to develop, either internally or with partners, the needed training beyond what is already provided to power system and bulk fuel operators.

Strengthen Investment in Power System Efficiency

AEA's Rural Power System Upgrade and Heat Recovery programs appear to offer some of the most cost-effective investments possible in the state's power systems. As mentioned, improvements to the powerhouse (like controls) are needed in any event to better integrate wind, solar, and run-of-river hydro as the state continues to advance renewable energy goals and communities work with the state to lower their costs of service. The day may arrive when rural Alaska utilities are able to integrate renewables without advanced diesel control systems, but that day is not yet here. Even systems in Kodiak and the Southeast, which have wind resources and an abundance of hydro storage, back that up with diesel generators. We recommend that distribution utilities and communities in rural Alaska invest more effectively in the efficiency of the existing diesel generation system where it is cost-effective to do so.

Here again, this issue is largely tied to capacity building and training. A well-managed system occasionally requires outside expert guidance on improvements to reduce the cost of operation. A casual review of PCE reports shows, for example, that there are significant opportunities to reconfigure many rural utilities' distribution systems to lower costs.

Improvements here can be small and incremental. PCE reports built from the information provided in annual reports from the communities show substantial gaps in information reported, high line losses (above ten percent), and poor conversion efficiency of diesel generation. Little information is readily available publicly (at least that is easily accessed) about power system quality, performance, and reliability. There is considerable potential for improving the efficiency of powerhouses and the distribution system. The return to communities is made all the more compelling with the standards of cost recovery applied by the RCA in its establishment of PCE rates. DOE and strategic partners can help by spotlighting opportunities, for example, throughpilot projects. We recommend that:

- Rural utilities should locate powerhouses in close proximity to community structures like clinics, schools, community centers to capture the value of the heat energy that would be otherwise lost.
- Communities should establish system improvements in their capital plans, and use ratepayer funds for investments that are cost-effective ratepayer investments even when grant capital is unavailable.
- DOE and its partners should sponsor technical studies and work with communities on pilot case studies that demonstrate and showcase the benefits of improvements to system efficiency.

Accountability/Incentives

Establish Customer-Focused Standards of Service, Performance, and Accountability

Many rural villages are currently meeting high standards of service and reliability, standards that cooperative utilities have played a major role in establishing. Yet *all* customers in the state are entitled to high standards of reliable service at affordable rates. To achieve reasonable standards of service across all rural areas, we recommend the following:

- Establish formal metrics and standards of service that focus on customer needs and that, over time, can be reasonably applied to all utilities in the state.
- Report on these metrics, which would begin with effective measures of reliability, power quality, and appropriate proxies of cost such as conversion efficiency, and line losses (the latter are already available for comparison in the PCE reports).
- Make metrics available for public review and inspection by the utility's customers, along with appropriate comparisons to similarly situated rural utility systems.
- Over time, use these metrics to form the basis of objective standards that should be met by all rural utilities.

The banding together with neighboring systems or joining larger existing systems (see earlier discussion of regionalization efforts) provides a potential path to accelerating and meeting such standards.

As the economic regulator of utilities in the state, the RCA has a potentially constructive role in helping to encourage improvements to rural utility service. Currently, however, the RCA has limited oversight over most of the small rural systems among the several hundred PCE communities that may be in greatest need of such oversight. We recommend that:

- The RCA should be given the resources to meet this challenge, and its role should be appropriately tailored to allow greater oversight of rural utilities and the establishment of appropriate benchmarks of performance in conjunction with the establishment of rates pursuant to its PCE authority.

With the importance of local control to Alaskans kept in mind, traditional forms of utility regulation can be adapted to apply a lighter hand that focuses on reporting and meeting standards of performance with measured steps to hold utilities accountable. Ultimately, all communities should be required to strengthen performance and meet reasonable service standards established by an objective representative of customer interests where it is within the state's authority to do so.

We recommend that DOE and strategic partners work with rural communities and regulators to identify appropriate metrics and standards of performance that rural utilities can achieve. Work here could also include engagement with the RCA to identify its appropriate role, as well as to determine the costs of extending appropriate oversight.

Align Incentives with Performance and Policy Objectives

Financial incentives matter in rural Alaska. This fact is reinforced by the high levels of participation in the PCE program and in pursuit of grant capital. Appropriate incentives can be established to encourage rural utilities, especially independent systems, to individually or collectively adopt the standards of service mentioned above. The goal would be to meet levels of service that are reasonably achievable by high-performing rural utility systems, like the larger cooperative utility systems.

The PCE program represents one of the few mechanisms available to positively influence the performance of rural utilities; as mentioned, the PCE formula already serves to encourage utilities to increase generation efficiency and cut down on line losses. We recommend that:

- The state should apply appropriate incentives to encourage rural utilities, especially independent systems, to move individually or collectively to the standards of service mentioned above.

- The PCE mechanism should be used to encourage better performance by rural utilities in other areas, including overall reliability and cost. As outlined above, we believe that the PCE formula can be modified in ways that encourage better customer performance, and need not be structured as a penalty for inferior performance.

Deploying such incentives successfully may require outreach, education, and stronger human resource capacity to be effective. One promising approach would be to split the PCE, creating stronger financial support for historically poor performing systems that improve.

The RCA and the AEA could play central roles in the strengthening of incentives. There is considerable room within the existing legal framework to make the changes needed to do so. DOE and strategic partners can help by sponsoring development of straw proposals with the potential cooperation and oversight of AEA and rural community partners.

Align Power Cost Equalization Formula Design with State Policy Objectives

The PCE program enjoys overwhelming support in rural communities. It contributed to the accomplishment of one of its original goals: reducing the cost of electricity in rural utilities to better align it with rates paid in the Railbelt. With appropriate modifications, however, it can do more for rural Alaska. The PCE formula should undergo revisions that better align the program's benefits with state policy and community and customer performance objectives.

One of the objectives of this revision should be to create further incentives for communities to pursue lower-cost and more sustainable local resources. We recommend that"

- The AEA and RCA should modify the formula to allow cost-effective investments in non-diesel alternatives to be reflected in lower rates for rural consumers. To the extent that legislative authority is needed, we recommend that it be sought.

The other objective should be to improve the performance of rural utilities through regulatory oversight (see "Establish Customer-Focused Standards of Service, Performance, and Accountability"). Already, the formula is structured with performance requirements that encourage lower line losses and high conversion efficiencies.

- The RCA should modify PCE filing requirements to include data responsive to relevant system performance metrics.
- The AEA should either petition the RCA to make modifications consistent with the recommendation above, or if necessary, recommend consistent language to the legislature.

We recommend that the AEA either petition the RCA for proposals to update the PCE formula and/or recommend legislative modifications to the PCE in light with the objectives outlined above.

Fostering Innovation in Energy Delivery

Strengthen Commitment to Energy Efficiency

The state already recognizes energy efficiency as "low-hanging fruit" and has established a target of 15 percent improvement in energy efficiency between 2010 and 2020. We recommend that it take further actions that implement this standard. Alaska should continue to increase its commitments to invest in energy efficiency to retrofit the existing stock of houses, government, community buildings and commercial structures in rural areas. It should implement the six policy recommendations produced in 2012 by AEA's task force, but tailored for the realities of rural communities. The recommendations include the following:

- Support existing programs, including building retrofits and weatherization.
- Apply building codes to all new buildings and retrofits.
- Provide the public with energy efficiency education, building on current efforts by AEA and AHFC.
- Require utilities to invest in all cost-effective energy efficiency.
- Establish a statewide efficiency utility to provide Alaskans with coordinated outreach, education, and technical assistance.
- Require state government to lead by example.

One of the main users of energy services in each community is the local school. The state can show leadership by ensuring that schools include all cost-effective improvements and are built to the same standard of efficiency. Regions and communities can similarly adopt high standards of thermal efficiency for government and community structures. Thermal efficiency is the main challenge for most communities. Electric utilities should work with regional housing authorities and weatherization providers such as RuralCAP to ensure that opportunities for electricity improvements are not missed. The installation of pay-as-you-go meters represents an important first step for communities to improve the behavioral aspects of energy efficiency by creating greater awareness of the connection between household use of electricity and electricity prices and the resulting bills.

In addition to implementing AEA's 2012 recommendations, we recommend that the state :

- Better coordinate and potentially consolidate the energy efficiency programs designed, delivered, and overseen by AEA and the AHFC. These agencies could create a joint program for efficiency program delivery, contracting with entities such as the Cold Climate Housing Research Center or an efficiency utility for technical assistance and outreach to rural Alaska.
- Develop for trial a public purpose energy services company (PPESCO) to enhance efficiency focused on community structures.
- Develop sustainable program funding sources that are independent of general fund appropriations, e.g., candidates include an energy efficiency charge attached to energy purchases statewide.
- Develop for trial demonstration community- and regional-based programs with obligations on distributors of energy for heat.
- Include efficient building design and construction in vocational training programs.
- Foster energy efficiency at the village level with standards focused on heating efficiency.

Strengthen Energy-Related Communications in Rural Communities

Effective communications capabilities are essential to rural communities. For energy needs, they can use SCADA to exchange data between modern powerhouses and remote monitors of systems. Remote communications can allow managers to access systems even when they are not on-site, and also enable remote billing. Strong models for effective use of rural communications exist within AVEC and are in use by AEA with modern powerhouses. When combined with appropriate technology, effective data communications can allow identification of individual customer problems and allow disconnection and reconnection. However in many remote communities, the available communication infrastructure is slow and expensive. We recommend that:

- The state and partners foster stronger communication links with remote villages, and competition among providers to ensure that services are competitively priced. This will help with data communications, but will also encourage opportunities for greater connection and cooperation between neighboring communities.

The availability of the Internet and social media open up a number of possibilities for information exchanges between rural communities, and between rural utilities and the AEA and RCA. The AEA has considered establishing some form of an online "dashboard" to allow communities to access information about their systems.

- The AEA should move forward with the dashboard concept.
- Government can provide further assistance to help villages and utilities to match grant and technical assistance opportunities with local needs.
- New avenues for information-sharing should be developed to empower utility managers and community members to better understand the quality and level of service that is achievable and being achieved both within the community and by neighboring systems.

DOE and strategic partners can assist the AEA and communities in the development of effective Internet platforms. Rural communities should reach out to funding partners to move forward the process of developing improved communications infrastructure.

Accelerate Testing and Adoption of Emerging Technologies

With respect to energy technology needs, Alaska is unique in the United States. Weather, topography, and soil conditions in remote villages require technologies that can perform well under cold and highly variable conditions over a sustained period. Innovations in this area will allow communities to diversify beyond dependence on diesel for generation and home heating. The state of Alaska and its partners can further accelerate the adoption of these innovations. Research organizations such as ACEP, with their advanced testing and simulation capabilities, offer a promising path for accelerating emerging technologies that have worked in other regions, but require assurances prior to field testing in Alaska. The Cold Climate Housing

Research Center is performing highly regarded work on energy efficiency in buildings in rural Alaska. These organizations are performing critical functions that we recommend be well funded to advance the needs of rural communities.

The Emerging Energy Technology Fund also appears to be providing a valued service by grounding in real-world experience the viability of near-commercial technologies potentially relevant to rural Alaska. Examples here include air source heat pumps, controlled loads, smart grid technologies, and testing the applicability of new forms of hydro and wind technology in cold climate conditions.

- The state should continue to provide financial support for the testing of close to commercial technologies that may be suitable for the cold and variable climate conditions in different regions of the state.

Another opportunity to accelerate the adoption of new technologies is to sponsor events that allow rural communities to share their experiences with new technologies. There is no shortage of innovation occurring in Rural Alaska. Many of the rural communities visited, particularly the larger ones, were testing the boundaries of technologies that are new to Alaska. Alaska's utilities would likely benefit from a single trade-show-style event, showcasing new technologies and experience with them, which includes both vendors and utilities.

- DOE and strategic partners should sponsor an event, or a segment of a larger event, that creates an opportunity for vendors to showcase new technologies and utility and independent power producers to share the lessons learned from new technologies in the remote Alaska settings. Potential models include the Alaska Rural Energy Conference and the Better Buildings by Design annual event in Burlington, Vermont, sponsored by the Vermont Energy Investment Corporation (VEIC).

Strengthen Delivery Through Third-Party Service Providers and Independent Power

The service-provider model is alive and well for segments of services in the state. Many communities rely on third-party engineering firms for improvements to system design, on neighboring systems for help with distribution line work, and on third parties to help with bookkeeping and accounting. The service provider community should be strengthened by outsourcing, wherever possible, regional and community-level service contracted through the state. The state already fosters community exchanges via social media about valued service provider experiences, and it can continue to do this.

- The AEA should continue to foster the market for service providers by outsourcing and using independent contractors for services provided to rural utilities. Other partners can help by encouraging information-sharing among communities.

Independent power producers provide opportunities for small rural systems to benefit from lessons learned beyond their boundaries. Independent power offers the opportunity to replicate innovations and successes for rural communities in ways that ideally leave providers with the risks of project development and with the financial burden of raising capital to develop projects. Depending on contract terms and sources of energy, independent power also offers the promise of more retail price stability.

- Communities should explore opportunities for the participation of independent power producers. Creating these opportunities likely include outreach, standard interconnection terms, and common standards across communities for price and contract terms that can be scaled across communities to attract developers.
- Incentives to encourage independent power can be incorporated into the rate recovery regime for regulated utilities and into the PCE compensation framework for other systems. However, the promise of improvements to system performance and community support for alternative sources of energy should, over time, provide some incentives.

Enhance the Role for Cost-Effective Renewable Energy

Alaska's goal is for the share of renewables in energy mix to reach 50 percent by 2025. The pathway forward for fostering the development of renewables in rural Alaska is not simple. The challenges ahead are real, but appear surmountable with the declining costs of technology, rural experience, innovation in rural Alaska, and increasing scale. Not surprisingly, rural utilities themselves, typically with significant grant capital, have generally been at the forefront of the development of wind projects in the state. A major challenge for most communities will be to effectively employ technology and loads to go "diesel-off." The is a point of strategic emphasis that will have the greatest impact on the reduction in diesel consumptions. We offer a detailed list of specific recommendations that are, in part, a response to the many issues and concerns highlighted during our travels.

There are at least four broad challenges typically associated with developing renewable energy in AK. They are: (i) identify viable renewable technologies, (ii) establish strategies for the integration of variable energy technologies like wind and solar, (iii) identify the costs and cost-effectiveness of the technologies, and (iv) address the implications for the financial health of utilities, ideally through revenue recovery.

Recommendations for each are included in the discussion that follows.

Identification of Renewable Potential

- Utilities should assess the local potential for renewables, ideally with the help of technical experts and regional planning efforts.
- Rural utilities should empower retail customers with clear rules of compensation and interconnection to allow customer participation.
- Rural utilities should foster an open-door policy for cost-effective renewables from independent power producers (those that can be integrated at costs to the system below the avoided costs) by establishing a clear policy and rules for interconnection and compensating independent power. (See discussion of IPPs in Section II-J.)

Integration

- Communities with viable renewable resource potential should incorporate improvements to the powerhouse in their capital plans.
- Communities should encourage the use of secondary loads, e.g., water and wastewater systems, through effective rate design that offers customers customer credits or a rate discount in exchange for some measure of control over loads.
- Communities should encourage load flexibility at customer locations through effective use of time-varying prices.
- Communities should include consideration of flexible storage in the form of batteries and other appropriate technologies to help with the integration challenges and assure power quality.

Costs of Renewables

- The AEA should encourage continued investment in near-commercial technologies, including renewable energy and enabling technologies for renewables.

Financial Impacts on Utilities

- Utilities should address concerns about finances by putting in place mechanisms that allow them to recover the cost of providing service regardless of how much electricity they sell.

Ongoing Funding Challenges and the Role of Strategic Partners

The authors recognize that many of the recommendations outlined above call for maintaining or even, for a time, expanding programs that require ongoing funding. This may seem contradictory in the environment of tightening state finances outlined in our Introduction. Our recommendations are made with an overarching goal of shifting from a persistent reliance on state general fund appropriations to a landscape that ultimately serves to reduce dependence on outside support. Where bridge funding is needed, there also exists a wider array of funding sources. With the understanding that state funding is key to spreading Alaska's resources fairly, we have noted areas where the state should continue to make such funding a strategic priority, such as the PCE endowment. But we have also proposed strategies that lower costs, shift the focus from grants to loans, and increase the availability of and reliance on both private and public capital that can be replenished through appropriate use of ratepayer funds.

Many of the recommendations above discuss the role of the state and its strategic partners—boroughs, native corporations, nonprofit organizations and academia, and the federal government, among others—in fairly broad terms. The authors expect that this will serve as a jumping-off point for these stakeholders, allowing them to fill in the details of how they will work together to ensure that investment in Alaska's rural utilities becomes more strategic, more resilient, and less reliant on any one source of funding.

Glossary

Ancillary services: Services that ensure reliability and support the distribution of electricity from generation sites to customer loads.

Alaska Energy Authority (AEA): an independent corporation of the state of Alaska and the state's energy office. See http://www.akenergyauthority.org/.

Alaska Vocational Technical Center (AVTEC): The vocational training program located in Seward. That program offers training for power plant operators for many rural communities. The Power Plant Operator I course "provides the basic introduction into the construction, operation and routine maintenance of diesel engines, lubrication systems, cooling systems, fuel systems, and basic power plant operating and maintenance procedures. The Power Plant Operator II course provides "training on the more advanced preventive maintenance, service, and operating procedures for three phase generators including diesel fuel injection systems, industrial controls, and switchgear."

Barrel (bbl.): A unit of volume equal to 42 U.S. gallons.

Buy-all sell-all: An arrangement in which the utility purchases all customer-provided electricity (not net of consumption) at a set wholesale price and then sells it at a higher retail rate. The practice typically requires separate meters on the energy purchased from the retail electricity provided to the end user.

Capital cost: The cost of field development, plant construction, and the equipment required for operations.

Combined heat and power (CHP) plant: A plant designed to produce both heat and electricity from a single heat source.

Commercial sector: An energy-consuming sector that consists of service-providing facilities and equipment of businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups.

Cooperative electric utility: An electric utility legally established to be owned by and operated for the benefit of those using its service. The utility company will generate, transmit, and/or distribute supplies of electric energy to a specified area not being serviced by another utility. Such ventures are generally exempt from Federal income tax laws.

Consumer (energy): Any individually metered dwelling, building, establishment, or location.

Cost-of-service regulation: A traditional electric utility regulation under which a utility is allowed to set rates based on the cost of providing service to customers and the right to earn a limited profit.

Denali Commission: Established by Congress in 1998, the commission is an independent federal agency designed to provide critical utilities, infrastructure, and economic support throughout Alaska. With the creation of the Denali Commission, Congress acknowledged the need for increased inter-agency cooperation and focus on Alaska's remote communities.

Diesel fuel: A fuel composed of distillates obtained in petroleum refining operation or blends of such distillates with residual oil used in motor vehicles. The boiling point and specific gravity are higher for diesel fuels than for gasoline.

Distribution system: The portion of the transmission and facilities of an electric system that is dedicated to delivering electric energy to an end-user.

Distributed resources: Resources like rooftop solar, storage capability, and loads that can be used or controlled by the local utility or end-use customers to provide electricity, or help maintain system quality and reliable service.

Electricity: A form of energy characterized by the presence and motion of elementary charged particles generated by friction, induction, or chemical change.

Electric plant or power house: A facility containing prime movers, electric generators, and auxiliary equipment for converting mechanical energy into electric energy.

Electric utility: A corporation, person, agency, authority, or other legal entity or instrumentality aligned with distribution facilities for delivery of electric energy for use primarily by the public. Included are investor-owned electric utilities, municipal and rural electric cooperatives.

Energy efficiency: A ratio of service provided to energy input (e.g., lumens to watts in the case of light bulbs). Services provided can include buildings-sector end uses such as lighting, refrigeration, and heating: industrial processes; or vehicle transportation. Unlike conservation, which involves some reduction of service, energy efficiency provides energy reductions without sacrifice of service.

Fuel expenses: Costs that include the fuel used in the production of electricity.

Furnished without payment (power): The amount of electricity furnished by the electric utility without charge, such as a municipality under a franchise agreement or for public street and highway lighting. It does not include energy consumed by the utility.

Generation: The process of producing electric energy by transforming other forms of energy; also, the amount of electric energy produced, expressed in kWh.

Geothermal energy: Hot water or steam extracted from geothermal reservoirs in the earth's crust. Water or steam extracted from geothermal reservoirs can be used for geothermal heat pumps, water heating, or electricity generation.

Grid: The layout of an electrical distribution system.

Gross generation: The total amount of electric energy produced by generating units and measured at the generating terminal in kilowatt-hours (kWh) or megawatt-hours (MWh).

Heating degree days (HDD): A measure of how cold a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit.

Hydroelectric power: The use of flowing water to produce electrical energy.

Installed capacity: The maximum theoretical production output of a plant, based either on nameplate capacity or actual (practically power from the electric system.

Megawatt (MW): One million watts of electricity *(see Watt)*.

Meter data management system (MDMS): Provides long-term data storage and management for the large quantities of data delivered by smart metering systems to utility operators.

Native corporations: The Alaska Native Regional Corporations (Alaska Native Corporations, Native Corporations, or ANCSA Corporations) were established in 1971 with the passage of the Alaska Native Claims Settlement Act (ANCSA). The Act settled land and financial claims made by the Alaska Natives and provided for the establishment of 12, and later 13, regional corporations to administer those claims.

Net generation: The amount of gross generation not including the electrical energy consumed at the generating station(s) for station service or auxiliaries. Note: Electricity required for pumping at pumped-storage plants is regarded as electricity for station service and is deducted from gross generation.

O&M: Operations and maintenance.

Peak: The amount of electricity required to meet customer demand at its highest. The summer peak period begins June 1 and ends September 30, and the winter peak period begins December 1 and ends March 31.

Plant: A term commonly used either as a synonym for an industrial establishment or a generating facility or to refer to a particular process within an establishment.

Power: The rate of producing, transferring, or using energy that is capable of doing work, most commonly associated with electricity. Power is measured in watts and often expressed in kilowatts (kW) or megawatts (MW).

Power Cost Equalization Program (PCE): Program administered by the Alaska Energy Authority under which participating utilities receive state funding to reduce the charge to consumers in rural areas, where prices can be three to five times higher than prices in urban areas.

Public purpose energy service company (PPESCO): An energy service company focused on public-purpose buildings in the affordable housing, education, health care, and municipal government markets. PPESCOs help owners make major energy improvements to their buildings—at very low financial risk, and with no up-front cost.

Railbelt: The portion of Alaska that is near the Alaska Railroad, generally including Fairbanks, Anchorage, the communities between these two cities, and the Kenai Peninsula.

Regulation: The governmental function of controlling or directing economic entities through the process of rulemaking and adjudication.

Regulatory Commission of Alaska (RCA): The authority in the state of Alaska charged with regulatory oversight of distribution utilities that provide electricity, and the entity responsible for setting the level of price supports under the PCE program.

Renewable Energy Fund (REF): Program established by the Alaska State Legislature and administered by the Alaska Energy Authority to competitively award grants to qualified applicants for renewable energy projects.

Residential sector: An energy-consuming sector that consists of living quarters for private households. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a variety of other appliances. The residential sector excludes institutional living quarters.

Revenue (electricity): The total amount of money received by an entity from sales of its products and/or services; gains from the sales or exchanges of assets, interest, and dividends earned on investments; and other increases in the owner's equity, except those arising from capital adjustments.

Rural Utilities Service (RUS): An agency under the Department of Agriculture, the RUS administers programs that provide infrastructure improvements to rural communities. These include electric power and telecommunications services.

SCADA (Supervisory Control and Data Acquisition): A system operating with coded signals over communication channels so as to provide control of remote equipment.

Secondary load: A flexible load that can be served with electricity at any number of times during the day when cheap electricity is available, rather than being dictated by the time of use.

Space heating: The use of energy to generate heat for warmth in housing units using space-heating equipment. It does not include the use of energy to operate appliances (such as lights, televisions, and refrigerators) that give off heat as a byproduct.

U.S. Department of Energy (DOE): Federal department that oversees programs, such as Wind Powering America, with the mission to advance national, economic, and energy security; promote innovation; and ensure environmental responsibility. See http://www.energy.gov/.

Unrestricted General Fund revenues: Pertains to the roughly $2.2 billion in revenues received by the state that pays for most of state government and that is not restricted by law or customer. See http://www.iser.uaa.alaska.edu/Publications/presentations/2015_08_04-IntroToAKFiscalFactsAndChoices.pdf.

Appendix

Attributes of the Tier System

	Underperforming Systems Tier IV		Basic Systems Tier III		Advanced Diesel Systems Tier II		Leading and Innovating Systems Tier I	
	Attributes	**Goals for System Improvement**	**Attributes**	**Goals for System Improvement**	**Attributes**	**Goals for System Improvement**	**Attributes**	**Goals for System Improvement**
Reliability	• Semi-annual major system outage with implications for community health and safety. • Inadequate vegetative maintenance where relevant.	• Upgrade and/ or rebuild aging facilities. • Maintain facilities to manufacturer specifications. • Where applicable – implement plan for vegetative management. • Establish distribution response plan (equipment, service contract, personnel). • Upgrade and modernize fuel storage facilities.	• Annual major system outage with implications for community health and safety. • No major power outages in recent years due to inadequate maintenance. • Stand-alone systems with little ability to realize scale economies from management and operations. • Aging or vulnerable storage facilities.	• Generators maintained to manufacturer specifications. • Fund and implement vegetative management practices.	• No system outage due to inadequate maintenance. • Major outages due to major weather events. • Good practices around vegetative management.	• Continued progress on reliability under changing system conditions associated with increasing share of renewable generation.	• Highest levels of plant reliability and distribution system reliability. • No system outage due to inadequate maintenance.	• Continued progress on reliability under changing system conditions associated with increasing share of renewable generation. • Achieve diesel-off conditions for increasing periods of time using advanced integration systems, battery and thermal sinks for loads, and other innovative technologies appropriate to the task.

	Underperforming Systems Tier IV		Basic Systems Tier III		Advanced Diesel Systems Tier II		Leading and Innovating Systems Tier I	
	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement
Planning: Capital & Strategic	• Little capital or strategic planning at the community level beyond response to immediate system capital requirements.	• Engagement in community and regional level planning. • Capital: e.g., application for grants. • Strategic: e.g., Resource planning with iterative vision for long-term goals.	• Reactive and opportunistic; focus on grant funding. • Inadequate consideration of distribution system losses. • Little consideration to partnership opportunities with neighboring systems. • Some consideration of alternatives to diesel generation.	• Engagement in community and regional level planning. • Capital: e.g., seek consulting resources to review and help implement plan for improvements to distribution plant; application for grants. • Strategic: e.g., create long-range resource plans for generator replacement, refurbishment.	• Opportunistic. • High levels of coordination between communities or through central management. • Intercommunity interties. • Power plant upgrades.	• Planning efforts to explore locally-sourced alternatives to diesel. • Establish rigor in business resource decisions based on technically feasible solutions that compete well with alternatives. • Consideration given to reducing exposure to volatile prices associated with heavy dependence on diesel generation.	• Opportunistic. • Utility possesses a vision for the future based on coordinated planning efforts between community and utility. • Community and utility have set goals for reduction in reliance on diesel generation. • Community and/or utility have engaged in long-term planning to consider economic alternatives to diesel generation. • Advanced distribution system planning with low line losses and consideration given to undergrounding where appropriate.	• Whole-system planning. • Expanding operational control of both demand-side and supply-side solutions.

	Underperforming Systems Tier IV		Basic Systems Tier III		Advanced Diesel Systems Tier II		Leading and Innovating Systems Tier I	
	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement
Management	• Absence of basic management practices for pricing, bookkeeping, and planning. • Communities unable or unwilling to participate in state assistance, grant or subsidy programs (e.g. PCE). • High levels of customer non-payment & arrearages. • Incomplete records, shortage of personnel. • Operations, maintenance, planning and billing challenges. • Little financial separation between utility and community and tribe.	• Engagement in intercommunity coordination related to planning, purchasing, interconnection, and systems support. • Standardized bookkeeping, recordkeeping, and reporting. • Improved grant-writing capabilities.	• Professionally trained bookkeeper; adequate financial record-keeping, and reasonable levels of customer payment. • Grant-writing capabilities. • Utility financial accounts distinct from community accounts. • Some intercommunity coordination on planning, purchasing, interconnection, and/or systems support. • Limited or poorly performing renewable energy systems.	• Improved management skills. • Improved and maintained creditworthiness • Improved levels of bookkeeping, record keeping, adequate financial record-keeping, and customer payment.	• Well-formed and documented plant management procedures and records. • Evidence of overcoming challenges associated with distance and scale in, e.g., purchasing, management, operations, and planning practices.	• Further engagement in regional planning processes. • Ongoing professional management training. • Staff specialization.	• Well-trained management professionals maintaining the operational and financial performance of the system while performing as innovators. • Demonstrating innovation in deployment of renewable resources. • Well-formed and documented procedures and records of plant management.	• Exploring commercial opportunities beyond own franchise system boundaries. • Provide leadership beyond individual organizations.

<table>
<tr><th rowspan="2"></th><th colspan="2">Underperforming Systems
Tier IV</th><th colspan="2">Basic Systems
Tier III</th><th colspan="2">Advanced Diesel Systems
Tier II</th><th colspan="2">Leading and Innovating Systems
Tier I</th></tr>
<tr><th>Attributes</th><th>Goals for System Improvement</th><th>Attributes</th><th>Goals for System Improvement</th><th>Attributes</th><th>Goals for System Improvement</th><th>Attributes</th><th>Goals for System Improvement</th></tr>
<tr><td>Workforce Development</td>
<td>• High staff turnover.
• Staff typically trained informally “on the job.”
• Difficulty in securing relevant staff training.</td>
<td>• Reduce turnover.
• Improve access to training.
• Provide adequate employee coverage for outages and time for training.
• Review compensation arrangements.</td>
<td>• Staff formally trained in key technical areas, e.g., power plant operation.
• Organized “on-the-job” training.
• Limited staff turnover. Underperform-ing renewable energy systems due to challeng-es related to limited training.</td>
<td>• Recruit or retain capacity to apply for and win grants.
• Establish plan for expanding staff training.
• Promote staff expertise through third-party developers and the state.
• Improve training for senior managers.</td>
<td>• Some staff specialization.
• Possess capacity to apply for and win grants.
• Plan/policy for staff training.
• Regular reliance on staff training by third parties and state.
• Regular senior management training.</td>
<td>• Plan and implantation of training for staff and senior management.
• Cooperation with neighboring systems.</td>
<td>• With sufficient scale, specialized human resource manager (training in respective tech areas or expertise.)
• Recruit or retain capacity to apply for and win grants.
• Expand staff training plan/ practices.
• Foster expertise through third-party developers and the state.
• Improve training for senior managers.</td>
<td>• Retaining staff.
• Adequate compensation to improve longevity of workforce.
• Working and sharing expertise with neighboring systems.
• Presenting at State and national conferences.
• Staff attending conferences and events that expand their capacity and network.</td></tr>
</table>

	Underperforming Systems Tier IV		Basic Systems Tier III		Advanced Diesel Systems Tier II		Leading and Innovating Systems Tier I	
	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement
Governance	• Poorly defined lines of authority between utility management and community leadership. • Limited formal training by oversight board or community leaders in utility management or oversight.	• Discussion of and planning for arm's-length oversight by utility management and community government. • Outreach to other communities that have undertaken same effort. • Plan for strengthening role of community leaders in providing effective oversight of utility management.	• Engagement in process to establish provisions for arm's-length oversight by utility management and community government, e.g., principals for utility, utility Board and community leadership to adopt.	• Agreement on principles articulating need for defined lines of authority between utility management, utility Board and, community government. • Introductory Board of Directors training on governance, and relevant technical aspects of utility operation.	• Adoption of principles establishing lines of authority among utility management, Board, and community government. • Continued training by utility staff and management, and outside experts of utility Board of Directors.	• Engagement in process to establish provisions for arm's-length oversight of utility by utility Board and community government.	• Established bylaws for Board oversight of utility. • Evidence of synergies between utility Board and management, e.g., presentation and review of utility's capital and strategic plans.	• Periodic review of bylaws for Board oversight of utility. • Continued synergies between utility Board and management on ideas related to management and direction of utility.

	Underperforming Systems Tier IV		Basic Systems Tier III		Advanced Diesel Systems Tier II		Leading and Innovating Systems Tier I	
	Attributes	**Goals for System Improvement**	**Attributes**	**Goals for System Improvement**	**Attributes**	**Goals for System Improvement**	**Attributes**	**Goals for System Improvement**
Financial Performance	• Heavy debt burden, including debt to fuel suppliers, and slow debt repayment. • High fuel costs. • High arrearages. • Periodically operating at a loss. • Limited access to capital.	• Improve pattern of payments from customers. • Ensure that utility revenues used only for utility needs.	• Utility under considerable financial pressure on multiple fronts. • Continued bill arrearages. • High fuel costs. • Lag in rate approvals. • Partial compensation for waste heat recovery.	• Improved financial record-keeping. • Covering costs plus a return or margin that can be used for future investment or to secure the confidence of investors.	• Good financial record-keeping. • Covering costs plus a return or margin for future investment. • Seeking timely rate approval where relevant.	• Improving credit rating to ensure promote confidence of prospective investors to enable access to lower-cost capital.	• Good financial record-keeping. • Maintaining acceptable credit rating. • Covering costs plus a return or margin that can be used for future investment.	• Better financial performance and more robust systems that perform well financially under a range of potential futures. • Increasing return on investment.

	Underperforming Systems Tier IV		Basic Systems Tier III		Advanced Diesel Systems Tier II		Leading and Innovating Systems Tier I	
	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement	Attributes	Goals for System Improvement
System Efficiency	• High levels of distribution system losses (>15%). • Non-optimized integration of diesel generators. • System operates out of balance on a persistent basis. • Diesel conversion efficiencies below accepted thresholds used for PCE reimbursement.	• Reduce line losses (<5%) • Automated controls for improved operation of diesel generators. • Better maintenance and records. • Improve system balance. • Get closer to standard thresholds for diesel conversion efficiency (per PCE guidelines).	• Generally higher levels of distribution system losses (>10%). • Improved control systems, and system phase balance to accommodate distributed resources. • Diesel conversion efficiency near the accepted thresholds used for PCE reimbursement.	• Reduce line losses (<5%). • Explore ways to improve system controls to accommodate distributed resources. • Detailed maintenance records to manufacturer specifications. • Improve diesel conversion efficiency well above PCE guidance. • Advanced system controls for effective integration of renewables. • System capable of diesel-off for short periods. • Remote monitoring.	• Distribution systems losses approaching (>5%). • Continued improvements to system to accommodate distributed resources. • Diesel systems maintained to manufacturing specifications. • Diesel conversion efficiency above PCE guidance. • Diesel-renewable hybrid controls over diesel generation. • Remote monitoring.	• Efforts to maintain distribution system losses of (<5%). • Improvement in distribution system characterized by ability to accommodate increased amounts of distributed resources. • Planned investment in control systems for better power generator performance. • Diesel-off-capable system for short periods. • Advanced technologies to improve engine efficiency.	• Robust distribution system that accommodate distributed resources and maintain low system losses. • Advanced control systems for better power generator performance. • Intermediate storage technologies such as batteries, effective use of secondary loads, flywheels to improve diesel operation and diesel-off capability • Advanced technologies to improve energy efficiency (mechanical, water jacket, exhaust stack and other new technologies).	• Pursue all cost effective investments to improve distribution performance. • System capable of supporting diesel-off for more than 80% of the time.

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