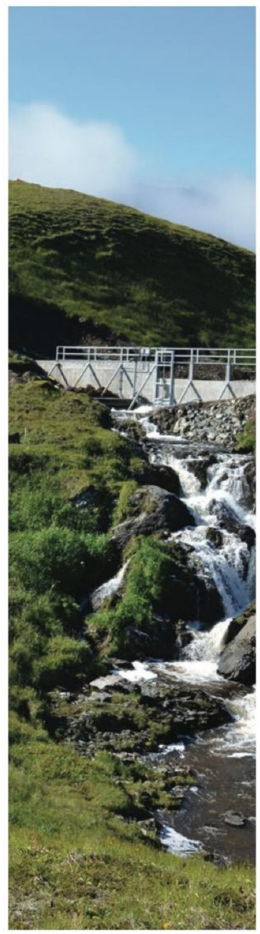
THE ALASKA AFFORDABLE ENERGY STRATEGY

METHODOLOGY, FINDINGS, AND RECOMMENDATIONS



ALASKA ENERGY AUTHORITY

February 2017

www.akenergyauthority.org

This report was made possible through a legislative mandate in SLA 2014 SB 138 requiring Alaska Energy Authority (AEA) to investigate opportunities for delivering affordable energy infrastructure in non-Railbelt communities.

Principal Investigator: Neil McMahon, Energy Planning Manager, AEA

ABSTRACT

The Alaska Affordable Energy Strategy (AkAES) fulfills the legislative mandate set out as part of Senate Bill 138 (SB138) in May 2014. SB138 required that the Alaska Energy Authority (AEA) develop a “plan and recommendations to the legislature on infrastructure needed to deliver affordable energy to areas in the state that do not have direct access to a North Slope natural gas pipeline.”

Not long after beginning the project, it became clear that AEA had two daunting tasks: 1) Deliver more affordable energy in the study area, and 2) respond to the immediate fiscal crisis so that communities do not lose critical energy services. Fortunately, research indicated that the state can tackle both tasks simultaneously.

Research did not discover any “one-size-fits-all” solutions for bringing more affordable energy to communities: No single fuel, resource, or practice can solve the decades-old dilemma of energy affordability in Alaska’s communities. With this in mind, the AkAES is a new, but not revolutionary, suite of recommended changes to incrementally improve the delivery of state energy programs. Through more efficient and effective resource allocation, the state has the expertise and experience to confront both the current fiscal challenges and help ensure the affordability of energy.

The following recommendations, grouped into four categories, aim to increase the efficiency of state funding and increase affordability by maintaining cost-effective projects by bankable entities for their useful life.

1. **Identify most appropriate projects –** Data collection and analysis can be improved to address the unique resources and needs of communities. The state can increase technical assistance to identify, plan, and finance the most appropriate projects.

2. **Finance cost-effective projects –** The state should direct funding to address investment barriers in communities and to address affordability challenges. Expanding the availability and sources of financing for generation, fuel supply and storage, and residential and non-residential efficiency will allow communities to more easily pursue cost-effective projects.

3. **Establish system of accountability and sustainability –** Through technical assistance and requirements, this system of accountability will help increase communities’ access to financing, reduce non-fuel costs, increase consumer protection and maximize the economic benefit of investments. State assistance to meet new standards will be augmented by supporting regional/statewide entities. Expanded utility requirements can help ensure the financial, managerial, and technical capacity of utilities. Objective metrics are suggested to foster cost-effective improvement in utility performance.

4. **Fund programs –** As required by the enabling legislation, AEA identified possible sustainable funding sources including potential revenue from the proposed gasline and potential consumer charges.

ACKNOWLEDGEMENTS

This report was funded by the 28th Alaska State Legislature in 2014 as part of Senate Bill 138.

The Alaska Energy Authority is grateful to the assistance provided by the numerous people who were directly and indirectly involved in the research, analysis, compilation, and editing of this report. With more than 60 State and federal agencies, universities, private companies, utilities, and regional organizations that provided assistance, it is not possible to thank everyone who was involved.

Without the data provided, expert opinion and guidance, and critique of work products provided by these individuals and entities, the Alaska Affordable Energy Strategy would have been less successful. AEA is particularly grateful for the team at the University of Alaska Fairbanks' Geographic Information Network of Alaska (GINA) for correcting AEA's math and logic and coding of the Alaska Affordable Energy Model. Without their work, much of the quantitative analysis in this report would been impossible.

Any unintended errors remaining in this report are the responsibility of the Alaska Energy Authority.

CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

AAEM	Alaska Affordable Energy Model
ABSN	Alaska Science Building Network
ACEP	Alaska Center for Energy and Power (University of Alaska Fairbanks)
ACS	American Community Survey
AEA	Alaska Energy Authority
AEDG	Alaska Energy Data Gateway
AEDI	Alaska Energy Data Inventory
AEERLP	Alaska Energy Efficiency Revolving Loan Program
AFN	Alaska Federation of Natives
AG	Attorney General
AGDC	Alaska Gasline Development Corporation
AHFC	Alaska Housing Finance Corporation
AIDEA	Alaska Industrial Development & Export Authority
AkAES	Alaska Affordable Energy Strategy
AKHAP	Alaska Heating Assistance Program
AMI	Area median income
ANCSA	Alaska Native Claims Settlement Act
ANTHC	Alaska Native Tribal Health Consortium
AO 247	Administrative Order 247
APC	Alaska Power Company
ARIS	Alaska Retrofit Information System
ARRA	American Recovery and Reinvestment Act
ARUC	Alaska Rural Utility Collaborative
ASHP	Air-source heat pump
AVEC	Alaska Village Electric Cooperative
AVTEC	Alaska Vocational Technical Center
B/C	Benefit-cost Ratio
BEES	Building Energy Efficiency Standard
BFU	Bulk Fuel Upgrade Program
BNEF	Bloomberg New Energy Finance
CAPEX	Capital expenditures
CCHRC	Cold Climate Housing Research Center
CDQ	Community development quota
CEFA	Community Energy Fund for Alaska
CF	Community facilities [USDA program]
CFL	Compact fluorescent lamp
CHP	Combined Heat & Power
COE	Cost of equity
COP	Coefficient of performance
COPA	Cost of power adjustment
C-PACE	Commercial Property Assessed Clean Energy
CPCN	Certificate of public convenience and necessity
DCCED	Alaska Department of Commerce, Community, and Economic Development
DCRA	Alaska Division of Community & Regional Affairs
DHSS	Alaska Department of Health & Social Services
DOE	U.S. Department of Energy
DOL&WD	Alaska Department of Labor & Workforce Development
DOT&PF	Alaska Department of Transportation & Public Facilities
EECBG	Energy Efficiency Community Block Grants
EERS	Energy Efficiency Resource Standard
EETF	Emerging Energy Technology Fund
EIA	Energy Information Administration
EM&V	Evaluation, measurement, and verification
EPA	U.S. Environmental Protection Agency
ESCO	Energy service company
EUI	Energy Use Intensity
GAO	General Accountability Office
GINA	Geographic Information Network of Alaska
GIS	Geographic Information System
GSHP	Ground-source heat pump
HDD	Heating degree days
HER	Home Energy Rebate Program
HUD	US Department of Housing & Urban Development
IPEC	Inside Passage Electric Cooperative
IPP	Independent power producer
IRS	Internal Revenue Service
ISER	Institute of Social and Economic Research (University of Alaska Anchorage)
kW	Kilowatt
kWh	Kilowatt-hour
LBNL	Lawrence Berkeley National Laboratory
LED	Light-emitting diode
LIHEAP	Low-income heating assistance program
LNG	Liquefied natural gas
MAFA	Mark A. Foster & Associates
MCF	One thousand cubic feet

MHI	Median household income
MMbtu	1 million British thermal units
MW	Megawatt
MWh	Megawatt-hour
NASEO	National Association of State Energy Offices
NGO	Non-governmental organization
NPV	Net present value
NREL	National Renewable Energy Laboratory
NSB	North Slope Borough
NSEDC	Norton Sound Economic Development Corporation
NWAB	Northwest Arctic Borough
O&M	Operations and maintenance
OPEX	Operating expenditures
PCE	Power Cost Equalization
PILT	Payments in lieu of taxes
PPESCO	Public purpose energy service company
PPF	Power Project Fund
PV	Photovoltaic
R&R	Repair and replacement
RCA	Regulatory Commission of Alaska
REF	Renewable Energy Fund
ROE	Return on equity
ROI	Return on investment
RPSU	Rural Power System Upgrade
RUS	Rural utility service
SB 138	Alaska Senate Bill 138-2014
SEIRP	Southeast Integrated Resource Plan
SETS	Sustainable Energy Transmission & Supply
SWAMC	Southeast Alaska Municipal Conference
TCC	Tanana Chiefs Conference
UAA	University of Alaska, Anchorage
UACED	University of Alaska, Center for Economic Development
UAF	University of Alaska, Fairbanks
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
VEEP	Village Energy Efficiency Program
VEIC	Vermont Energy Investment Corporation
VEUEM	Village End Use Efficiency Measures
WTI	West Texas Intermediate
WVR	Whole Village Retrofit
Wx	Weatherization Assistance Program

CHAPTER 1: OVERVIEW OF THE ALASKA AFFORDABLE ENERGY STRATEGY

Due to the critical importance of safe and reliable space heat and electric energy, the Alaska Energy Authority (AEA) was tasked by the 28th Alaska Legislature to make recommendations for energy policy consideration. The Alaska Affordable Energy Strategy (AkAES) is the result of AEA's effort to fulfill that responsibility.

The "Alaska Affordable Energy Strategy" refers to both the multi-year, multi-stakeholder project undertaken to meet the legislative mandate, as well as the results of that project. Those results are summarized in the current report. They include a strategic plan or framework for improving the way the State identifies, evaluates, develops, and maintains cost-effective energy solutions in non-Railbelt Alaska communities, followed by recommendations for how the framework can be implemented through policy levers, regulatory incentives, financing mechanisms, and other administrative tools.

The catalyst for the AkAES project was early planning for the new revenue stream that would result from a natural gas pipeline ("gasline"), another project initiated by the 28th Legislature. While that revenue stream remains at a minimum 10 years away, the AkAES recommendations point to actionable solutions that would make a positive impact with or without a gasline, including many that could be implemented immediately.

Access to safe and reliable heat and electricity is essential. The State of Alaska, through AEA and other State agencies, plays an important role in planning for and investing in energy infrastructure in all parts of the state, both within and outside the Railbelt. Alaska's high cost of energy creates a burden for Alaskans that the State has been working to address for decades. Ensuring the safety and reliability of energy systems increases the security of Alaskan families. Reducing energy costs leaves money in consumers' pockets, increasing their standard of living and creating jobs when that savings is spent on other goods and services.

The AkAES project investigated specific new infrastructure opportunities for delivering more affordable energy to non-Railbelt communities. It also studied the efficacy of existing energy programs and potential policy or regulatory changes that could contribute to more affordable, safe, stable, and reliable consumer energy in non-Railbelt communities. After more than two years of research and analysis, the primary conclusion is that the State can best improve the affordability of energy in AkAES study area communities by developing a streamlined, data-driven framework to identify, evaluate, develop, and maintain cost-effective energy solutions.

To recommend ways to improve the State's delivery of energy programs, the AkAES analysis drew from decades of experience working to bring safe, stable, and reliable energy to rural communities, while also considering current economic conditions. Of critical importance in light of the State's recent fiscal challenges, the AkAES provides valuable insights for how to ease the transition from a reliance on grants for funding energy infrastructure to a new paradigm in which loans and private investment play a larger role. This transition will require a significant change in the way we think about and do things. The AkAES includes recommendations to guide that change which, if implemented, would result in a more sustainable energy infrastructure in Alaska communities.

THE REQUIREMENTS OF THE ALASKA AFFORDABLE ENERGY STRATEGY

The legislative mandate that became the AkAES was passed in 2014 as part of Senate Bill 138 (SB 138) and is contained in Section 75, Chapter 14, SLA 2014 [HCS CSSB 138(FIN) am H]. The study area specified in the legislation includes all areas of the state that would not have direct access to the proposed North Slope natural gas pipeline. Working with the Alaska Gasline Development Corporation (AGDC), AEA defined the study area as the entire state excluding communities served by the Railbelt electric grid. This includes more than 200 communities and a total population of over 165,000.

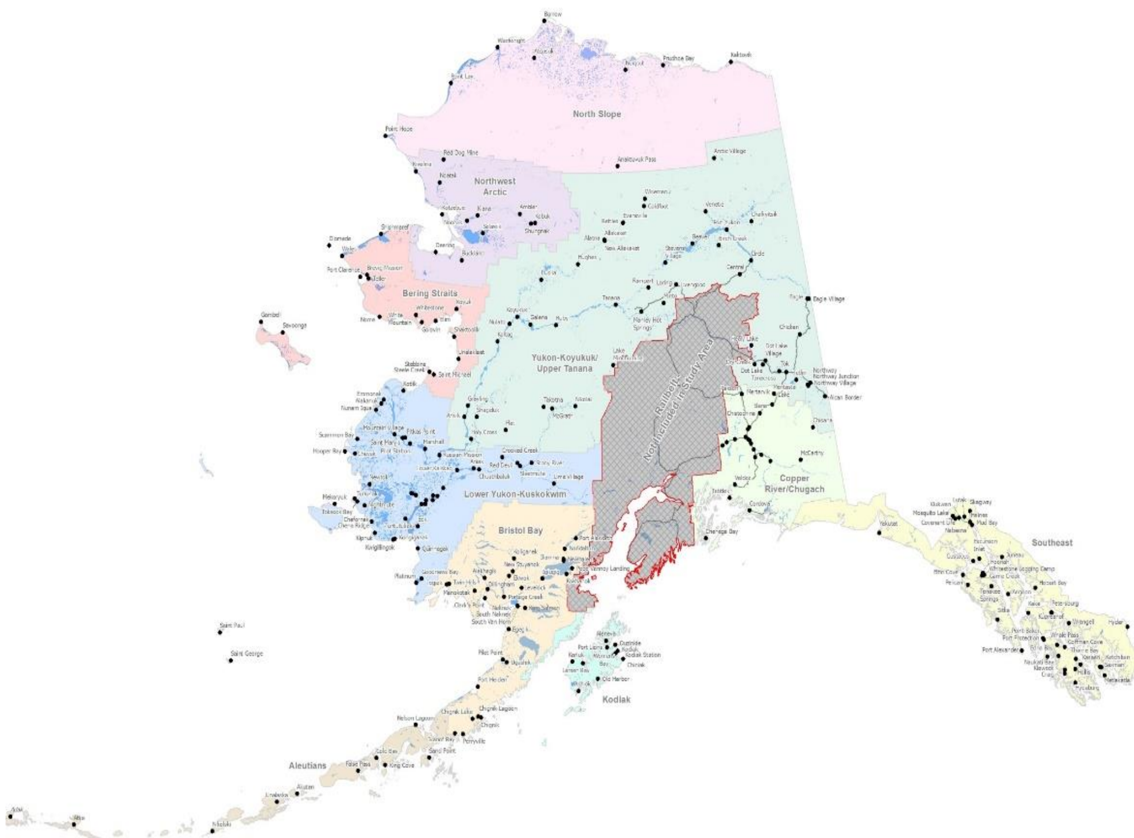


Figure 1: Map of Alaska Affordable Energy Strategy study area

Under SB 138, AEA was instructed to:

- “develop a plan for developing infrastructure to deliver **more affordable energy** to areas of the state that are not expected to have direct access to a North Slope natural gas pipeline;”
- “identify **ownership options**, different **energy sources**… [and] recommend the means for generating, delivering, receiving, and storing energy in the **most cost-efficient manner;**”

- “consider the development of regional energy systems that can receive and store bulk fuel;”
- “[for] those citizens for whom there is no economically viable infrastructure available, recommend the means for **directly underwriting the energy costs** of the citizens to make their energy costs more affordable;”
- “recommend a plan for funding the design, development, and construction of the required infrastructure” including to “**identify a source of rent, royalty, income or tax;**” and
- “provide the **plan and suggested legislation** for the design, development, construction, and financing of the required infrastructure to the legislature before January 1, 2017.”

The full text of the authorizing legislation can be found in Appendix A

AEA was also directed to consider existing State energy policy under AS 44.99.115 and Section 1, Chapter 82, SLA 2010. While the requirements under SB 138 focus on reducing costs to communities, significant synergy exists between the AkAES and the earlier state energy policy, which set goals that the state:

- achieve a 15 percent increase in energy efficiency on a per capita basis between 2010 and 2020;
- receive 50 percent of its electric generation from renewable and alternative energy sources by 2025;
- work to ensure a reliable in-state gas supply for residents of the state; and
- remain a leader in petroleum and natural gas production and become a leader in renewable and alternative energy development.

The 2010 legislation also indicated that the power project fund (AS 42.45.010) should serve as the main source of State assistance for energy projects. The AkAES addresses all these energy policies directly except for ensuring a reliable in-state gas supply, which is outside AEA’s purview. Other elements of AS 44.99.115 and Section 1, Chapter 82, SLA 2010 are addressed elsewhere in the report.

HOW THE AKAES DEFINES THE TERMS IN THE LEGISLATION

Guided by its understanding of the Legislature’s intent, AEA had to determine how to define many of the terms used in the authorizing legislation. This section outlines the terms and definitions used by AEA in implementing the AkAES.

SECTORS

The legislation refers to delivering more affordable energy to “areas” and “citizens.” It does not list specific sectors of the energy market that should or should not be addressed in the plan. After reviewing existing state energy policy, AEA included the following sectors in the study:

- Residential building heat and electricity
- Non-residential building (private and public commercial) heat and electricity
- Water and wastewater heat and electricity

Though the AkAES does not address opportunities within Alaska’s industrial and transportation sectors to make energy more affordable, various recommendations in the study will benefit those sectors—particularly the investigation of potential improvements in the fuel delivery system.

INFRASTRUCTURE

SB 138 requires that AEA "develop a plan for developing Infrastructure to deliver more affordable energy." AEA has interpreted "infrastructure" expansively to include electric and heat generation resources, both renewable and non-renewable, as well as analysis of energy efficiency improvements to existing and future residential and non-residential building stock.

COST-EFFICIENT AND ECONOMICALLY VIABLE

The legislation provided two tests for recommended infrastructure: "cost-efficient" and "economically viable." Using the common definition of cost-efficient, AEA interpreted it to mean projects whose benefits outweigh their costs. AEA looks at costs and benefits from a universal perspective: that is, independent of who pays for the project or receives the benefits. For example, if a project is grant funded, a community might not include the grant as a cost, but the study would. Likewise, if the cost of electricity is reduced but results in lower Power Cost Equalization (PCE) payments to the community, the AkAES will still count the reduced costs as a benefit, even though the community does not receive the full savings benefit directly.

Economic viability is similar in meaning to cost-efficient, but it places more emphasis on long-term sustainability given market factors and projected revenues and ignores externalities (costs not paid for by the producer or consumer and social or environmental benefits not given a monetary value). A project or activity is predicted to be economically viable if projected revenues equal or exceed projected expenditures, including financing costs, asset depreciation, and profit. In other words, economic viability is a measure of profitability: revenues (rather than benefits) exceeding costs. Public policy in the form of tax credits and subsidies can be used to make a project or technology more economically viable than it would be otherwise. Selective taxes, tariffs and any regulation that increases development or operational costs are examples of policies that can reduce a project or technology's profitability.

AEA evaluates cost-effectiveness by modeling the costs and benefits of a proposed infrastructure project over its expected economic lifespan using the Alaska Affordable Energy Model (AAEM). A detailed explanation of the methods and assumptions used in the AAEM is included as Appendix B. The AAEM is intended to be a living, perpetually updated energy evaluation and planning tool. It is available at http://www.akenergyinventory.org/energymodel.

The results of the AAEM are included in Chapter 6 for many energy projects proposed throughout the study area. These are high-level estimates most suited to the reconnaissance stage in project planning. To refine these estimates for use in feasibility assessments or go/no-go financing or construction decisions for individual projects will require the development of more site-specific detailed cost inputs based on accurate resource assessments and technical/design specifications. It will also require revenue forecasts based on completed business plans as well as knowledge of the particular project financing plans.

DIRECT UNDERWRITING AND CITIZENS

AEA was required to "recommend a means of directly underwriting" the cost of energy for "citizens" who would not have access to cost-effective infrastructure. AEA interprets direct underwriting to mean directly subsidizing the cost of energy.

SOURCES OF RENT, ROYALTY, INCOME OR TAX

The legislation requires that AEA identify a "source of rent, royalty, income, or tax" to help to pay for the infrastructure. By definition, cost-effective projects will pay for themselves over time; but, by identifying new revenue streams to help fund energy infrastructure, the State may be able to shorten those payback periods, make marginal projects more economically viable, and increase the number of energy projects that can be built. In 2014, the Legislature created the Affordable Energy Fund, which provisionally sets aside a percentage of the State's royalty gas revenue from a future North Slope gasline to help fund energy projects in the AkAES study area. Given the uncertain future of the gasline and of State budgets, AEA interprets this section of the AkAES authorizing legislation broadly to mean recommendations for providing the State with near-term revenue as well as for preparing for the possible deployment of Affordable Energy Fund revenue.

DEFINING "AFFORDABLE" ENERGY

AEA's mission is to "reduce the cost of energy in Alaska." The agency and the State are keenly aware of the need to make energy more affordable, especially in rural areas of the state where the burden of high energy prices hits hardest. In the course of this study, AEA investigated two different ways to define "affordable" as a measurable target for assessing competing energy projects or policies, but neither proved wholly satisfactory.

1. **Unit cost parity across Alaska:** While bringing energy costs in the AkAES study area down to costs paid in Southcentral would be ideal, it is not financially or technically feasible to do so. AEA estimates that the 200+ communities in the AkAES region spend over $630 million for heat and electricity annually, after State and federal subsidies. That includes approximately $330 million in heating and $300 million in electric costs. To bring that down to Southcentral levels would require a reduction in energy costs of $330 million or 52%. To put this in perspective, PCE payments in FY16 were approximately $31 million, less than 10% of the annual subsidy that would be required to achieve energy cost parity with Southcentral. That level of subsidy is not achievable with the State's current fiscal gap and would not be sustainable in any foreseeable fiscal future.

2. **Percent of income**: Affordability can be defined in relative terms: the more money a household has, the higher the energy costs it can afford. Numerous international standards exist for what constitutes "affordable" energy, generally falling between 10-20% of household income.[1] For comparison sake, the University of Alaska's Institute of Social and Economic Research (ISER) published a study in 2007 that estimated that energy costs in Anchorage were 3.1% of median household income and 9.9% in remote communities in 2006.[2] The State and federal government consider applicant income in determining eligibility for a number of energy-related programs including low income Weatherization

[1] Compiled in Samuel Fankhauser and Sladjana Tepic. "Can poor consumers pay for energy and water? An affordability analysis for transition countries." European Bank for Reconstruction and Development. May 2005. http://www.ebrd.com/downloads/research/economics/workingpapers/wp0092.pdf

[2] Ben Saylor and Sharman Haley. "Effects of Rising Utility Costs on Household Budgets, 2000-2006." March 2007. http://www.iser.uaa.alaska.edu/Publications/risingutilitycosts_final.pdf

Assistance Program[3] and the Low Income Heating Assistance Program (LIHEAP).[4] Neither program sets a maximum threshold for the percent of household income spent on energy costs. Eligibility is determined by household, not by community, through income data provided by the applicant.

Unfortunately, no reliable data source exists that would allow the State to make a similar determination at a community scale. The international standards referenced above do not take into account the cost of living in different regions and sub-regions of the state. Median household income (MHI) is the most likely measure that could be used, in combination with localized energy costs, to establish a standard for affordable energy that could be applied at the whole community level.

For example, if a community's MHI were $50,000 and the statewide standard for energy affordability were set at 15% of household income, then average household energy costs of $7,500 per year or less would be considered affordable. Maximum rates for electricity and heating fuels could be based on this value and energy costs above the threshold would make the community eligible for affordable energy investments or subsidies. However, in Alaska, Census areas are generally the smallest geographic unit for which the MHI is accurate. The MHI for Alaska Census areas is shown in Figure 2.

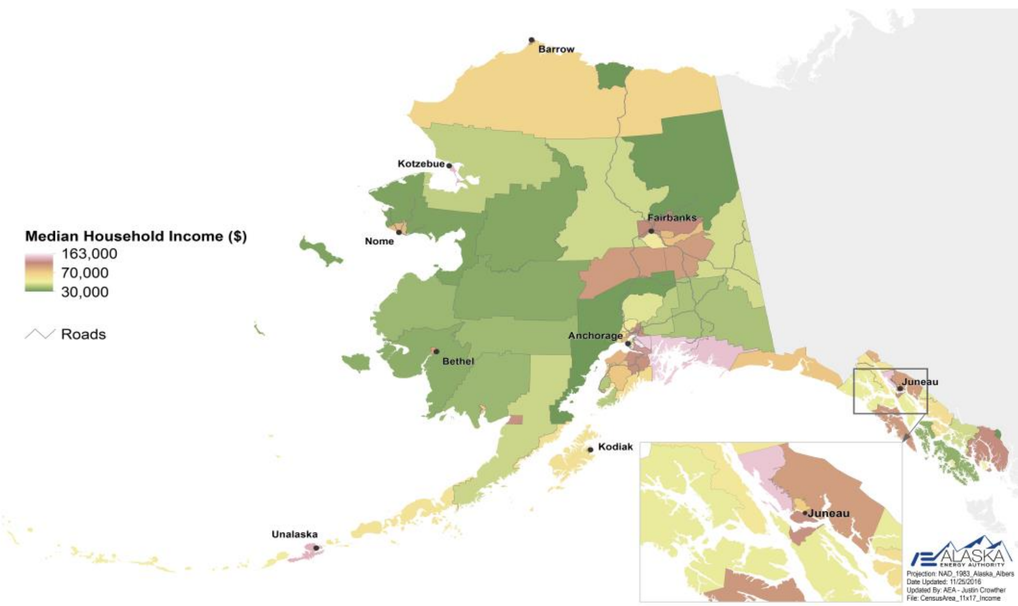


Figure 2: Median household income by Census area[5]

Statewide the median household income is close to $70,000. As can be seen in Figure 2, much the AkAES study area has an MHI nearly half the statewide average. However, there is a risk of failing to serve high-need communities due to reliance on this more-accurate, regional-level data which may not reflect the reality at the community level. The MHI in individual communities can vary greatly from that of the Census area; there may be communities with low MHIs in regions with high MHIs and vice versa. Also low-income

[3] https://www.benefits.gov/benefits/benefit-details/1842
[4] https://www.benefits.gov/benefits/benefit-details/1411
[5] American Community Survey 2014 5-Year TRACT 02 ALASKA X19: Income Table https://www.census.gov/geo/maps-data/data/tiger.html

residents in high MHI communities could be adversely affected if funding decisions were only based on regional and community-level data. All communities include both high and low-income households.

The unreliability of community-level census data is due to the small populations and sample sizes outside urban Alaska. The margin of error for MHI is well over 100% in some communities. As one example, the Census Bureau's estimate for MHI in Lime Village was $145,313 with a margin of error of plus or minus $266,070 (183%).[6] It would not be prudent to make funding decisions based on data with this level of uncertainty.

Given the challenges of developing a statewide measure for "affordable" energy that could be applied fairly and sustainably across communities, AEA decided its resources would be more practically used in developing a plan for delivering energy services to Alaska's communities in the most cost-effective manner. This plan and the accompanying recommendations can have a positive impact on Alaska's communities even with the current fiscal challenges.

RESEARCH METHODS

In two years of research, AEA drew on: the expertise of state, national and international entities and energy stakeholder groups; historical outcomes of State and federal energy programs; policy recommendations; and previous work from State, federal, and NGO researchers. AEA has learned from and built on these previous efforts, while coordinating with concurrent local, regional, and federal efforts in energy planning to minimize the duplication of work.

The AkAES assessed current and past energy programs and policies for effectiveness, identified and filled in gaps in key areas where data and analysis was lacking, and solicited feedback and critique from a wide range of stakeholders, including academics, national labs, and other local, regional, and statewide entities.

AEA's research focused on identifying the most effective policy levers the State could use to help Alaska communities succeed in their energy programs given current budget realities. To accomplish this, significant work was done to evaluate potential infrastructure and policy options. The recommendations that resulted from this research will not alleviate all the challenges of delivering affordable energy to communities, but will point to definitive actions that can help Alaskan citizens and communities.

STAKEHOLDER INVOLVEMENT

AEA worked with three distinct stakeholder groups throughout the AkAES project:

Technical Advisory Committee: Comprised of the Alaska Center for Energy and Power (ACEP), the Institute of Social and Economic Research (ISER), and the Alaska Gasline Development Corporation (AGDC), the technical advisory committee provided guidance on study methodology as well as assessment and evaluation of technology solutions.

---

[6] US Census Bureau. "American Community Survey 2009-2013 5-Year Estimates." Accessed from Division of Community and Regional Affairs Community Database Online. https://www.commerce.alaska.gov/dcra/DCRAExternal/community/Details/5db73dd9-b52c-486a-acf4-a323b8d8f3cf

Advisory Group: Comprised of eight state and regional organizations, the Advisory Group provided guidance and review of material developed over the course of the study, including work done by AEA and its contractors. Advisory Group members included the AGDC, Alaska Federation of Natives (AFN), Department of Transportation and Public Facilities (DOT&PF), Tanana Chiefs Conference (TCC), Inside Passage Electric Cooperative (IPEC), Northwest Arctic Borough (NWAB), and Nuvista Light and Electric Cooperative. The Regulatory Commission of Alaska (RCA) was also a participant in the advisory group, but withdrew once recommendations were introduced that impacted the RCA, but were not vetted at AkAES meetings nor discussed with RCA representatives prior to inclusion in the report. The RCA representatives had concerns that their involvement could be viewed as support for the recommendations.

Alaska Energy Stakeholders: Comprised of other local, regional, state, and federal governments and NGOs, as well as private companies and utilities, this group contributed data, expertise, and review of work products.

Participation and input from stakeholders and/or Advisory Group members is not an explicit or implicit endorsement of the work or recommendations from the AkAES.

PREVIOUS ENERGY RESEARCH IN ALASKA

Before developing a scope of work for the AkAES project, AEA conducted a thorough investigation of previous research and analysis that could serve as a foundation for the new study. The literature review process continued throughout the AkAES study. As new problems were identified, new data sources were discovered, and new ideas proffered.

AEA investigated previous work in three main categories: Best Practice, Best Ideas, and Best Data. Best Practice investigated federal and NGO guides on how to do energy planning for states, regions and communities. Best Ideas looked at studies completed previously in Alaska, including infrastructure and policy studies. Best Data aimed to discover all the energy-related data that could be used to answer the challenging and important requirements established by the legislation.

BEST PRACTICE—NATIONAL GUIDANCE ON HOW TO DO ENERGY PLANNING

Although the AkAES is not a statewide energy plan, the study area is larger than any other state in the union. In response to new energy regulations formulated in the federal Clean Power Plan, a number of new national energy planning and data resources became available over the past few years. Federal agencies, including the Environmental Protection Agency (EPA)[7], have developed comprehensive state energy planning frameworks. The National Association of State Energy Offices (NASEO) has also published material that provides guidance for statewide planning.[8] Each of these planning guides provided key insights into how to develop comprehensive, adaptable and strategic plans.

---

[7] Environmental Protection Agency. "Energy and Environment Guide to Action: State Policies and Best Practices for Advancing Energy Efficiency, Renewable Energy, and Combined Heat and Power." 2015 Edition. https://www.epa.gov/sites/production/files/2015-08/documents/guide_action_full.pdf

[8] National Association of State Energy Officials. "State Energy Planning Guidelines: A Guide to Develop a Comprehensive State Energy Plan Plus Supplemental Policy and Program Options." https://www.naseo.org/data/sites/1/documents/publications/NASEO-State-Energy-Planning-Guidelines.pdf

Other federal agencies provide resources for more local-level energy planning. In a study commissioned by the Department of Energy (DOE)'s Office of Indian Energy, the National Renewable Energy Laboratory (NREL) developed a valuable community-planning document specifically for Alaska.[9]

From these and other resources, AEA considered and, where appropriate, incorporated many suggestions and lessons learned. The AkAES is an amalgamation of the best of these approaches, tailored for Alaska.

BEST IDEAS—INFRASTRUCTURE AND POLICY OPTIONS IDENTIFIED IN PREVIOUS ALASKA-SPECIFIC STUDIES

AEA assessed previous, relevant, Alaska-specific energy policy recommendations as one of the first steps in its AkAES work. Over the past decade, a number of policy papers have been developed for specific energy sectors. These provided an excellent foundation for AkAES analysis and recommendations.

Numerous reports have provided recommendations for changes to State energy policy. Policy papers by the University of Alaska's ISER[10], Commonwealth North[11], the U.S. DOE Office of Indian Energy[12], the Alaska Arctic Policy Commission[13], and the Walker/Mallot Consumer Energy Transition Team[14] served as a baseline in assessing what has been deemed important by others.

Within the past decade, AEA published two studies that looked at infrastructure options across the state: the 2009 "Alaska Energy: A first step toward energy independence[15] and the 2010 "Energy Pathway."[16] These had a different purpose than the AkAES and were developed under a very different fiscal climate. The two studies aimed to assist communities in identifying projects to access the new source of project funding and counter the high costs of energy. Neither specifically addressed needed policy change, but they did provide significant, useful information about Alaska's energy systems that contributed to the development of AkAES findings and recommendations.

"Alaska Energy" provides an excellent history of Alaska's State energy policy, a review that was not repeated in this document. The "Energy Pathway" provided actions for energy efficiency, renewable energy, climate change, energy security, economic development, investing in innovation, and education and workforce development, many of which are included in this document.

---

[9] A. Dane and L Doris. "Alaska Strategic Energy Plan and Planning Handbook." 2013. National Renewable Energy Laboratory. https://energy.gov/sites/prod/files/2014/05/f16/AKStrategicPlanningHandbook_v17.pdf
[10] Steve Colt, Ginny Fay, Matt Berman, Sohrab Pathan. "Energy Policy Recommendations Draft Final Report." January 25, 2013. http://www.iser.uaa.alaska.edu/Publications/2013_01_25-EnergyPolicyRecommendations.pdf
[11] Commonwealth North. "Energy for a Sustainable Alaska: The Rural Conundrum." February 2012. http://www.commonwealthnorth.org/download/Reports/2012_CWN%20Report%20-%20Energy%20for%20a%20Sustainable%20Alaska%20-%20The%20Rural%20Conundrum.pdf
[12] Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf
[13] Alaska Arctic Policy Commission. "Final Report of the Alaska Arctic Policy Commission." January 30, 2015. http://www.akarctic.com/wp-content/uploads/2015/01/AAPC_final_report_lowres.pdf
[14] Walker/Mallot Transition Team Conference. "Team Report". *Consumer Energy*. November 21-24, 2014. https://gov.alaska.gov/Walker_media/transition_page/combined-report_final.pdf
[15] Alaska Energy Authority. "Alaska Energy: A first step toward energy independence." January 2009. http://www.akenergyauthority.org/Content/Publications/AKEnergyJan2009.pdf
[16] Alaska Energy Authority. "Alaska Energy Pathway. Toward energy independence." July 2010. ftp://ftp.aidea.org/2010AlaskaEnergyPlan/2010%20Alaska%20Energy%20Plan/Narrative/Narrative%202010%20Energy%20Plan.pdf

Of all the potential ways to reduce the cost of energy in communities, energy efficiency has had the most extensive review of policy recommendations. Reports commissioned by AEA and AHFC in 2008[17], 2011[18], and 2012[19] provided an analysis of potential policies for reducing consumer energy costs for both heat and electricity. An additional study commissioned by Cold Climate Housing Research Center (CCHRC) focused on policy recommendations focused on electrical efficiency.[20]

Regional energy plans have recently been completed for all regions of the state. The first regional plan, completed in 2010, was the Railbelt Integrated Resource Plan. The next regional study was the Southeast IRP (SEIRP), completed in 2012.[21] From 2012 to 2016 the remaining nine energy regions (as defined by AEA) completed energy planning initiatives.[22] Once the AkAES study was underway, data collection and analysis being performed for regional energy plans were coordinated with work on the AkAES to the greatest extent possible.

In developing the AkAES recommendations outlined in Chapter 7, AEA did not constrain itself to previously proposed recommendations but used them as a starting point for further investigation.

Best data—how to evaluate potential policy options

To understand the potential benefits and risks of various energy policy options it is necessary to understand the factors underlying retail energy prices. AEA scoured relevant literature on the components of energy costs in Alaska. Studies performed by ISER over the past 15 years (especially in 2003[23], 2008[24], 2009[25], 2010[26]) and the attorney general's 2010 report investigating if the high cost of energy in rural Alaska was the result of illegal conduct proved valuable.[27]

AEA tested previous recommendations from energy policy research and analysis (increased renewable generation, for example) against updated community-level data where possible. This required that AEA compile a robust set of data to better understand energy consumption, generation, resource availability,

---

[17] Cady Lister, Brian Rogers, and Charles Ermer. "Alaska Energy Efficiency Program and Policy Recommendations." June 5, 2008. http://www.cchrc.org/sites/default/files/docs/EE_Final.pdf
[18] John Davies, Nathaniel Mohatt, Cady Lister. "Alaska Energy Efficiency Policy and Programs Recommendations: Review and Update." June 27, 2011. http://www.cchrc.org/sites/default/files/docs/Interim_EE_Policy_Report.pdf
[19] Cold Climate Housing Research Center, "Energy Efficiency Policy Recommendations for Alaska." May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf
[20] Information Insights, Inc. "Electric Energy Efficiency, Environmental Scan: Barriers & Opportunities" October 7, 2011. http://www.cchrc.org/sites/default/files/docs/Electric_EE_Environmental_Scan_Lit_Review.pdf
[21] Black and Veatch. "Southeast Alaska Integrated Resource Plan." July 2012. http://www.akenergyauthority.org/Content/Publications/SEIRP/SEIRP-Vol1-ExecSumm.pdf
[22] http://www.akenergyauthority.org/Policy/RegionalPlanning
[23] Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm.
[24] Meghan Wilson, Ben Saylor, Nick Szymoniak, Steve Colt, and Ginny Fay. Components of Delivered Fuel Prices in Alaska. June 2008. http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf
[25] Ginny Fay, Ben Saylor, Nick Szymoniak, Meghan Wilson and Steve Colt. Study of the Components of Delivered Fuel Costs in Alaska: January 2009 Update. January 2009. http://www.iser.uaa.alaska.edu/Publications/fuelpricedeliveredupdate.pdf
[26] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf
[27] Alaska Attorney General's Office. "Rural Fuel Pricing in Alaska: A Supplement to the 2008 Attorney General's Gasoline Price Investigation." 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf

population, costs, and other relevant factors. Hundreds of previous studies, datasets, resource and technology reports, and program evaluations provided the foundation for this analysis.

Modeling the effectiveness of various energy infrastructure opportunities required the creation of a new community-scale energy model. The Alaska Affordable Energy Model was built off work from AEA's energy models from the 2009 "Alaska Energy – A first step toward energy independence" and the 2010 "Alaska Energy Pathway," ISER's Village End Use Model[28], AHFC's 2014 Housing Assessment[29], AEA's Renewable Energy Fund (REF) economic model[30], and others. AEA maintained most of the assumptions from the REF model, including the diesel fuel price forecast updated in 2016.

Previous work by AEA, University of Alaska researchers, AHFC, and other state agencies, was used to populate the AAEM with data. Databases such as the AEA-funded, ISER-maintained Alaska Energy Data Gateway (AEDG)[31], AHFC's Alaska Retrofit Information System (ARIS)[32], and the Alaska Energy Data inventory (AEDI)[33] proved invaluable for providing Alaska-specific energy costs, generation and consumption data.

Federal data sources, such as the American Community Survey (ACS), U.S. Decennial Census and the Energy Information Administration (EIA), provided data not collected by the State of Alaska. Alaska's Department of Labor and Workforce Development was also an excellent source of population estimates and certain types of housing data.[34]

Hundreds of studies assessing the merits of individual infrastructure projects have been conducted across the state, some going back decades. AEA compiled these results from numerous sources, including the REF, AEA's 2012 Rural Power House Inventory, 2015 Bulk Fuel Upgrade Inventory, and numerous other state and federal sources. Preliminary results from over 400 reconnaissance-level hydro studies were available through a 2014 US Army Corps of Engineers (USACE) compilation of Alaska's potential hydro resources.[35] Non-project specific resource data was available through AEDI, including the NREL Alaska wind map and woody biomass data layers, and solar resource estimates were collected through NREL's PVWatts online application.[36]

Numerous state and federal agencies have studied the feasibility of specific technologies in Alaska, including the parameters needed for optimal performance. Specific reports, too numerous to include here

---

[28] Steve Colt and Tobias Schwoerer. "Alaska Village Energy Model." 2013. http://www.iser.uaa.alaska.edu/Publications/2013-07_Village_energy_model_notes.pdf
[29] Alaska Housing Finance Corporation. "2014 Alaska Housing Assessment." https://www.ahfc.us/efficiency/research-information-center/housing-assessment/
[30] http://www.akenergyauthority.org/Programs/RenewableEnergyFund
[31] https://akenergygateway.alaska.edu/
[32] ARIS is not a publicly available database
[33] http://www.akenergyinventory.org/
[34] Department of Labor and Workforce Development Research and Analysis. Alaska Local and Regional Information. http://live.laborstats.alaska.gov/alari/
[35] Individual hydroelectric reconnaissance and feasibility reports are accessible through http://www.akenergyinventory.org/
[36] National Renewable Energy Laboratory. PVWatts Calculator. http://pvwatts.nrel.gov/

but accessible through the AAEM, used in the AkAES analysis include work by ACEP, CCHRC, NREL, U.S. DOE and USACE.

Evaluations of the REF[37], Weatherization[38] and Home Energy Rebate[39] programs were included in the analysis for AkAES.

Alaska-specific building-level data was obtained from a number of sources. AHFC's ARIS database includes data from energy audits of thousands of residential buildings statewide, as well as both modeled and reported information for over 1,000 non-residential buildings. AEA supplemented the non-residential data from ARIS with sources that included AEA's 2012 End Use study[40], Alaska Native Tribal Health Consortium (ANTHC) energy audits, community property tax rolls and regional energy plans.

Water and wastewater data and research for consumption, savings, and utility best practices was collected from ANTHC[41] and the Alaska Rural Utility Collaborative (ARUC).[42]

AEA gathered additional data from unpublished sources, including working documents from AEA programs and reports to the Legislature from multiple State agencies.

Money is needed to bring most projects to life. Grants and loans, primarily from State and federal sources, have been a primary source of financing for energy projects in the AkAES study area. Where it was possible, AEA collected historical data on funding directly from state and federal agencies.

For financing future projects, the best catalog of Alaska-specific financing opportunities was compiled by the National Renewable Energy Laboratory in 2013.[43]

To understand better the finances and non-fuel costs of PCE-eligible utilities, AEA worked with the Regulatory Commission of Alaska (RCA) to obtain relevant data from utility submittals. Additional data on community creditworthiness was gathered through AEA's Bulk Fuel Loan program (2000-2013).

For all data sources that are not proprietary or otherwise confidential, AEA has endeavored to make the access easier and have developed a tool (the Alaska Affordable Energy Model) to provide integrated analysis.

---

[37] David Hill, Chris Badger, Leslie Badger, Nikki Clace, and Molly Taylor. "Alaska Energy Authority: Renewable Energy Grant Recommendation Program Impact Evaluation Report." 2012. https://www.veic.org/resource-library/alaska-energy-authority-renewable-energy-grant-recommendation-program-process-and-impact-evaluation-reports

[38] Cold Climate Housing Research Center. "Weatherization Assistance Program Outcomes." August 6, 2012. http://www.cchrc.org/sites/default/files/docs/WX_final.pdf

[39] Kathryn Dodge, Nathan Wiltse, Virginia Valentine. "Home Energy Rebate Program Outcomes." June 26, 2012. http://www.cchrc.org/docs/reports/HERP_final.pdf

[40] Alaska Energy Authority. "End Use Study: 2012" April 30, 2012. http://www.akenergyauthority.org/Content/Efficiency/EndUse/Documents/AlaskaEndUseStudy2012.pdf

[41] Daniel Reitz, Art Ronimus, Carl Remley, Emily Black. "Energy Use and Costs for Operating Sanitation Facilities in Rural Alaska: A survey." October 2011.

[42] Alaska Rural Utility Collaborative. "2014 Report on Activities." https://anthc.org/wp-content/uploads/2015/12/2014-ARUC-Report-on-Activities-v2_02.09.15_email.pdf

[43] K. Ardani, D. Hillman, and S. Busche. National Renewable Energy Laboratory. "Financing Opportunities for Renewable Energy Development in Alaska." April 2013. http://www.nrel.gov/docs/fy13osti/57491.pdf

A complete list of data sources is available in the References section at the end of the report. Individual data sources are cited as footnotes throughout the report.

NEW RESEARCH PERFORMED

To fill knowledge gaps, AEA contracted with academics, private-sector consultants and federal entities to answer specific technology, program or policy questions through additional data collection and analysis.

The deliverables from these discreet research and analysis projects were used to inform the final recommendations and are included in the supplemental material, available through AEA's website (http://www.akenergyauthority.org/).

Table 1: Contracted deliverables that informed the AkAES

Report or deliverable title	Report Author(s)
Alaska Affordable Energy Model	Developed by AEA, coded by UAF Geographic Information Network of Alaska (GINA)
Energy efficiency program evaluation and financing needs assessment	Vermont Energy Investment Corporation; Cold Climate Housing Research Center
LNG feasibility for AkAES communities	Northern Economics; Michael Baker International
Rural utility financial analysis	UAA Center for Economic Development
Documentation of Alaska-specific technology development needs in support of the AkAES	UAF Alaska Center for Energy & Power
Barriers and opportunities for private investment in rural Alaska energy projects	UAF Alaska Center for Energy & Power
Fuel transportation improvement report	US Army Corps of Engineers, Alaska District
Demographic modeling	UAA Institute of Social & Economic Research
Sustainable utilities study updates, utility structure analysis, and subsidy program analysis	UAA Institute of Social & Economic Research, Mark Foster & Associates
Energy costs and rural Alaska out-migration	UAA Institute of Social & Economic Research

AEA also tapped its internal knowledge and expertise to perform additional primary and secondary research in support of the project. The results of numerous research studies performed by AEA staff are incorporated into this report.

HOW TO READ THE REPORT

The remainder of this report is structured under three broad themes:

Chapters 2 and 3 describe how and why energy is less affordable in some areas of the state.

Chapter 2 describes baseline energy costs and consumption in communities across the AkAES study area. Socioeconomic characteristics, including population trends and other factors that affect communities' ability to pay for infrastructure, are also discussed. Estimates for investment needed to maintain the current state of energy systems in communities over next 20 years is provided in this chapter.

Chapter 3 investigates the factors that drive the cost of energy in communities—for both electricity and heat. The chapter follows the supply chain from crude oil to consumption to understand which factors have the most sway over the total cost consumers pay for energy.

Chapters 4, 5 and 6 describe and analyze factors that could help bring affordable energy to Alaska communities.

Chapter 4 explores the risks and barriers to project development, categorized by technology and phase. By planning for and mitigating these risks, communities' and the State's return on investment (ROI) can be increased.

Chapter 5 provides an overview and brief analysis of current and historical state energy programs to understand what has been effective to date in bringing affordable energy to communities.

Chapter 6 expands on the cost drivers in Chapter 3 to delve into infrastructure and non-infrastructure opportunities for reducing community energy costs.

Chapter 7 builds on the results of all previous chapters to propose a framework for statutory, regulatory and policy changes to bring more affordable energy to Alaska communities.

CHAPTER 2: CURRENT CONDITIONS OF THE AKAES STUDY AREA

Key Takeaways

1. The median community size in the AkAES study area is about 300 people.
2. The wide variety of conditions across the state preclude any one-size-fits-all solution to delivery of affordable energy.
3. Heating buildings is approximately two-thirds of consumers' energy cost.
4. The cost of doing nothing new – the average annual capital cost of current energy infrastructure under the existing policy and regulatory framework in communities with populations less than 2,000 – is estimated to be more than $30M per year.
5. There is a wide range of communities' and utilities' ability to pay for needed energy projects. The differences in the tax and economic bases are widely dissimilar across the state.
6. Access to non-grant financing requires proper financial management, excluding some communities from being able to access project financing.

Alaska is an incredibly diverse state culturally, geographically, and economically. Each community and region has its own unique set of needs and opportunities. This great variability does not allow for a one-size-fits-all approach to energy solutions in Alaska. Chapter 2 outlines energy and demographic conditions within the AkAES study area.

To influence energy costs conditions as they currently are, it must first be adequately understood: What energy sources have people chosen? How much energy do different sectors of the economy consume? How much does energy cost per unit? Answers to these and other questions provide a baseline of information that the State and communities can use to test different ways of improving the situation.

In addition to information about energy, it is also important to understand community and regional demographics within the AkAES study area. Given the sheer number of communities within the study area, all analysis will be presented on the regional level in this report. Community-level data is available through the Alaska Affordable Energy Model (AAEM).[44]

AEA found that community population is generally the most important factor for estimating energy consumption. It is important, then, to forecast, using best available data and current trends, what communities might look like in the future.

Economic conditions in AkAES study area communities and regions are also investigated in this chapter. Outside of the Railbelt, Alaska's economic data is less reliable, which makes understanding complicated community issues such as access to non-grant financing difficult.

[44] The AAEM is accessible through AEA's website www.akenergyauthority.org

POPULATION

The AkAES region, home to approximately 165,000 people, encompasses approximately one-quarter of Alaska's population. Except for Juneau, all of the 240 communities within the study area have populations less than 10,000.

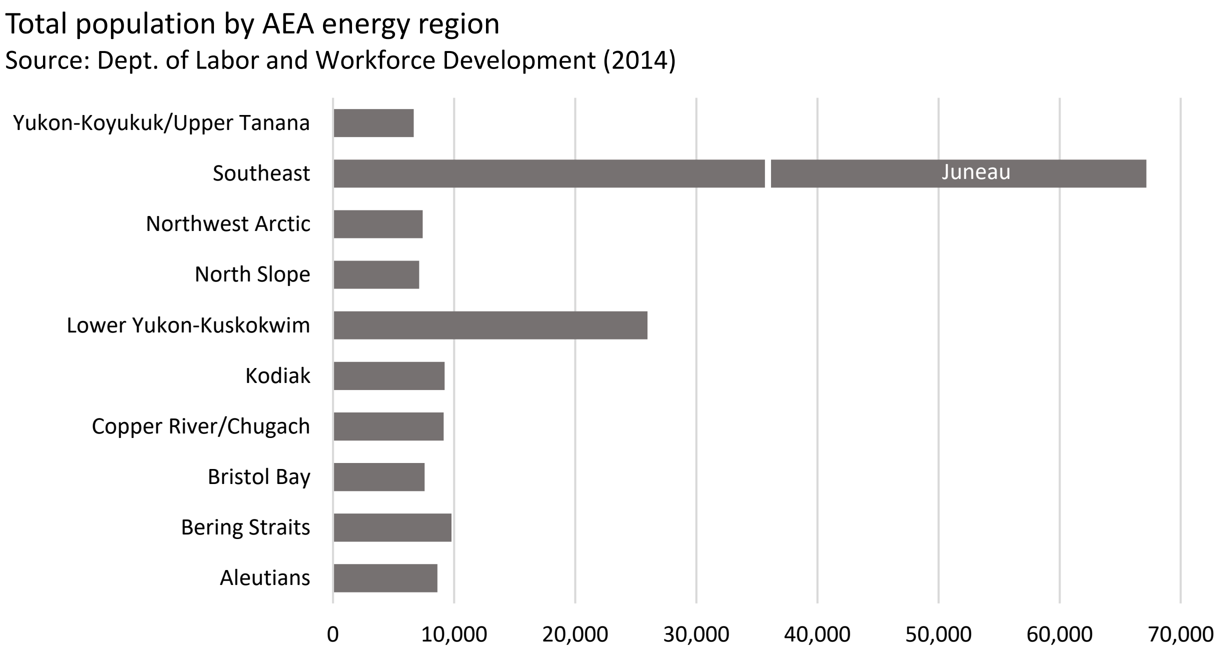


Figure 3: Total population by AEA energy region[45]

The AEA-defined energy regions are similar in population size, except for the Lower Yukon-Kuskokwim and Southeast regions, as seen in Figure 3. Throughout the report, information will be presented in a number of ways: in some cases, the data will be normalized by population or some other factor, but in other cases it will be summarized as totals. It will be important to recognize that the much larger populations of Southeast and the Lower Yukon-Kuskokwim will inevitably make those two regions more prominent—Southeast is nearly seven times larger in population and the Lower Yukon-Kuskokwim is almost three times larger in population than the other regions.

It is important to understand the diversity of community sizes within any given region and tailor energy affordability assistance to each specific community's needs.

[45] Alaska Dept. of Labor and Workforce Development population. Accessed through Alaska Energy Data Gateway.

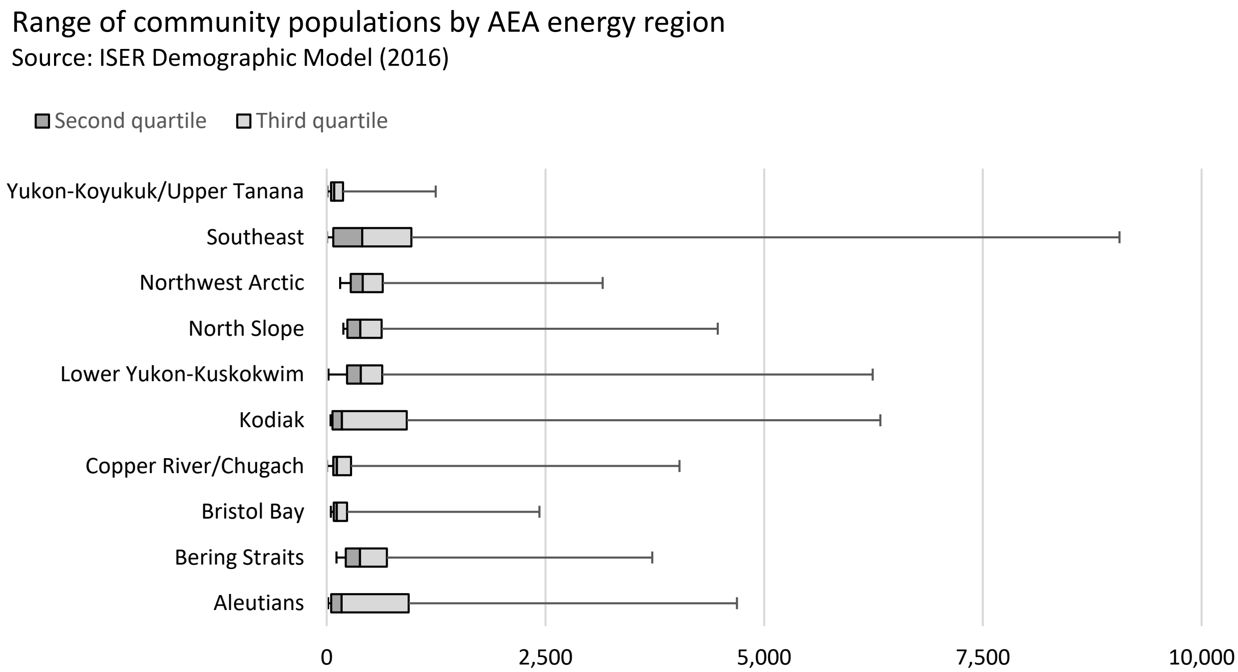


Figure 4: Range of community populations by AEA energy region[46]

The median population of communities in almost all regions is less than 300 people, as depicted in Figure 4 (Juneau has been removed from the chart so as not to skew the chart). In each region there is at least one large town over 1,000 people, the so-called regional hub. Most regional hubs have more than 2,000 people. The relatively small size of the largest community in the Yukon-Koyukuk/Upper Tanana region might indicate that Fairbanks effectively acts as the regional hub, which is why the maximum community size in the Yukon-Koyukuk/Upper Tanana is only 1,200 people.

Community size is particularly important when considering the value of economies of scale. While the majority of people live in communities greater than 1,200, the vast majority of towns are less than 300 people. As seen in Table 2, the smallest communities constitute about 60% of the communities in the AkAES study area but only 10% of the total population, and communities with populations greater than 1,200 make up 8% of the communities but 62% of the total study area population. It is just as important for the State to effectively assist the many small communities as it is to assist the fewer larger communities, and each of these communities has unique needs.

[46] AEA analysis of ISER demographic projection (2016)

Table 2: Distribution of population by community size[47]

Range of population	Number of communities	Percent of communities	Total population	Percent of population
Less than 300	137	60%	16,401	10%
Between 300 & 1,200	83	32%	47,577	28%
Greater than 1,200	20	8%	103,381	62%
AkAES total	**240**		**167,359**	

There are occasional inconsistencies in the number of communities included throughout this report. This is generally due to how various government agencies define "community;" some areas that might be considered "subdivisions" or "suburbs" of a larger town by one agency may or may not be included as a different place name by other agencies.

POPULATION CHANGE

The amount of population change–both long-term net changes and yearly turnover–can have important impacts on energy programs. As mentioned before, long-term population trends will greatly influence the amount of energy consumed in communities. The annual movement of people into and out of communities may also have important impacts on energy systems. Small changes in the community population could have major consequences, depending on who moves. If the community energy champion, who is a key part of any successful community energy project, moves out of the community, that movement will have an outsized impact on the community.

Except for a few isolated areas where energy-intensive industry exists (e.g. fish processing), population changes are the main predictor of future community energy load. This is most true in the residential sector, if we assume that the number of people per household remains constant through changes in community population.

Over the past 25 years, each energy region has experienced unique population trends. Population growth in communities and regions has occurred irregularly, with populations growing in some communities within a region and shrinking in other communities within the same region. Regional changes are not always good predictors for the population change for communities within that region. Since 1990, as a whole, Alaska has grown at a rate of 1.1% per year, with most of that growth taking place in the Cook Inlet region. Among the AkAES study area regions, only the North Slope region has surpassed the statewide average annual population growth.

[47] AEA analysis of ISER demographic projection (2016)

Regional average yearly population growth rates by AEA energy region
Sources: US Census and ADOL&WD 1990-2014

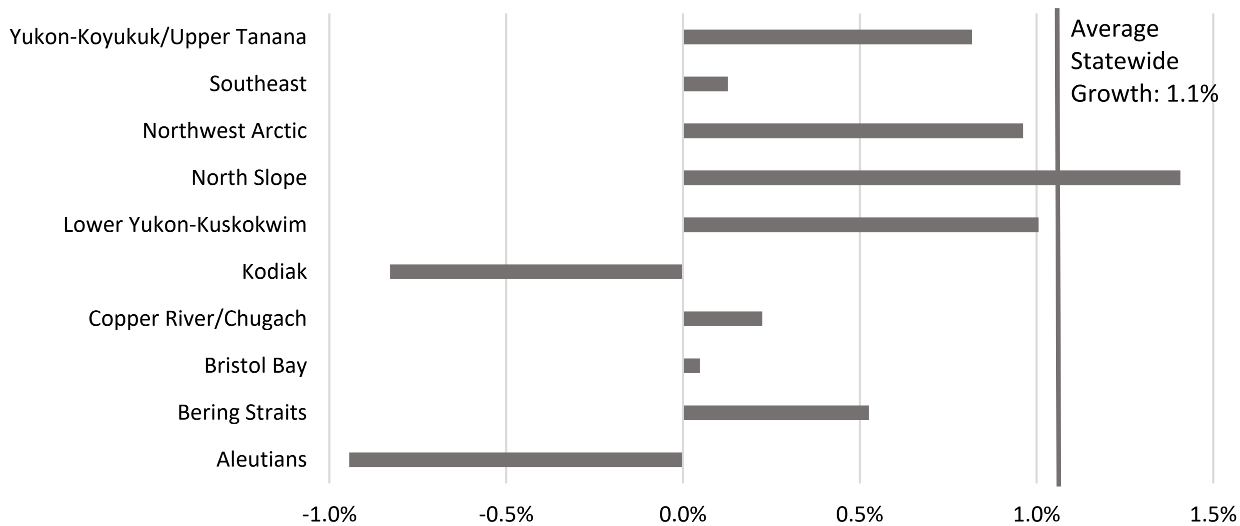


Figure 5: Regional average yearly population growth rates by AEA energy region[48]

Gross population changes hide high inmigration and outmigration on a yearly basis. Through Permanent Fund Dividend applications, the state is able to track how people move around the state. This dataset for the change between 2013 and 2014, in Figure 6, presents a clearer example of mobility as it removes the births and deaths from population change. While the migration shown in Figure 6 looks significant, it is not notably different from national averages. For example, between 2014-15, the U.S. Census estimated that 12% of Americans moved both within and between counties.[49]

Intraregional differences in population change are also hidden by the regional averages. Some communities have had rapid population growth and others have shrunk and disappeared.

[48] AEA analysis of U.S. Census and Alaska Department of Labor and Workforce Development data

[49] U.S. Census. Table 1. General mobility, by race and Hispanic origin, region, sex, age, relationship to householder, educational attainment, marital status, nativity, tenure, and poverty status: 2014 to 2015. http://www.census.gov/data/tables/2015/demo/geographic-mobility/cps-2015.html

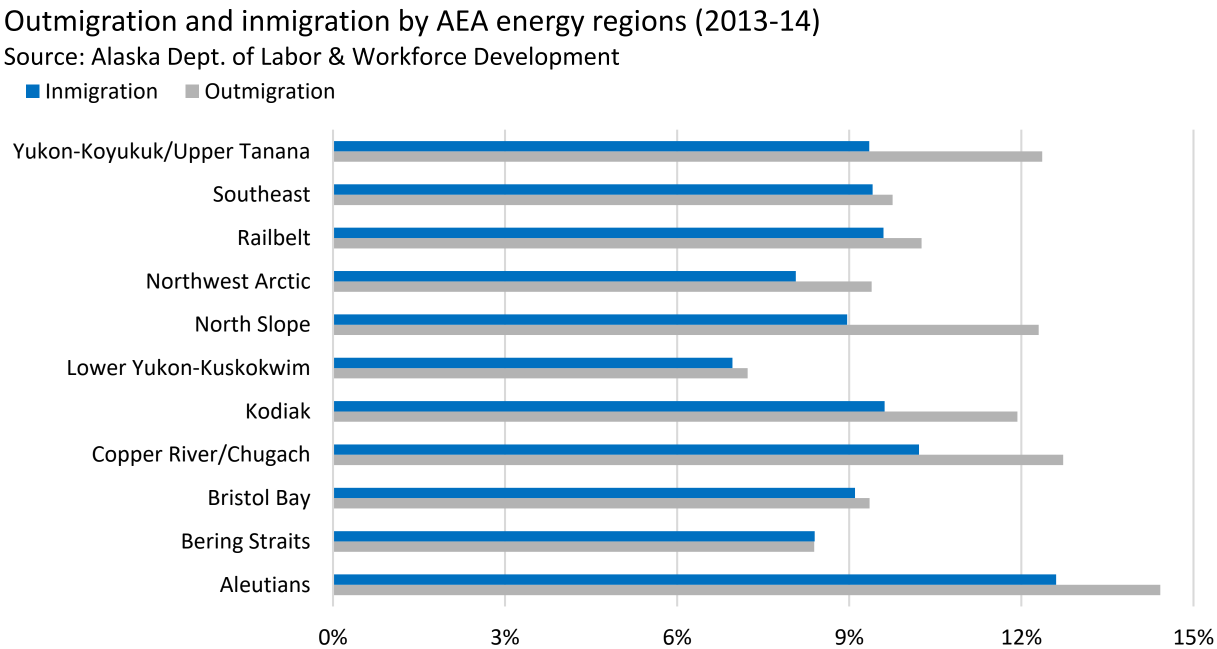


Figure 6: Outmigration and inmigration by AEA energy regions[50]

Between 2013 and 2014, only the Bering Straits region had more people move into it than moved out. The Lower Yukon-Kuskokwim was the least mobile region, both inbound and outbound, whereas the Aleutians saw the most movement into and out of the region.

It has been suggested that high-energy costs are a primary motivating factor for people moving from Alaska's rural communities. Research has not been able to confirm this suggestion. Worldwide there is a trend of people moving to urban areas. In Alaska, researchers have found that people are most likely to move from small communities to hub communities and then from hub communities to urban communities.[51] Two different studies performed by ISER over the past decade, using very different methods, did not find a strong relationship between the cost of energy and migration patterns.[52,53] Other considerations, such job opportunities, education, and safety, appear to be more important factors. It is unlikely that delivering more affordable energy to communities will change the migration trends, as complex factors influence individual decisions on where they live.

There is a perception that personnel turnover at rural utilities is high due to outmigration, but there are unfortunately few data sources to confirm this perception. The list of participants in AEA's training programs suggests that is true with some exceptions. Of the approximately 1,000 participants, most had only attended one course, but 52 had taken courses over at least a 5-year period, and 17 over a 10-year

[50] AEA analysis of "Change in Borough or Census Area of Residence for Alaska Permanent Fund Dividend Applicants, 2013 to 2014" from Alaska Department of Labor and Workforce Development, Research and Analysis Section (2014). http://live.laborstats.alaska.gov/pop/migration/PFDMigrationBCA.xls

[51] E Lance Howe, Lee Huskey, and Matthew Berman. "Migration in Arctic Alaska: Empirical evidence of the stepping stones hypothesis." Migrat Stud (2014) 2 (1): 97-123.doi: 10.1093/migration/mnt017

[52] Stephanie Martin, Mary Killorin, and Steve Colt, "Fuel Costs, Migration, and Community Viability", May 2008. http://www.iser.uaa.alaska.edu/Publications/Fuelcost_viability_final.pdf

[53] Matt Berman and Eddie Hunsinger, "Energy Cost and Rural Alaska Out-migration." 2016.

period. AEA's 2015 bulk fuel assessment, an evaluation of 56 communities that had been pre-identified as being in the most need, showed that the 130 bulk fuel operators in those communities had an average of 10 years of experience, but there was no indication of the length of tenure.[54] It is likely that personnel turnover is highly variable by community and utility.

ENERGY SOURCES, CONSUMPTION, AND COSTS ACROSS THE STUDY AREA

Before the cost of energy in communities can be influenced, it is important to understand the baseline. What types of energy are consumed? How much is consumed? How much does it cost?

Since the information presented in this section is at the regional level, some of the variations within regions will be muted. Some regions are composed of similar types of communities with very similar conditions, while other regions have significant variability. Community-level data is not shown in this report; instead, the community-level data has been aggregated on the regional level.

ENERGY SOURCES CONSUMED ACROSS THE AKAES STUDY AREA

The two primary uses of energy in communities, are for electricity and heat. Within regions there can be significant differences in the ratio between end-use heat and electricity consumption, as a number of factors can impact energy consumption. Figure 7 shows the end-use consumption of energy for residential and non-residential buildings in the AkAES study area. In cases where communities also use electricity for heat, it is included in the "electricity" column. This chart represents "site energy," that is energy consumed on site, instead of "source energy," which also includes the fuel needed to produce the energy—as in the case of electricity produced by diesel-fired generators.

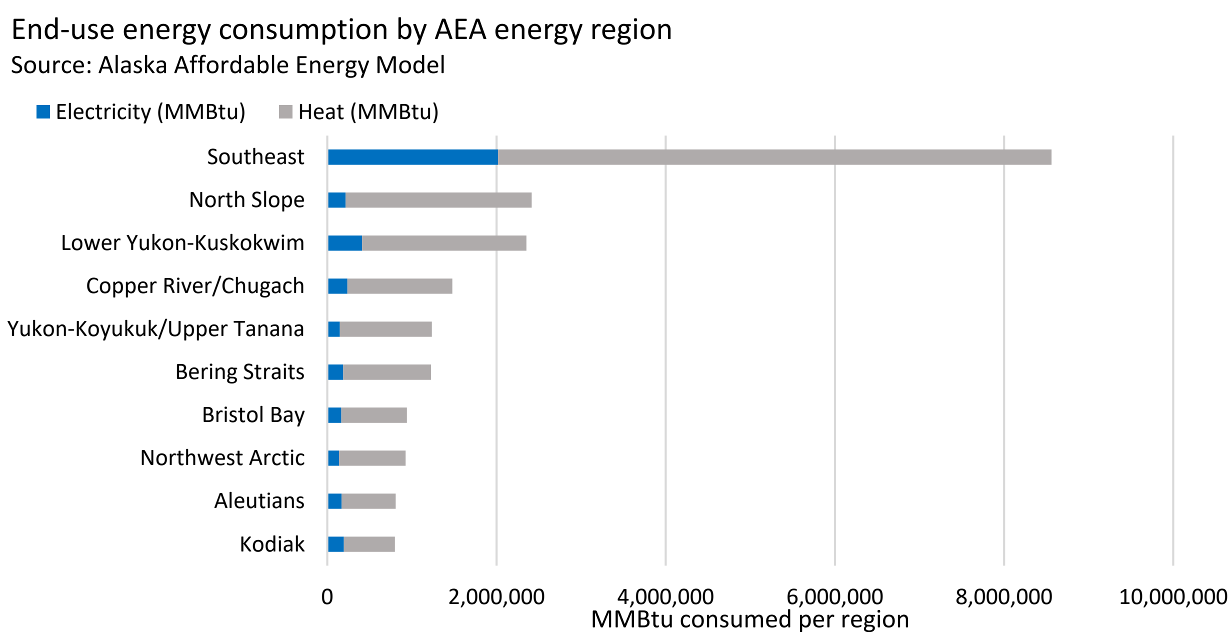


Figure 7: End-use energy consumption by AEA energy region[55]

---

[54] Unpublished AEA data

[55] AEA analysis of Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

The Southeast region consumes significantly more energy for electricity and heat than any other region, primarily due to that region's much larger population. In all regions within the AkAES study area, heat is the main end-use energy need in terms of units of energy. As a percentage of end-use consumption, electricity ranges from about 10% in the North Slope to over 20% in the Southeast and Kodiak regions. It should be noted that the energy needed to produce electricity is not factored into Figure 7.

AkAES study area diesel consumption

Based on estimates from the Alaska Affordable Energy Model, approximately 120 million gallons of diesel and heating oil are consumed within all AkAES regions together. Figure 8 illustrates how these gallons are consumed by the different regions. This figure includes the "source energy" for diesel-fired generation.

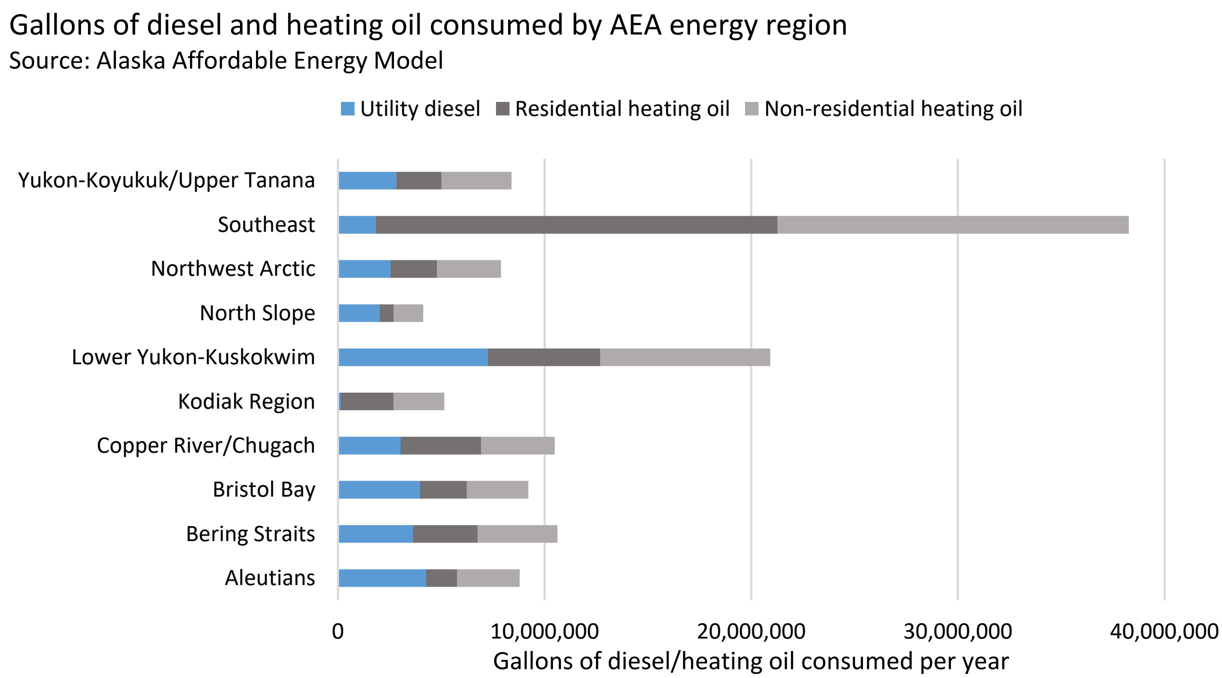


Figure 8: Gallons of diesel and heating oil consumed by AEA energy region[56]

With the exception of Kodiak, the Southeast region consumes the least amount of diesel for electric generation despite its large population and higher per capita electricity consumption; both Kodiak and Southeast have large, mature hydro projects that provide the majority of power in the more populated communities Diesel consumption in the North Slope region is unexpectedly small because of access to locally supplied natural gas in Barrow and Nuiqsut. In general, diesel for electricity is about one-third of the diesel and/or heating oil consumed in any given community. All regions rely heavily on heating oil for both residential and non-residential heat.

Electricity in the AkAES study area

Of all the energy data available in Alaska, electricity is the most reliable. Almost all communities have a certificated utility, and the utilities are required to report generation and sales figures to AEA, the

[56] AEA analysis of Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

Regulatory Commission of Alaska (RCA), and/or the federal Energy Information Authority (EIA). Electricity is charged by the unit, and sales are easily measured for billing purposes.

Figure 9 shows the large regional and intra-regional differences for how electricity is generated.

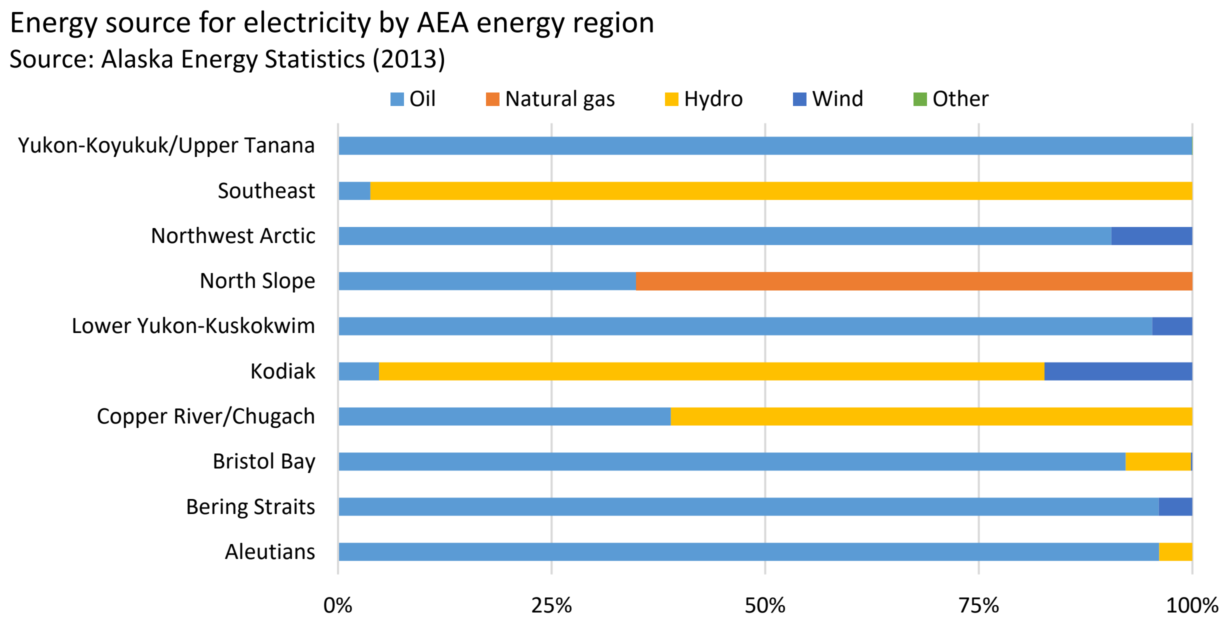


Figure 9: Energy source for electricity by AEA energy region[57]

Energy sources for electricity generation within the AkAES study area vary considerably. Outside the Railbelt region, natural gas is used to generate electricity in only two communities – North Slope's Barrow and Nuiqsut. Regional electricity production totals hide variation at the local level — Southeast in particular shows nearly 100% hydropower, which is true in Juneau, Ketchikan, Metlakatla, Wrangell, Sitka, and Petersburg. However, some of the other smaller, isolated communities rely solely on diesel. Southeast and Kodiak generate more than 90% of their electricity through renewable energy sources, whereas the Aleutians, Bering Straits, Bristol Bay, Lower Yukon-Kuskokwim, and Yukon-Koyukuk/Upper Tanana regions are almost entirely reliant on diesel for power generation.

A relatively small but increasing amount of wind power is generated in the Bering Straits, Lower Yukon-Kuskokwim, and Northwest Arctic regions. Bristol Bay and Aleutians regions have developed some hydro resources. As we will see in Chapter 6, there are still a number of cost-effective renewable energy options that can be capitalized on using available technology. Future changes in technology costs and/or performance may increase the range of where renewable resources are economically viable.

The amount of hydro and wind generation is expected to increase as more projects funded through the Renewable Energy Fund (REF) come online.

[57] AEA analysis of Alaska Energy Statistics (2012). Accessible from: http://www.akenergyauthority.org/Publications

HEAT SOURCES IN AKAES STUDY AREA

Mostly due to Alaska's cold climate, heating accounts for the largest percentage of energy consumption for consumers across all AkAES study area regions. Except for two natural gas utilities on the North Slope, Barrow and Nuiqsut, heating fuels are supplied by an unregulated local heating oil company. Because of this, the volumes and types of heating fuels consumed are not known with the same precision as is electricity consumption. The most reliable and widespread data source for residential heating information was through the American Community Survey (ACS), a product of the U.S. Census that is updated on a rolling five-year schedule. Figure 10 compiles the data from the ACS by AEA energy region and shows the diverse range of sources used to heat homes in Alaska. Throughout the following figures, the Railbelt is included as a means of comparison.

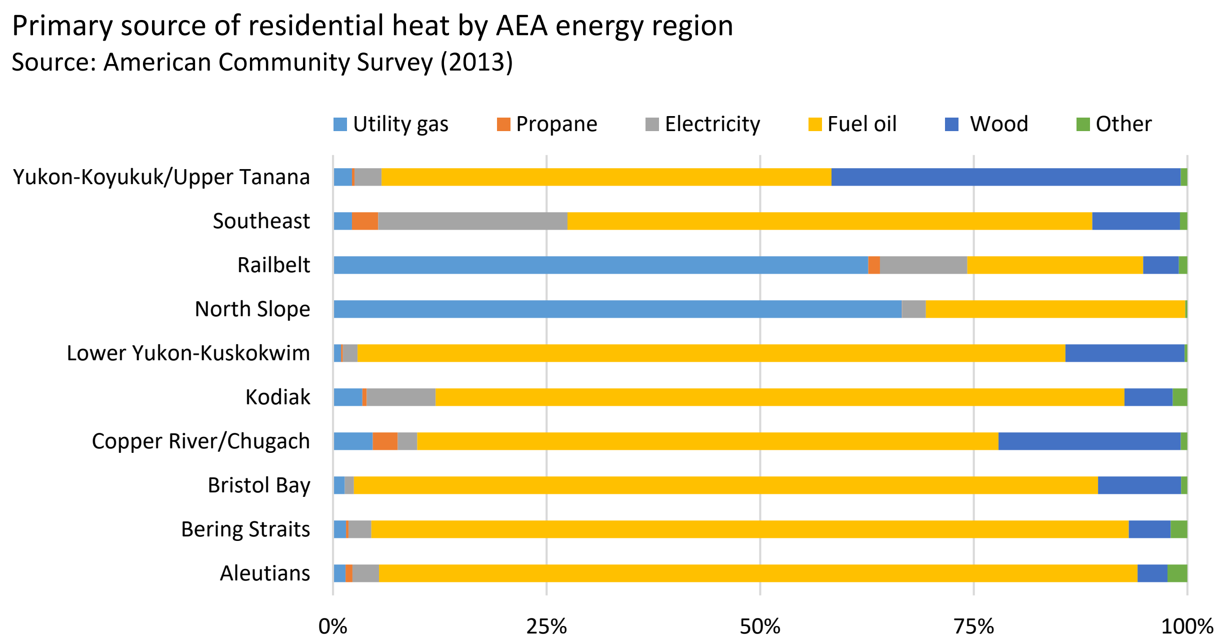


Figure 10: Primary source of residential heat by AEA energy region[58]

The first thing to note is the apparent statistical aberrations: utility gas (natural gas) is not available outside of the Railbelt and the North Slope, but we have not removed this data. A number of the other categories less than 2% were aggregated as "other", including coal, solar, and other.

In the regions that have access to natural gas, nearly all customers who have access choose to connect to the utility. In the other regions there is a mix of fuel used. In areas with forests—Yukon-Kuskokwim/Upper Tanana and Copper River, in particular—there is a significant amount of firewood used to heat homes. Except for the relatively high penetration of electric heat (almost 20%) in Southeast, the vast majority of residential heat throughout the AkAES study area is supplied by fuel oil. Without a significant reason to change these choices, AEA assumes that this regional residential heat profile will remain the same into the future.

[58] United States Census Bureau. "B25040: House Heating Fuel [10]". 2008-13 U.S. Census Bureau's American Community Survey Office, 2013. January 2015 <http://ftp2.census.gov/>.

Fuel oil is also the fuel of choice for non-residential buildings. Of the nearly 6,000 non-residential buildings identified in the AkAES study area (out of approximately 10,000 total assumed buildings), very few use an alternative to fuel oil for heat. An unknown but potentially sizable number of non-residential buildings in Southeast communities with low-cost hydropower use electric resistance heating.[59] Sixty non-residential buildings and five water and wastewater systems currently use biomass as heat. Sixty-one buildings have been identified as utilizing heat recovered from diesel generators. A small number of buildings use heat from excess electricity generated by wind or hydro as secondary loads.

HOW COMMUNITIES CONSUME ENERGY

This section offers more detailed information on how energy is consumed in the regions.

PER CAPITA DIFFERENCES IN CONSUMPTION BASED ON THE SIZE OF COMMUNITY

While regional differences in how energy is consumed exist, there are also strong differences in energy consumption and costs based on the size of the community. In general, smaller communities have fewer types and smaller buildings than larger communities. Based on the available data, almost all communities have a core set of buildings—a school, clinic, warehouse, store, municipal or tribal facility, community hall—and these buildings do not necessarily get smaller at the same rate as the population. These factors lead to greater per capita non-residential energy consumption in the smallest communities.

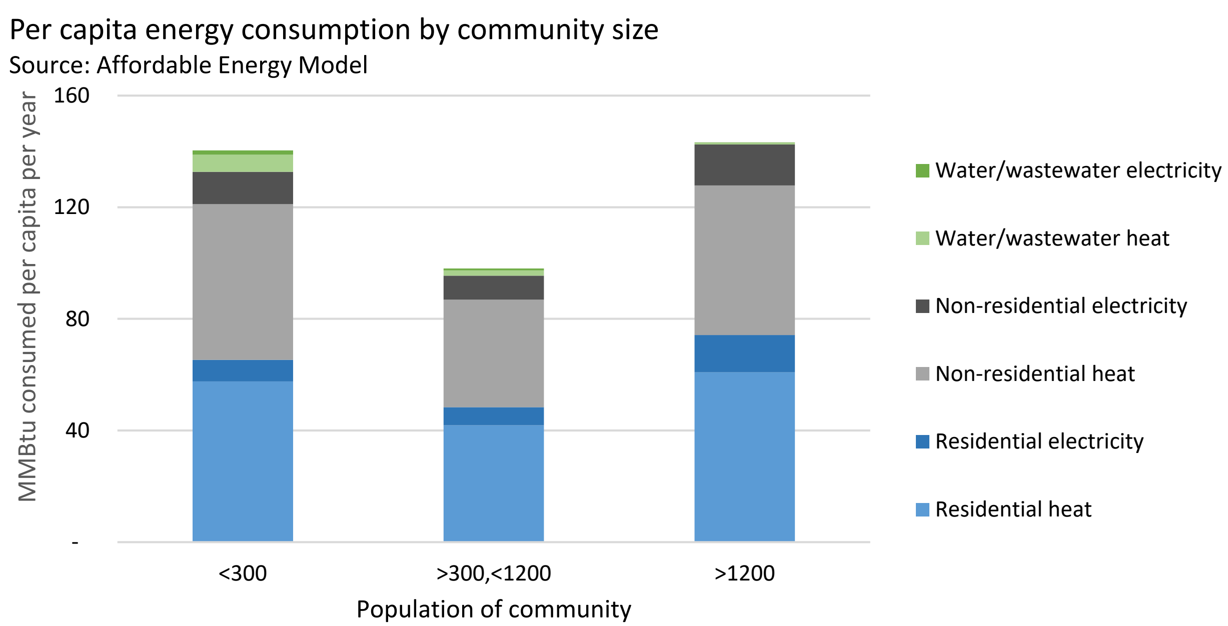


Figure 11: Per capita consumption in MMBtu/year by community size[60]

The largest communities, defined here as those with populations of more than 1,200, have the highest per capita consumption of energy. The largest communities had the highest per capita consumption in all categories, except for water/wastewater heat and electricity. The largest communities generally serve as

[59] Black & Veatch. "Southeast Alaska Integrated Resource Plan." July 2012. http://www.akenergyauthority.org/Content/Publications/SEIRP/SEIRP-Vol1-ExecSumm.pdf

[60] AEA analysis of results from Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

hubs for the medium-sized and smallest communities within their region, with the additional services and facilities that this would require. It is surprising that the medium-size communities, defined as having a population between 300 and 1,200, have the lowest per capita consumption, but this may be due to a limited amount of economy of scale relative to the smallest communities. These communities have more people to stretch the basic services seen in almost all communities—schools, public safety, public assembly etc.—but not so much of an expanded economy as to have the ancillary businesses and services of the larger communities.

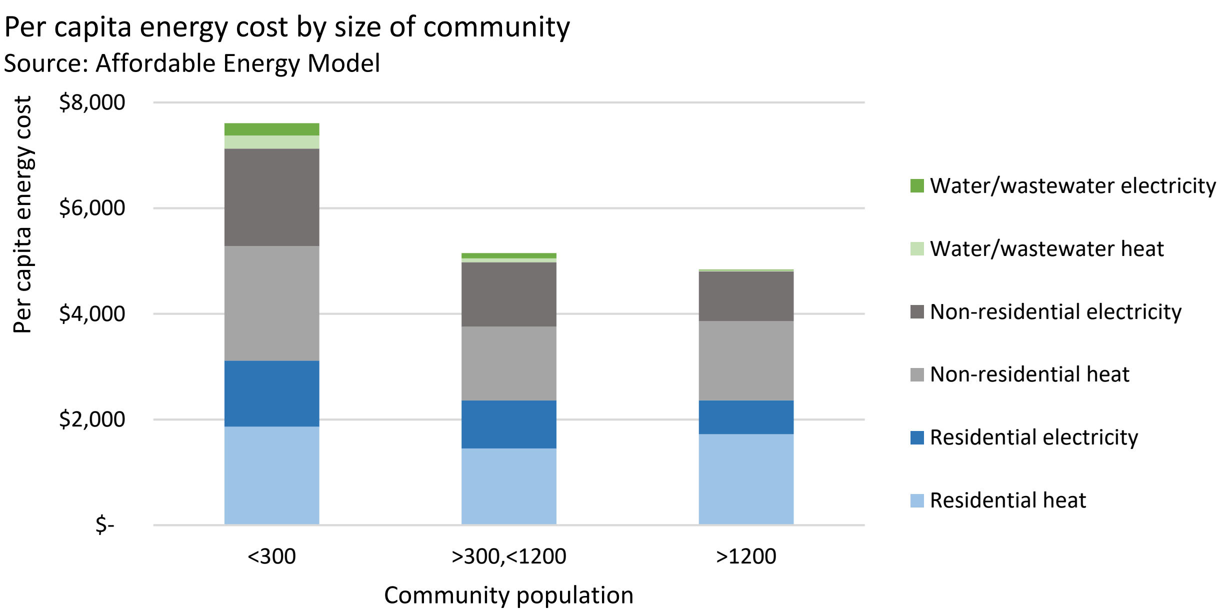


Figure 12: Per capita energy cost by size of community[61]

Figure 12 shows a strikingly different picture from Figure 11. Displaying energy costs per person by community size illustrates a distinct upwards trend as communities decrease in size—the total per-capita cost in the smallest communities are nearly twice as much as the largest category of communities in the AkAES study area. Figure 12 does not include subsidies, such as Power Cost Equalization (PCE) or the federal Low-income Heating Assistance Program (LIHEAP) or the State Alaska Heating Assistance Program (AKHAP).

Water/wastewater energy use becomes a larger share of the consumption and cost as a community decreases in size. A baseline amount of energy is needed to run these systems regardless of the number of customers, and the incremental increase for each additional person is relatively small.

The per capita cost of electricity—residential, non-residential, and water/wastewater—has the largest difference across the community sizes. Small communities generally have a minimum number and size of buildings — public safety, education, store, etc. — that get spread out over fewer people in smaller communities.

[61] AEA analysis of results from Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

Consumption of Electricity

As mentioned before, electricity generation and sales are reported to state and federal agencies. The data aggregated and analyzed in this report generally maintain a distinction between the residential and non-residential sectors. Depending on the community, the non-residential sector can include a number of subsectors, e.g., industry, government, public facilities, and commercial, but such granular detail is not always available for all communities. Figure 13 shows the average annual per capita consumption by region in megawatt-hours (MWhs); each MWh is equal to 1,000 kilowatt-hours (kWh).

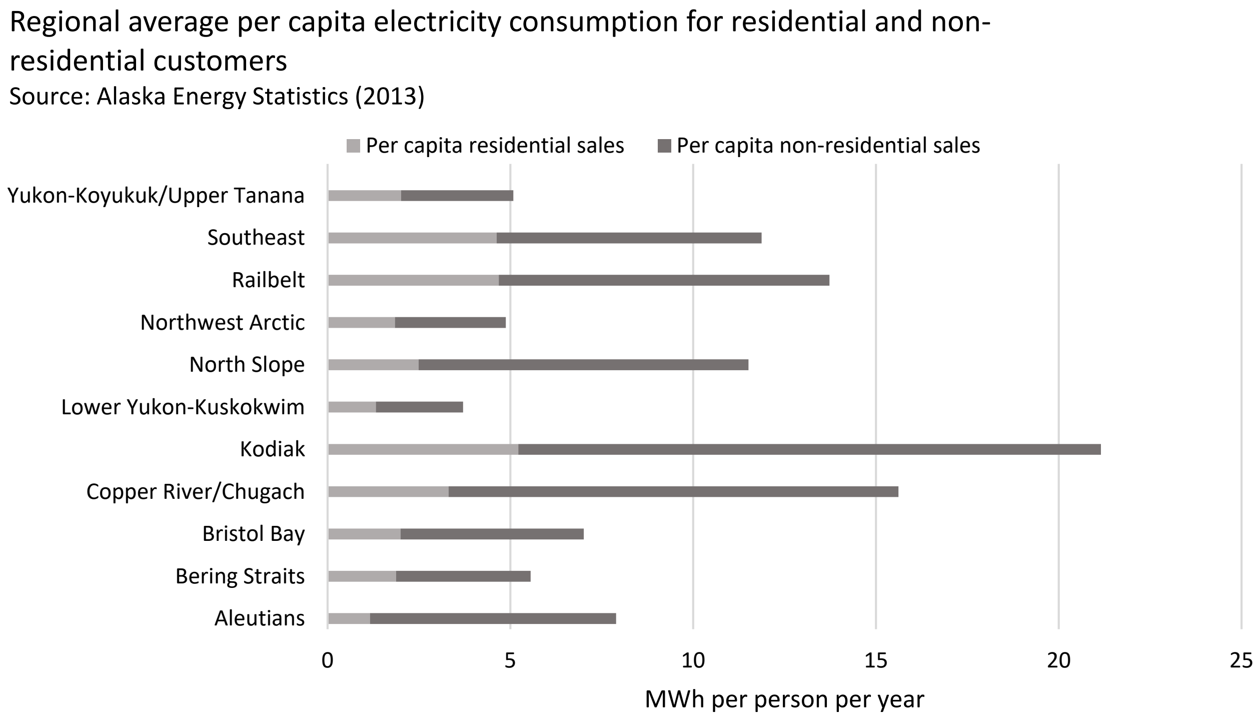


Figure 13: Regional average per capita electricity consumption for residential and non-residential customers[62]

There is a huge difference in average per capita electricity consumption between regions. Annual use in the residential sector ranges from just over one MWh per capita, as in the Aleutians, to more than five MWh per capita, as in Kodiak. The residential sector in some regions, such as Kodiak, Southeast, and the Railbelt, consumes more or nearly as much as all sectors combined in other regions, such as Lower Yukon-Kuskokwim and Northwest Arctic. Factors likely contributing to these regional differences include the number of people per household, the economic prosperity of the region, and the price of electricity.

Although there are likely a number of contributing factors, including, but not limited to the unit price of electricity, there is a clear trend, Table 3 shows that residential customers consume less electricity when the unit price is higher.

[62] Alaska Energy Statistics, 2013. Accessible from: http://www.akenergyauthority.org/Publications

Table 3: Mean consumption per residential customer per month in PCE communities[63]

Effective rate	kWh per customer per month	Average cost per month
Less than $0.19	453	$ 86.07
$0.20-0.29	395	$98.75
$0.30-0.39	304	$106.40
$0.40-0.49	304	$136.80
$0.5-0.59	178	$97.90
More than $0.60	212	$137.80

Table 3 also shows that the effective rate consumers pay, after including PCE payments, is closely correlated with the amount of electricity consumed. The average amount spent per month is relatively consistent across each of the rate groups, at approximately $110/month, plus or minus about $20. This value does not include the seasonality of consumption, as in winter PCE covers 65% to 83% of residential consumption (this figure is 70% to 94% in summer).[64] Other factors, such as the size of housing and the economic condition of the community, also contribute to this trend. If all communities charge cost-based rates and are able to provide documentation for utility costs, the effective rate in all communities would be nearly equal and near the PCE base rate. Thus, the higher effective rate might be indicative of other community attributes that could also affect consumption. Table 3 could indicate that a reduction in a community's electric rate might increase consumption, an effect referred to as rebound.[65]

The amount of non-residential consumption is an indicator of the amount and type of industries in a region. More energy-intensive industries, at least on a per capita basis, such as fish processing in the Aleutians, Copper River/Chugach, and Kodiak or the oil transportation industry in the Copper River/Chugach region, have much more non-residential energy consumption than less developed areas. The data in Figure 13 actually underestimates the consumption in some regions, particularly the Aleutians, since a number of industries, such as fish processors, self-generate. The high cost of running an electric utility makes it relatively less expensive for some consumers to generate their own power, which is termed bypass risk.[66] Additionally, in some communities the local schools also self-generate.

The differences in regional and community industrial activity are a factor that influences the consumption of electricity in communities. The community population is another factor that influences electricity

---

[63] Alaska Energy Statistics, 2013. Accessible from: http://www.akenergyauthority.org/Publications
[64] Alaska Energy Statistics, 2013. Accessible from: http://www.akenergyauthority.org/Publications
[65] Jesse Jenkins, Ted Nordhaus, and Michael Shellenberger. "Energy Emergence: Rebound & Backfire as Emergent Phenomena." February 2011. http://thebreakthrough.org/blog/Energy_Emergence.pdf
[66] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

consumption. As seen in Table 4, the average contribution of each building type changes with the size of the community, but is most noticeable in the education sector.

Table 4: Percentage of non-residential electricity consumption by building type[67]

Building Type	<300	Between 300 & 1200	>1200
Education	25%	26%	10%
Office	8%	5%	5%
Public Assembly	5%	4%	5%
Accommodation Services	5%	3%	1%
Warehousing	5%	4%	1%
Health Care - Hospitals	4%	2%	4%
All other	49%	55%	76%

The education sector is the largest known consumer of electricity in study-area communities; however, the contribution decreases in the largest communities as a more diverse economy increases the contribution from other sectors. Offices, public assembly, accommodation services, clinic/hospitals, and warehouses are responsible for the second tier of known consumer electricity consumption in the AkAES study area. Data such as this will help communities and the State target particular sectors that will most benefit from efficiency.

Heat consumption

As mentioned before, outside of the natural gas service areas, information about the amount of energy consumed to heat the built environment is not collected by any state or federal agencies, so the data for heating fuels has been modeled. The description of the method used to develop modeled estimates in this section is explained in depth in the supplemental material.[68] Chapter 3 will explore the factors influencing consumption in greater depth.

Residential heating

While it might not always be the largest sector for heating fuels consumption in a community, residential heating is what impacts individual Alaskans most directly. Numerous studies have shown that heating is the largest energy cost for most households, and this is also indicated in the AAEM. Outside of the communities with natural gas, which can be easily measured for sales, the consumption of most heating fuels is not directly measured.

---

[67] AEA analysis of results from Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

[68] http://www.akenergyauthority.org/Policy-Planning/AlaskaAffordableEnergyStrategy

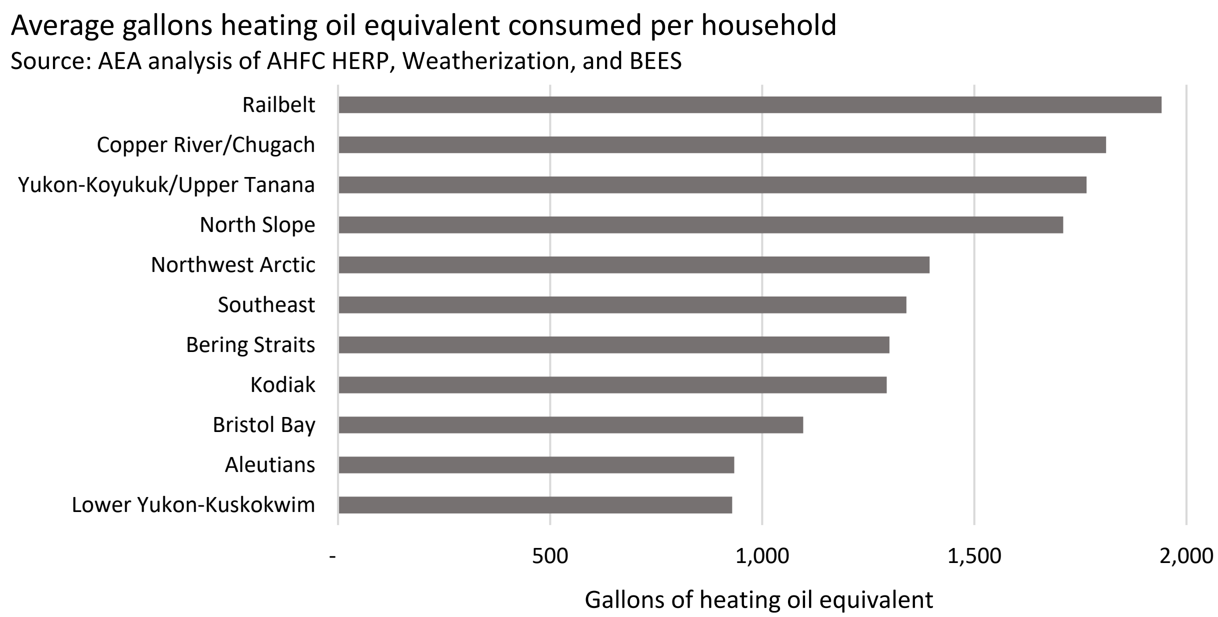


Figure 14: Average gallons of heating oil equivalent consumed per household[69]

In order to have a common unit to discuss the thermal load of residences, Figure 14 shows all energy sources (wood, natural gas, etc.) in the equivalent number of gallons of heating oil. For example, even though the Yukon-Koyukuk/Upper Tanana region has a high percentage of wood consumption, the energy in wood is shown here as an equivalent gallons of heating oil. The values presented above are based on AHFC data from over 17,000 audits of houses in the AkAES region. It may be surprising that some of the colder parts of the state, such as the Lower Yukon-Kuskokwim and Bering Straits, are in the lower end of heat energy consumption. As we will see in Chapter 3, multiple factors influence consumption, and the climate is just one of the drivers.

Non-residential heating

Just like electricity consumption, the impact of non-residential heat consumption is not generally felt directly by residences. Instead it is indirectly paid for in more expensive goods and services, reduced government services, constrained choices, and higher water and sewer rates.

Table 5: Percent of total non-residential heating fuel consumption by community size[70]

Building Type	<300	Between 300 & 1200	>1200
Education	28%	33%	13%
Office	8%	5%	6%
Public Assembly	7%	5%	3%
Accommodation Services	3%	2%	1%
Warehousing	6%	5%	2%
Health Care - Hospitals	3%	2%	2%
All other	45%	48%	73%

[69] AEA data analysis based on records in Alaska Retrofit Information System (2015)
[70] AEA analysis of results from Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

As a whole, the results shown in Table 5 are similar to those seen in Table 4. Education is the largest identified consumer of thermal energy, up to one-third of all non-residential heating oil consumption in some communities.

RATES FOR ELECTRICITY AND HEAT

The total amount that people pay for energy is determined by the combination of the amount consumed and the rates utilities charge. Knowing the rates is obviously an important part of evaluating the opportunity for bringing more affordable energy to communities; Chapter 3 will delve into understanding why the rates are what they are.

Rates undoubtedly influence how people consume energy, but we have little hard evidence to definitively show or test this, particularly for heating fuels. There is likely less elasticity of demand for heating fuels than for electricity, especially as heat load is controlled more by the quality of building design and construction than personal choice, though some factor of demand will always be based on consumer choices such as building size, interior temperature set points, leaving doors and windows open, etc.

Table 6 provides the most common units and their abbreviations, detailing how each will be used in this report to represent regional energy sources. A common option for trying to reduce costs is to evaluate if switching fuels will be effective. Since it can be difficult to understand how the value of a certain number of kilowatt-hours (kWh) compares to gallons of heating oil, Table 6 provides a common reference between each energy type and the equivalent unit price of heating oil. The table does not include the different potential conversion efficiencies of each fuel type.

Table 6: Cost conversions for various energy sources

Fuel type	Heating oil ($/gal)	Electricity ($/kWh)	Natural gas ($/Mcf)	Firewood ($/cord)	Pellets ($/ton)	Propane ($/gal)
Assumed energy density	*0.138 MMBtu/ gal*	*0.003412 MMBtu/ kWh*	*1.028 MMBtu/Mcf*	*16 MMBtu/ cord*	*17.6 MMBtu/ton*	*0.0915 MMBtu/ gal*
Equivalent unit prices	$ 1.00	$ 0.02	$ 7.45	$ 116	$ 105	$ 0.66
	$ 2.00	$ 0.05	$ 14.90	$ 232	$ 211	$ 1.33
	$ 3.00	$ 0.07	$ 22.35	$ 348	$ 316	$ 1.99
	$ 4.00	$ 0.10	$ 29.80	$ 464	$ 422	$ 2.65
	$ 5.00	$ 0.12	$ 37.25	$ 580	$ 527	$ 3.32
	$ 6.00	$ 0.15	$ 44.70	$ 696	$ 633	$ 3.98
	$ 7.00	$ 0.17	$ 52.14	$ 812	$ 738	$ 4.64
	$ 8.00	$ 0.20	$ 59.59	$ 928	$ 844	$ 5.30
	$ 9.00	$ 0.22	$ 67.04	$ 1,043	$ 948	$ 5.97
	$ 10.00	$ 0.25	$ 74.49	$ 1,159	$ 1,054	$ 6.63

Table 6 can be most readily understood by following any given price of heating oil horizontally to find the equivalent unit cost for each of the other fuels. For example, for propane to be cost competitive with heating oil when heating oil is $4.00 per gallon, propane must be less than $2.65 per gallon.

ELECTRIC RATES

Electricity is the highest quality and most useful form of energy available—its versatility allows it to be used for a wider array of uses than other energy sources. Because of its flexibility, electricity has become a requirement for a modern American lifestyle and achieving operational efficiency for businesses.

To put the rates shown in Figure 15 in perspective, the average U.S. electricity rate is $0.12/kWh.[71] While especially high electricity rates may impede economic growth, reduce profits, and/or complicate household financial choices, other highly industrialized countries have significantly higher rates than the U.S. For example, the average electricity rate in Germany is $0.29/kWh[72], and Germany has been able to maintain one of the strongest manufacturing sectors in the world. This indicates that a complex relationship between energy costs and economic development exists. The Railbelt is included for sake of comparison.

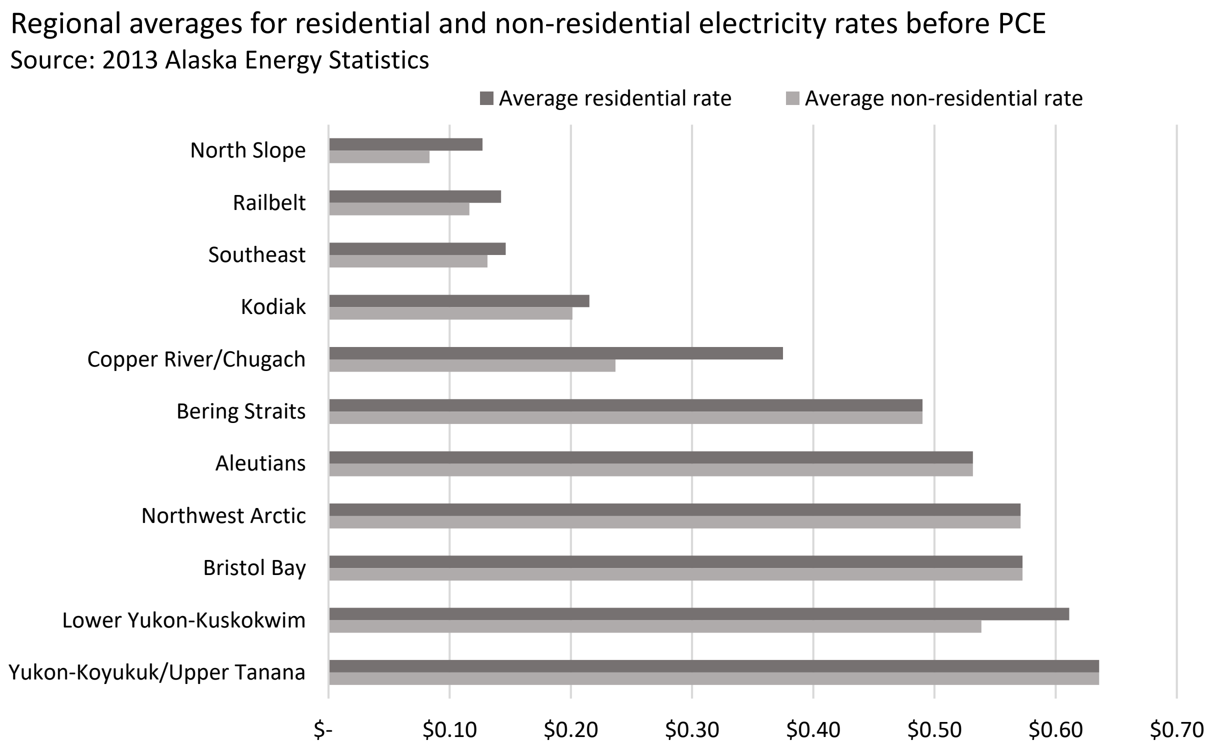


Figure 15: Regional averages for residential and non-residential electricity rates before PCE reimbursement[73]

The similarities between the non-residential and residential rates show a combination of a lack of discernable differentiation in pricing structures and lack of data. In particular, smaller utilities are less likely to have separate rates for different sectors or to have tiered rates.[74] On average, the rural regions have electric rates four times higher than the Railbelt or larger communities in Southeast. Factors

[71] Jess Jiang, "The Price of Electricity in Your State." National Public Radio. October 28, 2011. http://www.npr.org/sections/money/2011/10/27/141766341/the-price-of-electricity-in-your-state
[72] Ellen Thalman, "What German households pay for power." November 2, 2016. https://www.cleanenergywire.org/factsheets/what-german-households-pay-power
[73] Alaska Energy Statistics, 2013. Accessible from: http://www.akenergyauthority.org/Publications
[74] Unpublished AEA analysis of PCE filings to RCA (2000-2014)

contributing to these price differences, explored in more detail in Chapter 3, include higher fuel costs, due to more expensive diesel fuel, lower generation efficiency, and higher line losses, as well as non-fuel costs, such as labor and materials. The regional weighted averages used in Figure 15 hide large differences within the regions, as can be seen in the map Figure 16.

Data on non-residential electricity rates are not collected systematically by any agency. Likewise, if there are multiple residential rates or tiered rates, these are not included in publically available databases. The lack of access to data can cause some limitations on understanding the impact of policies and projects on all consumers, especially if there are different price structures for different types of users.

It is important to recognize that the rates paid by consumers do not necessarily reflect the true cost of delivering power. Due to a subsidy across the borough, the North Slope has an anomalously low electricity rate. The subsidies for residential customers can be greater than $0.70/kWh in some communities. In many other communities, if the capital costs for generation plants, much of which was paid for through state and federal grants, were included, the retail rates would be significantly higher. This will be detailed in Chapter 3.

Figure 16 shows residential rates across the state, and it is easy to see that there are large differences across regions. The North Slope is subsidized by the borough. Southeast has significant variety, both some of the lowest and some of highest cost utilities in the state.

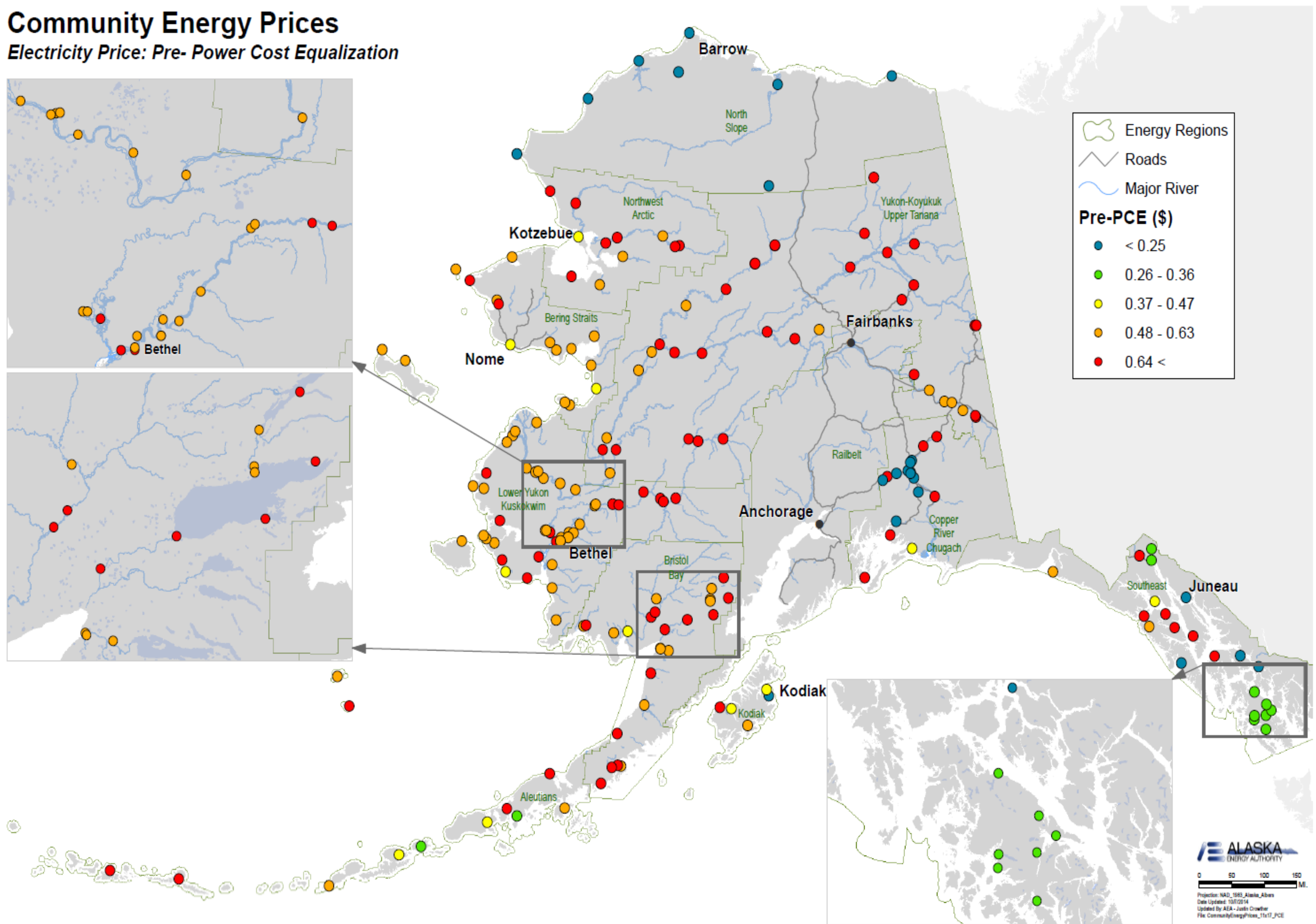


Figure 16: Map of residential electricity prices in AkAES study area

Heating fuel rates

Outside of the Railbelt, heating oil is the main source of heat for residential and non-residential facilities due to convenience as well as safety of use and ease of transport. It is because heating oil is commonly used that all other fuels are compared to heating oil in this report, and this section focuses on the consumer rates of heating oil.

While heating oil constitutes the majority of all thermal loads outside of the Railbelt, other energy sources, such as electricity, biomass (cordwood and pellets), propane and natural gas, contribute a locally and/or regionally important role in maintaining safe and healthy temperatures in buildings.

Electricity is generally only used for heat in the Southeast region, where some utilities have special rates and metering for electric heat.

Firewood—otherwise referred to as cordwood—requires attention of a person to start and stoke the fire and, as such, is much more labor intensive than the other heating fuels in this section. In addition, firewood can be "free" if it is collected by a household. Even though there is not a dollar amount ascribed to it, there is still a cost to collecting firewood. We do not know how to calculate the opportunity costs accrued by those collecting firewood themselves, nor do we know how many people participate in this activity instead of purchasing firewood. AEA has used the reported prices in communities and regions as the rate for firewood, even if people have collected their own firewood. The amount of energy in a cord of wood varies by species of wood, regionally defined parameters, as well as water content of the wood, which must be considered because of boilers that do not capture the heat used to boil off the water in the wood.

Pellets are a relatively recent product on the market. With uniform size, shape, moisture and energy content, pellets allow for a mechanization and control of temperature output, unlike cordwood, and they also provide a convenience more similar to oil- or natural gas-fired heating appliances than cordwood.

The American Community Survey (ACS) includes propane as a minor thermal energy source, which, given the margin of error, is likely overstated in many regions. Based on its pricing, propane is a viable substitute for some electrical uses that require thermal input, such as cooking, heating water, or drying clothes, rather than for space heating. In many cases, propane is a less expensive alternative to electricity and may reduce the loads on diesel generators.[75] Propane is less energy dense than heating oil, and a gallon of propane only has 67% of the heating content of a gallon of heating oil. So, a building that might require 1,000 gallons of heating oil would require nearly 1,500 gallons of propane. Propane is also a less viable source because it is a pressurized fuel, meaning that it requires a heavy tank for transportation and storage. The two factors of lower energy density and the heavy pressure vessel increases the delivered cost of propane relative to diesel.

Natural gas is currently available in two communities outside of the Railbelt: Barrow and Nuiqsut, both of which happen to be very close to natural gas deposits. Actual costs of natural gas are unknown in these

[75] Dave Pelunis Messier, personal communication, 4/4/2016

communities, as neither community pays market prices for the gas or associated infrastructure and operation.

The cost of heating oil by location is similar to electricity cost by location (see Figure 17). In places where electricity costs are higher, the heating oil costs are also generally higher. While it might not be readily apparent, there is a greater difference between the highest and lowest cost communities for electricity than for heating oil. There are also greater differences between communities that are relatively close to each other. Some communities might be selling at a loss while others may be selling at profit.[76, 77] This may indicate that additional local-level data, such as timing of deliveries, what was left over from previous year, etc., could help to disentangle the issue.

Road accessible communities have some of the lowest rates, even lower than many areas in Southeast, which are closest to refineries in Washington.

---

[76] Alaska Attorney General. "Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General's gasoline pricing investigation", 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf

[77] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

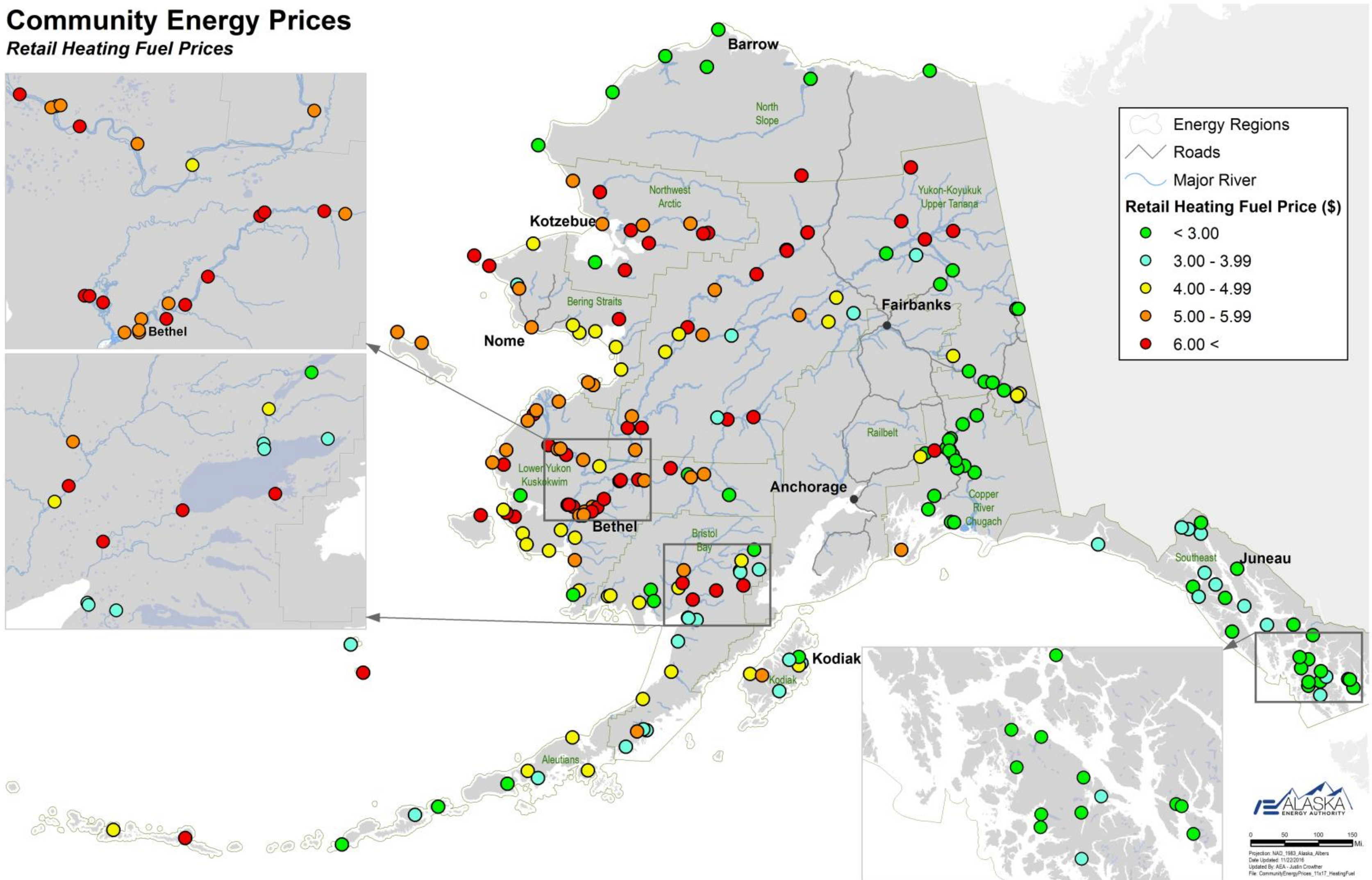


Figure 17: Map of community heating oil price in AkAES study area (2015)

FORECASTS

Much of the research referenced in this report is meant to help understand how to predict future costs, benefits, consumption, generation, and performance. While it is impossible to know what will happen in the future, making educated choices based on lessons learned and a study of past action can lessen the risk of stranded investments and assist in preparing for investment to meet growth.

For the purpose of the AkAES research and analysis, AEA assumed that the choices and preferences revealed by consumers' historical actions will be continued in the future. If there has been a downward trend in per capita consumption of electricity then, which is true in many parts of the state, AEA assumed that this trend will continue into the future in addition to any population trends that might also exist.

Everyone can relate to the experience of planning a weekend based on the promise of sunny weather just to have it ruined by an unexpected rainstorm. All forecasts risk being inaccurate, but that does not mean that they are not useful. Forecasts allow us to use what we know today to make informed decisions and plan for possible/probable scenarios.

Forecasts allow us to use what we know today to make informed decisions and plan for possible/probable scenarios.

The assumptions used in this report represent one view of a potential future–what AEA thinks is the most likely outcome based on current conditions. Forecasts must be actively, continuously evaluated and adjusted based on new information and updated data. To make this process most relevant, it must be an iterative process.

In order to do an adequate analysis of the cost-effectiveness of potential infrastructure projects, assumptions must be made about the future in order to compare potential project against the status quo. Two types of forecasts are required to do this analysis; forecasts for energy prices and consumption. The methods used to develop these forecasts are described in in the following pages.

ENERGY PRICE FORECASTS

Since energy infrastructure projects can last for 20 years or more (more than 100 years for hydro projects in some cases), economic analysis is based on educated guesses regarding the future price of energy. What follows is a description of how the forecasts for diesel, heating oil, and electricity were developed for each community and/or intertie in the AkAES study area.

DIESEL PRICE FORECAST

AEA has relied on forecasts by the EIA, the federal agency that develops the most widely followed forecasts on energy futures. In particular, the Brent crude price has been chosen over other indices, as historically the crude inputs for Alaska's diesel has better tracked Brent than other domestic indices, such as West Texas Intermediate (WTI) crude prices.

Crude oil is priced on the international market. The market cannot be predicted because there are many volatile elements that impact cost. Figure 18 shows the historical yearly averages of Brent crude and the 2016 forecast produced by the EIA.

Historical and forecasted yearly average Brent crude oil price
Source: 2016 Energy Information Administration

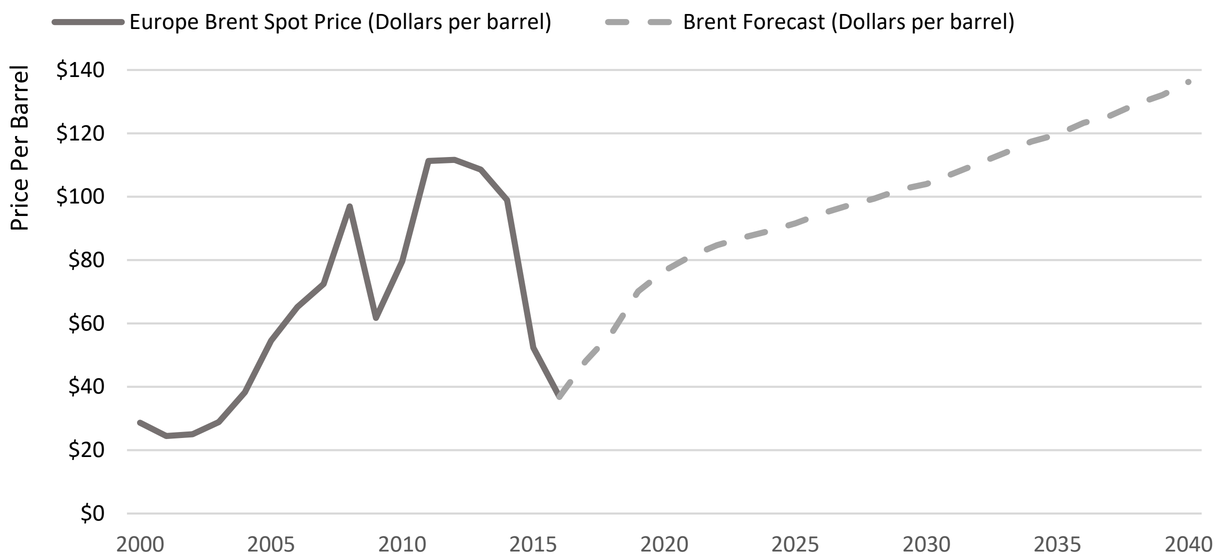


Figure 18: Historical yearly average Brent crude oil price[78] and 2016 Energy Information Adminstration forecast[79]

The historical yearly averages are in nominal dollars for U.S. dollars per barrel of crude oil. The volatility between 2003 and 2016 shows how difficult it can be to forecast future prices as large price increases can be followed by crashes. The dashed line starting in 2017, which is used for the base case economic analysis, is likely to be incorrect on a year-to-year basis, but it is expected to be reasonable over the long-term.

The forecast shown in Figure 18 is then used to develop the forecasts for diesel prices through a method developed by the Alaska Center for Energy and Power (ACEP). ACEP personnel went through the laborious task of recording individual fuel invoices submitted to the RCA for PCE reimbursement. Marking these invoices against the crude oil price at the date of purchase from the refinery (the lift date), ACEP developed equations to predict the local utility price for diesel based on Brent crude price (Brent was chosen by AEA because there are forecasts produced by EIA).[80] While there are local discrepancies and uncertainties exist, the work by ACEP improved the quality of estimates that goes into AEA's economic analysis.

Figure 19 demonstrates an example of how the EIA crude oil forecast is applied to an individual community, in this case Bethel.

---

[78] Europe Brent Spot Price FOB (Dollars per Barrel), 3/2/2016.
http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=A
[79] Real Petroleum Prices Crude Oil Brent Spot (Case Reference case),
http://www.eia.gov/forecasts/aeo/data/browser/#/?id=12-AEO2015
[80] Dominique Pride, Matthew Snodgrass, Antony Scott. "Correlating Community Specific Rural Diesel Fuel Prices with Published Indices of Crude Oil Prices, and Potential Price Projection Applications" June 2015.
http://www.akenergyauthority.org/Content/Programs/RenewableEnergyFund/Documents/Round%209/RuralFuelModelReportFinalDraft.pdf

Diesel price—Historical and forecast for Bethel
Source: PCE and Alaska Affordable Energy Model

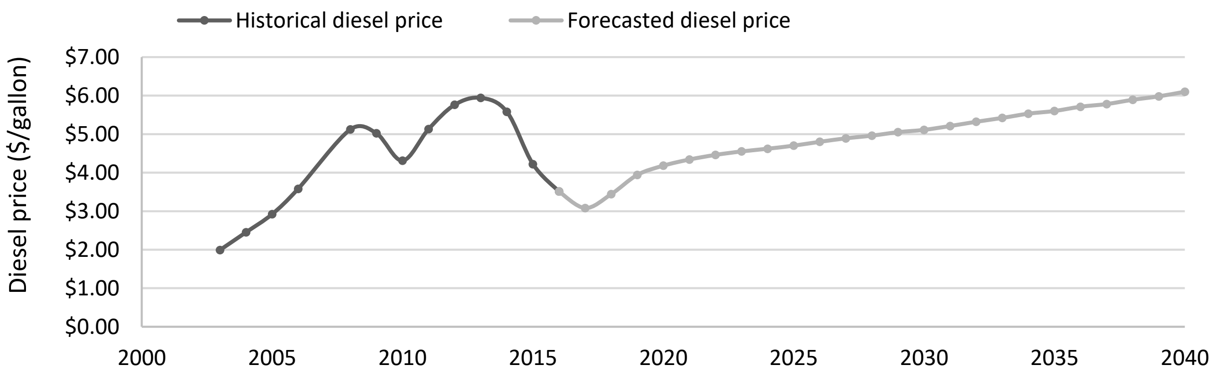


Figure 19: Diesel price—Historical and forecast for Bethel[81]

The actual price per gallon, shown in Figure 19, paid between 2003 and 2015 mirrors changes in the average annual Brent costs for the same timeframe. The actual values are less volatile than the crude oil prices. For instance, from 2008 to 2009 there was a nearly 40% drop in the average yearly price in crude oil but only a 2% drop in the local diesel price. The drop was not felt entirely until the next year and then only as a 14% reduction.

Heating oil price forecast

A number of entities, including AEA and ISER, have unsuccessfully investigated the mechanisms that lead to the differences in heating oil costs between communities, as explained in depth in Chapter 3. Lacking this site-specific information, AEA used regional averages of the difference between the retail price of heating oil (both #1 and #2) and the diesel price reported to PCE to forecast the heating oil prices for the AkAES project. AEA created a workable proxy for heating costs in communities using ACEP's work predicting the price of diesel based on the EIA Brent crude oil price and the regional average for the local markup. This creates additional uncertainty for the community-level evaluation of projects that either deliver or save thermal energy, but it is expected to be generally correct at the regional level.

As in the previous figure, Figure 20 applies this method to Bethel.

[81] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

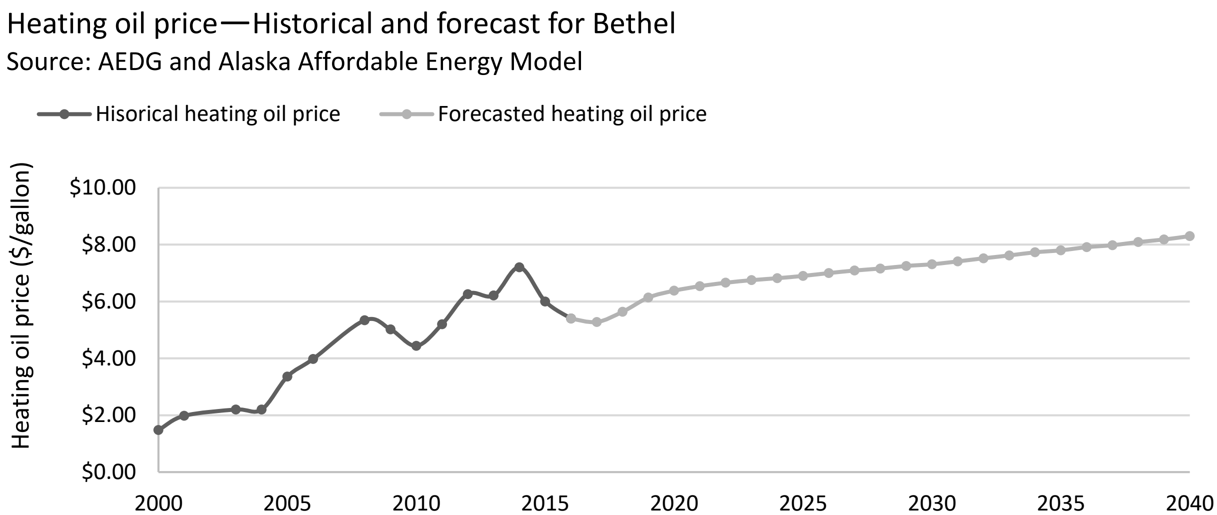


Figure 20: Heating oil price—Historical and forecast for Bethel[82]

Figure 20 shows just how difficult it can be to use external factors to forecast the price of heating oil in a community. While there are some similarities between the shape of the curve of the commodity cost of oil, shown in Figure 18, and the retail price of heating oil, there is no evident correlation. The rise in costs after 2010 are not commensurate with the rise in the commodity cost. This may be due to a number of factors that will be discussed in Chapter 3.

Electricity price forecast

Electricity prices are another necessary but difficult element to forecast. The first source of uncertainty is that many communities rely on diesel to produce electricity and the future price of diesel is uncertain. As with heating oil, AEA has limited this uncertainty by using ACEP's work and the EIA projection for Brent crude oil to forecast diesel at the local level. Converting the diesel price to a dollar per kilowatt-hour ($/kWh) price for electricity requires further knowledge and assumptions about the utility. To forecast the price, AEA has assumed that the generation efficiency and line loss remain consistent into the future and that the nonfuel costs—defined as the difference between fuel cost and residential rate —remains constant over time.

[82] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

Electricity price—Historical and forecast for Bethel
Source: AEDG and Alaska Affordable Energy Model

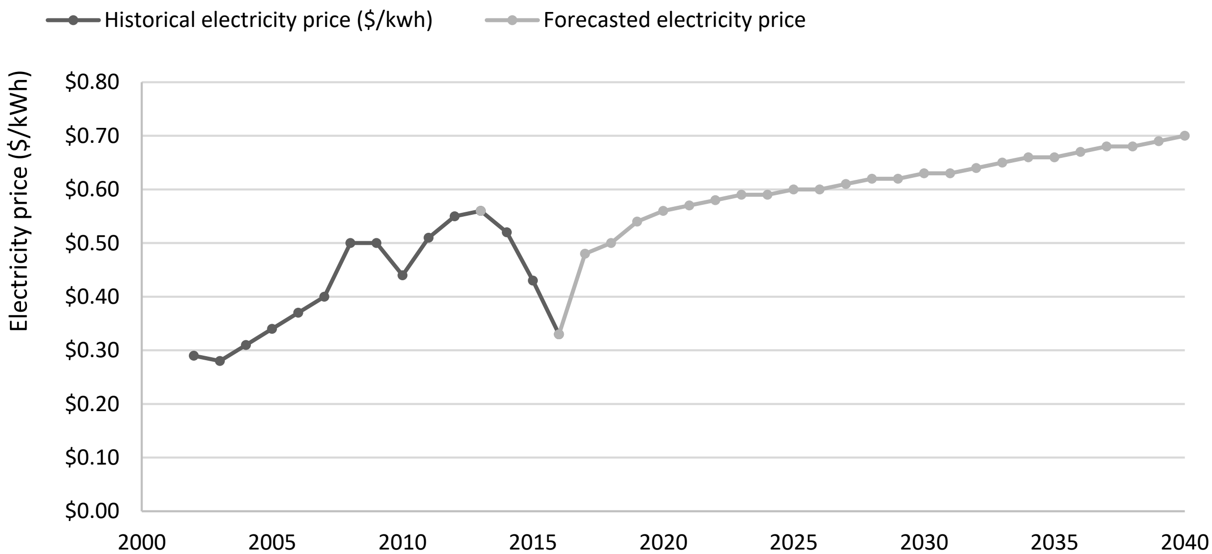


Figure 21: Electricity price—Historical and forecast for Bethel[83]

Compared to heating oil, the electricity price is less sensitive to the commodity cost. For instance, the 40% reduction in the average yearly oil price between 2008 to 2009 was not felt in the data until 2009 and 2010, and then only as a 13% reduction in electricity cost. Because there are a number of other factors that influence the cost of electricity, which will be investigated in Chapter 3, this muted response is not a surprise. As a note, the Bethel utility was purchased by Alaska Village Electric Cooperative (AVEC) in 2014, and because new data has not been available for the model, the forecast may not take into account any potentially significant cost reductions that have been possible through AVEC's purchase of the utility.[84]

POPULATION FORECAST

Since population is a major driver of community consumption and load, and hence cost, estimating how the population may change is very important. No government agency currently does community-level population projections because of the uncertainty involved in doing so for small communities. Understanding the potential difficulties, but needing the data, AEA commissioned community-level population forecasts from the Institute of Social and Economic Research (ISER) at the University of Alaska Anchorage. ISER applied the common method of population forecasting by employing the historical birth, death, and migration rates to individual communities.

---

[83] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

[84] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

ELECTRICITY CONSUMPTION/GENERATION FORECAST

In order to forecast future demand and ensure that sufficient generation capacity will be available for a community, previous studies have generally used a 1% or higher annual growth rate. This growth rate is not consistent with the empirical change in communities. Contrary to this assumption, for many utilities, the per customer and total demand have both declined. The electric consumption and generation forecasts improve on this baseline assumption by doing an analysis of the consumption trends, based on population, for each community and/or utility.

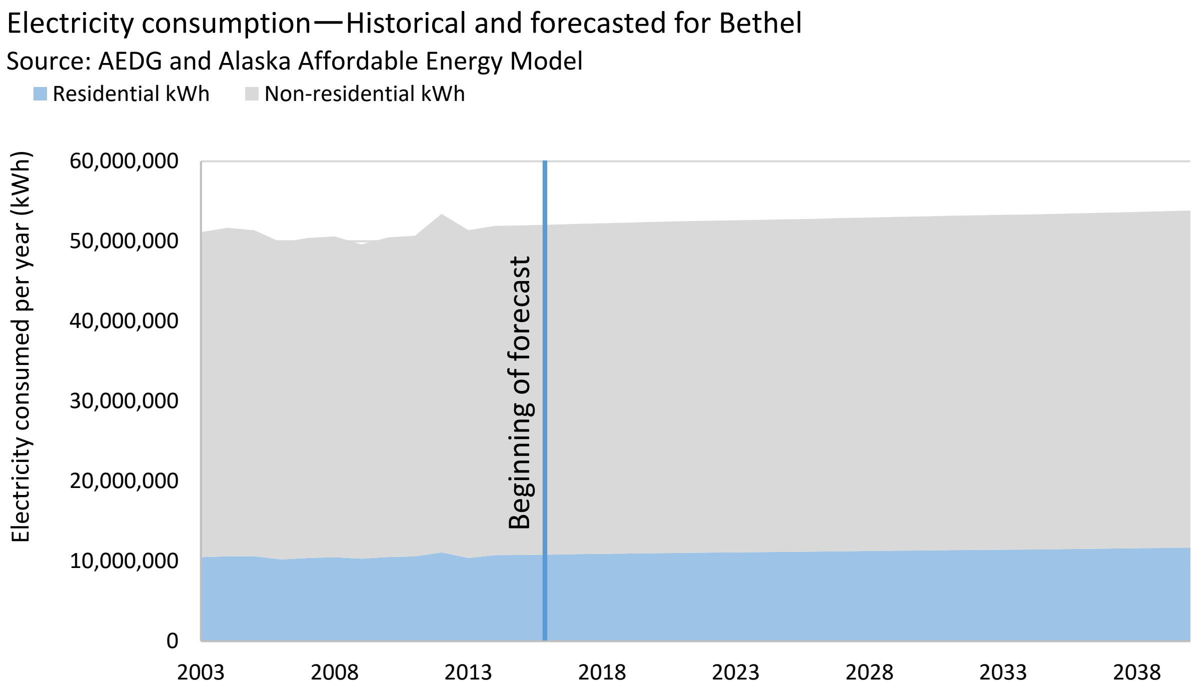


Figure 22: Electricity consumption—Historical and forecasted for Bethel[85]

The example shown in Figure 22 is somewhat atypical for AkAES communities. Aside from the very high level of consumption, the level of consumption has been particularly steady over the past decade, with residential consumption at about 10 million kWhs per year and non-residential at about 40 million kWhs per year. At 80% of the total consumption, the non-residential consumption is also a higher proportion of the total consumption than in many communities. The slight uptick in consumption, primarily from the residential sector, is based on the forecast of steady population growth in the community until 2040.

Although Bethel is one of the larger communities in the AkAES study area, and as a regional hub has a larger-than-average, non-residential sector, each community has its own unique characteristics. The residential sector can be anywhere from 8% to 70% of the total electrical load in a community, with the majority of communities between 30% and 50%.[86] The split between the residential and non-residential

[85] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

[86] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

sector is important for a number of reasons, including indicating how much PCE assists in covering the total utility costs and how reactive the demand will be to population changes.

INVESTMENT NEEDED TO MAINTAIN THE CURRENT LEVEL OF SERVICE IN AKAES COMMUNITIES

Even without trying to bring more affordable energy to communities, there will still be a need for continued investment in communities to maintain the current level of service. Assuming proper maintenance, energy infrastructure has a standard design life, after which the infrastructure is expected to be replaced. Given that the primary function of an electric utility is to maintain safe, stable, and reliable energy, it is critical that the State's current fiscal uncertainty does not lead to underinvestment in community energy infrastructure that imperils the utilities' ability to perform their required functions now or in the future.

UTILITY PERFORMANCE IN DELIVERING STABLE, RELIABLE ENERGY

Utilities provide a service that does not lend itself to competition, especially in small markets, and thus utilities are granted a local monopoly in exchange for fulfilling its obligations to its customers. Even if a utility is not economically regulated, in order to be granted a certificate of public convenience and necessity (CPCN) from the Regulatory Commission of Alaska (RCA), a utility must be fit, willing, and able to provide the applicable services,[87] which is defined as exhibiting adequate financial, managerial, and technical fitness.[88]

It is difficult to know how well utilities perform as a whole in delivering the required services to customers because no State agency collects the data needed to make this determination. The RCA collects some of this data for economically regulated utilities, but it is not available for most of the utilities in the AkAES study area, and many regulated utilities do not report.[89]

Outages and frequency/voltage stability remain key concerns for residential and business consumers. Outages can cause a wide range of issues, including general consumer dissatisfaction; loss of stored food, which can be a particular concern in rural areas; or even loss of life, should an outage occur at a medical clinic, for example. Episodes of low voltage can cause electric motors to fail. Unstable frequency can also cause issues such as clocks not keeping time properly, which may appear unimportant at first but can lead to serious issues with electromechanical devices.[90]

---

[87] AS 42.05.241

[88] Regulatory Commission of Alaska. Order U-15-012(2) "Order Denying Request for Expedited Consideration; Approving Application for Certificate of Public Convenience and Necessity; Approving Service Area Description, Tariff Sheets, and Power Sales Agreement; Requiring Filing; and Closing Docket." http://rca.alaska.gov/RCAWeb/ViewFile.aspx?id=69f102f0-4fdb-4475-bfd8-471318c96bff

[89] James Layne. "Electric Utility Outage Reporting 2003 to 2013." Presentation. Regulatory Commission of Alaska. April 22, 2015.

[90] Lisa Demer, "Time warp in Bethel? It's improving thanks to changes in the electrical system." Alaska Dispatch News. 8/27/2016. http://www.adn.com/alaska-news/rural-alaska/2016/08/27/time-warp-in-bethel-muted-with-improved-electrical-system/

ANNUAL INVESTMENT NEEDED TO MAINTAIN THE CURRENT LEVEL OF SERVICE

POWER PLANTS

To estimate the annual investment needed in power plant replacement in order to maintain the current level of service, AEA chose to make a conservative estimate based on experience from the Rural Power System Upgrade program (RPSU). The 194 communities eligible for the RPSU meet the four following criteria:

- have a population of at least 20 but less than 2,000;
- are not predominantly a military or industrial site;
- have a central community power system; and
- are not connected to the Railbelt electrical grid (Homer-Seward-Anchorage-Fairbanks), Four Dam Pool (Glennallen-Valdez, Wrangell-Petersburg, Ketchikan, Kodiak), or Juneau power distribution systems.

Restricting the analysis to communities meeting these criteria, and assuming a 30-year design life and cost of $3.5 million per powerhouse, a yearly average investment in physical infrastructure of over $20 million is needed to maintain the same level of service in Alaska's small, rural communities if no other changes are made.

… a yearly average investment in physical infrastructure of over $20 million is needed to maintain the same level of service in Alaska's small, rural communities if no other changes are made.

BULK FUEL FACILITIES

To estimate the annual investment needed to maintain the current level of bulk fuel storage in communities, key for keeping buildings warm and providing fuel for electricity, AEA used its experience from the Bulk Fuel Upgrade (BFU) program to provide a conservative estimate. The communities included within the estimate had populations between 20 and 2,000, per the BFU regulations. Based on the population and average fuel capacity per capita from the 2015 Bulk Fuel Assessment, AEA estimates that there are approximately 29 million gallons of storage combined in communities eligible for the BFU program. Assuming that a bulk fuel tank farm life is 30 years on average and using the median cost of tank farm projects between 2005 and 2016 ($18/gallon in 2017 dollars) over $17 million per year of investment in physical infrastructure is needed to maintain the current standard of bulk fuel storage in Alaska's small, rural communities if no other changes are made.

…over $17 million per year of investment in physical infrastructure is needed to maintain the current standard of bulk fuel storage in Alaska's small, rural communities if no other changes are made.

THE ABILITY OF COMMUNITIES AND REGIONS TO PAY FOR ENERGY INFRASTRUCTURE

In the near term, at a minimum, it is likely that the amount of State grants for energy infrastructure will decrease, and there will be a subsequent need for communities to pay a larger share than has been historically required. It must be assumed that the need for the replacement infrastructure outlined above will not magically disappear with the reduction in State funding, and it seems unlikely that federal funds will increase to make up the difference. Therefore, the State must prepare to assist communities in accessing loan financing.

Assessing a community's or region's ability to pay for energy infrastructure is challenging. Especially considering conflicting needs within a community or region, it is very difficult to know how much a community or utility might be able or willing to pay.

With reduced or no access to State grant funds there are three main ways in which energy infrastructure could be paid for by communities, regions, or utilities:

1. The energy infrastructure could be paid for outright by using tax or other local/regional revenue sources.
2. The community could finance the infrastructure through state, federal, or private loans.
3. Non-state grant programs, particularly through the federal government, could be accessed.

PAY OUTRIGHT FOR PROJECTS AND SUBSIDIES

Probably the easiest way for energy infrastructure to be paid for, from an administrative perspective, is by using local or regional revenue sources, such as taxes. Some communities and boroughs already use this strategy to build new infrastructure or, even more commonly, subsidize the cost of energy.

As seen in Figure 23, the availability of tax revenue is not equally distributed across the state.

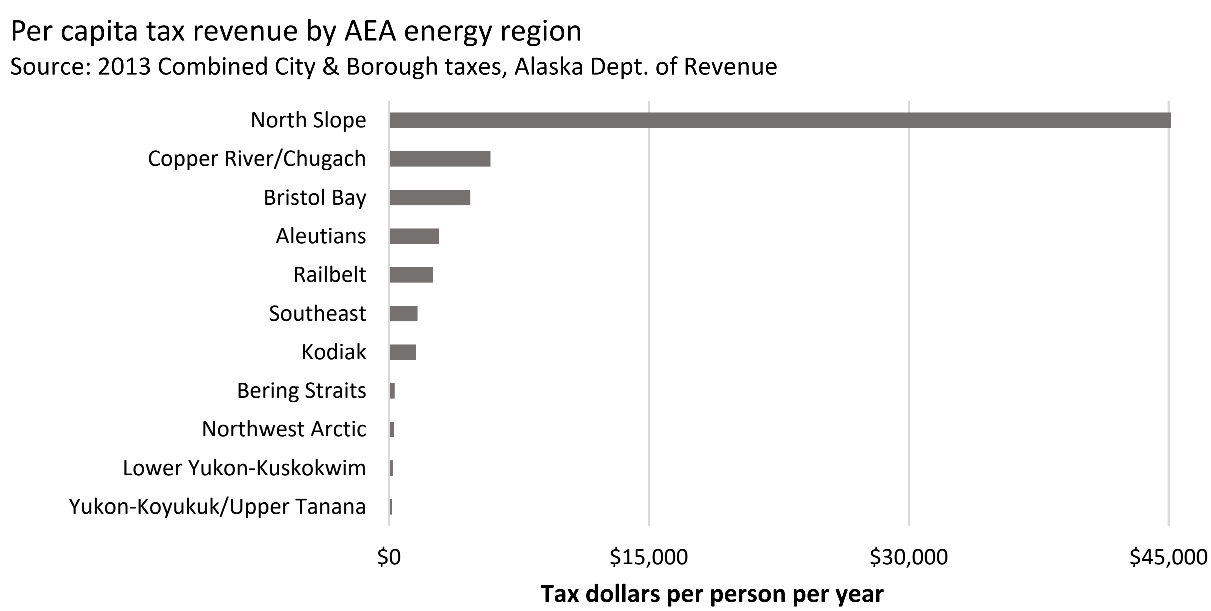


Figure 23: Per capita tax revenue by AEA energy region[91]

[91] Alaska Department of Commerce, Community, and Economic Development, Division of Community and Regional Affairs. Alaska Taxable Database. Accessed September 2014. https://www.commerce.alaska.gov/dcra/DCRARepoExt/Pages/AlaskaTaxableDatabase.aspx

Figure 23 shows the combined local and borough tax revenue per capita by region. A little over 100 communities showed some local tax revenue. Since borough tax revenue was more common than local tax revenue, intra-regional differences were generally low. There are huge differences, nearly three orders of magnitude, between the per capita tax revenue in the North Slope and the bottom four regions. Figure 23 shows the unequal distribution of tax revenue.

Some communities and regions, such as the North Slope and Valdez[92], choose to use tax revenue to affect energy costs through direct subsidies. In addition to direct subsidies, it may be possible to use tax revenue as a form of collateral for energy projects. Regional organizations and Community Development Quota (CDQ) groups, such as Norton Sound Economic Development Corporation (NSEDC), also contribute to local subsidies amounting to $1.32 million to electric customers in member communities in 2014.[93]

There are other potential local and regional revenue sources that could be used to pay for energy infrastructure. CDQ revenues, payments in lieu of taxes (PILT), 7(i), and 7(j) payments are all other potential revenue sources. 7(i) and 7(j) payments are requirements under the Alaska Native Claims Settlement Act (ANCSA) that distributes various forms of revenue between the 12 regional native corporations and between the regional native corporations and the village corporations. As noted earlier, communities have many needs for revenue and energy infrastructure might not be the highest priority need identified by the community. In those cases, the community will need to be able to access other sources of funding.

ABILITY TO ACCESS FINANCING

Although it has not been the case since its passage in 2010, State energy policy directs that the power project fund (PPF), an AEA loan program, instead of grants will be the main source of assistance for energy projects.[94] In light of reduced State grant funding for energy projects, entities will need to have greater access to both State and non-State loans.

There is uncertainty surrounding the issue of utility creditworthiness. AEA was not able to find a comprehensive resource for credit scores, bond ratings, or other commonly used financial measures. This requires that lending agents perform credit checks on a one-off basis.

In a study commissioned for the AkAES, the Alaska Center for Energy and Power identified characteristics that lenders looked for in their loan applicants. Those characteristics included the ability of the applicant to repay the debt, a reasonable payback time for the loan, collateral to secure the loan, sufficient administrative capacity to manage the project and loan, and an equity contribution.[95]

In a report commissioned for the AkAES, the University of Alaska Center for Economic Development, (UACED) investigated the finances of 32 utilities, covering over 90 communities, through public reporting

[92] Lee Revis, "Free energy credit: coming to a utility bill near you." Valdez Star, 11/9/2016. http://www.valdezstar.net/story/2016/11/09/main-news/free-energy-credit-coming-to-a-utility-bill-near-you/1423.html
[93] http://www.nsedc.com/wp-content/uploads/267304-NSEDC-AR-proof.pdf
[94] AS 44.99.115
[95] Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. "Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects." December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280

to the State or Internal Revenue Service (IRS). UACED found a wide range of ability to adequately report financial data. Many of the financial statements did not include all known sources of income (such as PCE payments), were internally inconsistent, or were inconsistent with other reporting, including to the RCA.[96]

UACED found that the majority of communities assessed had especially low debt loads; generally, only larger communities had debt loads.[97] This is likely because of the utilities' success in accessing grant funds, and that larger communities are ineligible for State and federal programs such as the Rural Power System Upgrade and Bulk Fuel Upgrade programs, which are limited to populations under 2,000. With regards to liquidity metrics, most of the utilities had a strong balance between the near-term cash-producing assets and near-term liabilities. The net revenue of many of the utilities was highly volatile from year to year.

This work indicates that many utilities have some financial attributes, such as low debt loads and strong liquidity measures, that could make them potentially attractive to lenders, but that there are many other factors, including inadequate financial reporting and volatile net revenue and cash flow, that will be a hindrance to debt financing energy projects.[98]

Other factors that affect bankability were not included in this study, which was focused solely on what could be gleaned from available financial reports. Probably the most important is the lack of collateral in many communities. Even for a short-term State loan program such as the Bulk Fuel Loan program, which acts significantly less risk averse than private financers, lack of collateral has been a common reason for rejecting loan applications. For long-term infrastructure projects, where the infrastructure is not likely going to be seen as a means to secure the loan, the lack of collateral can be an even larger barrier. Additional analysis of the barriers to applicants to the Bulk Fuel Loan program and Power Project Fund are contained in Chapter 5.

ABILITY TO ACCESS NON-STATE FINANCING

All of the communities in the AkAES study area are eligible for many federal programs focused on rural and high-energy cost regions, including through the Denali Commission and the U.S. Department of Agriculture (USDA) High Energy Cost and Rural Utility Service (RUS) grant programs. These two federal entities have been major contributors to rural Alaska infrastructure, with the Denali Commission contributing $811 million in grants since 2001 and the USDA $61 million in grants since 2009.

In addition to the important role that many tribes play in the governance and sustainability of communities, tribal membership brings access to a number of federal programs. The U.S. Department of Energy, U.S. Department of Housing and Urban Development; USDA; and other federal programs specifically focus on tribal land and organizations in grant and loan solicitations. The number and percentage of communities within a region with federally recognized tribes are far from uniform across

[96] University of Alaska Center for Economic Development. "Utility Financial Analysis and Benchmarking Study Draft." October 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/Utilityfinancialanalysisandbenchmarkingstudy.pdf
[97] UACED 2016
[98] UACED 2016

the state, as shown in Figure 24. Almost all communities in the Northwest Arctic, North Slope, Lower Yukon-Kuskokwim, and Bering Straits have a federally recognized tribe.

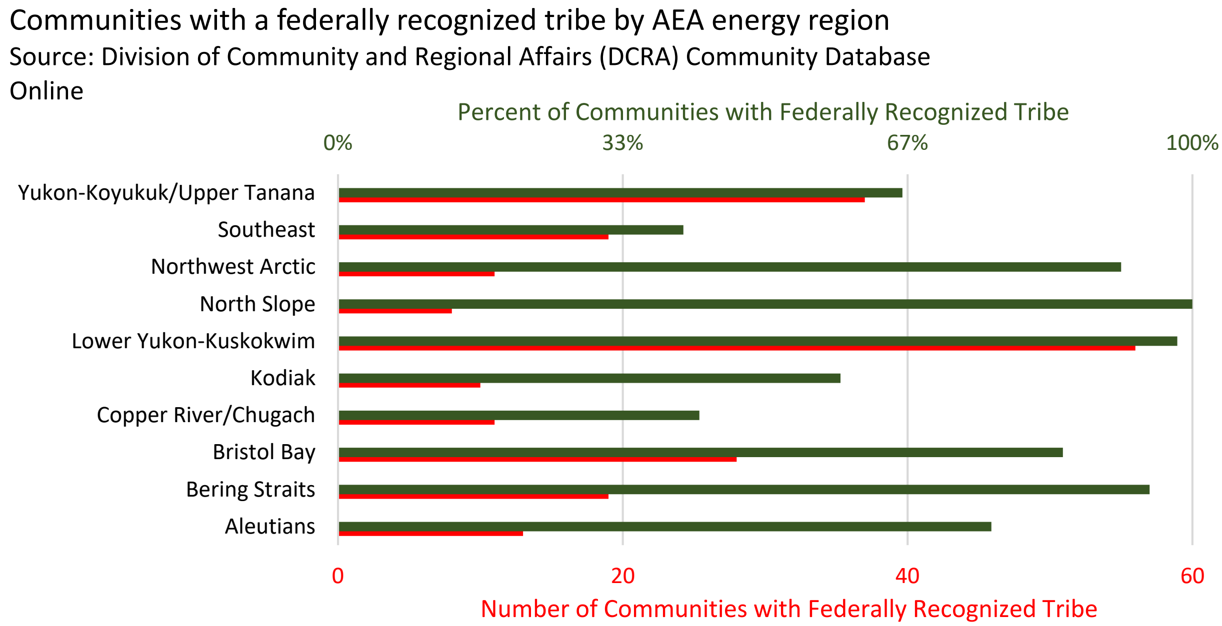


Figure 24: Communities with a federally recognized tribe by AEA energy region[99]

A number of regional non-governmental organizations also provide support for energy projects in Alaska. One example is the Norton Sound Economic Development Corporation's Community Energy Fund (CEF), which allocated $1 million for each of its 15 communities with a sunset in 2021. CEF program funding may be for a number of construction-ready, community-wide generation and distribution projects, including renewable and alternative energy, and efficiency upgrades. This program will not fund feasibility studies for energy upgrades or construction projects. The program funds facilitate the actual implementation of projects that are past the feasibility, licensing, and final design phases ("shovel-ready").[100] Not all regions of the state have similar energy programs.

[99] Alaska Department of Commerce, Community, and Economic Development, Division of Community and Regional Affairs. Alaska Community Database Online. Accessed September 2015. https://www.commerce.alaska.gov/dcra/DCRAExternal

[100] http://www.nsedc.com/programs/community-benefits/community-energy-fund/

Federal and private debt financing

The AkAES study area has significant variability in terms of ability to access private capital to develop projects. For power generation, larger utilities, utilities operating in larger hub communities and small cities, and those that are members of larger cooperatives often have the ability to access traditional debt financing to develop projects. Access to traditional debt financing is available when borrowers have attractive balance sheets, stable revenue streams, traditional collateral to secure loans, and staff who are able to manage and meet the requirements of complex financing tools.

Access to traditional debt financing is available when borrowers have attractive balance sheets, stable revenue streams, traditional collateral to secure loans, and staff who are able to manage and meet the requirements of complex financing tools.

For many small, stand-alone utilities, accessing private financing is more challenging. Potential borrowers may lack the financial health to be able to secure traditional loans. Additionally, typical private commercial lending terms are not well matched for large utility projects that may require longer repayment terms to avoid causing cash flow problems.

USDA Rural Development has a wide variety of programs that fund different types of community development projects in rural communities. The programs that are most relevant to this study are the Rural Utilities Service (RUS) electric grant and loan programs, the Community Facilities (CF) grant and loan programs, and the Rural Energy for America Program (REAP) grants and loan guarantees. Some of these grant programs have been used extensively in the study area, but use of the loan programs has been much more limited for a variety of reasons.

All of the loan programs have extensive paperwork involved, and they may require applicants to have first applied to commercial lenders. RUS loans have extensive requirements for applicants to demonstrate their creditworthiness and the feasibility of the loan, as well as environmental review and regulatory approval requirements that can involve a substantial amount of work for a small utility. CF loans are direct loans from USDA to the applicant, and typically applicants have to have applied for commercial credit and been denied to be eligible. REAP does not do direct loans but has loan guarantees, as do RUS and CF, and in these cases applicants first need to secure commercial financing before applying to USDA. At least partially due to these requirements, use of USDA loan programs in the study area has been very limited despite the large amount of money potentially available.

The only USDA loan originated between 2009 and 2015 for electric projects in the study area was a $10.6 million guaranteed loan to Kodiak Electric and a $2.9 million guaranteed loan to the Kotzebue Electric Association. Several other utilities in the study area appear to have USDA loans, either direct or guaranteed, from before 2009. All other USDA loans for electric utilities ($432 million) between 2009 and 2015 went to Railbelt utilities.

Table 7: USDA loans for businesses, energy programs, hospitals, water systems, and housing in Alaska (2009-2015)[101]

AEA Energy Region	USDA Energy-specific loans	USDA total loans in region	Percent of USDA loans in Alaska
Railbelt	$418,500,000	$963,864,551	66%
Lower Yukon-Kuskokwim	$0	$214,584,940	15%
Southeast	$0	$146,605,366	10%
Kodiak	$10,600,000	$58,890,859	4%
Copper River/Chugach	$0	$31,123,446	2%
Bering Straits	$0	$22,751,676	2%
Bristol Bay	$0	$13,275,938	1%
Northwest Arctic	$2,900,000	$8,063,265	1%
Aleutians	$0	$6,927,650	0%
Yukon-Koyukuk/Upper Tanana	$0	$1,634,650	0%
North Slope	$0	$725,912	0%

Entities in the study area have accessed USDA loan products. Although the majority of USDA loans have been within the Railbelt, the USDA provided nearly $500 million in direct and guaranteed loans in the AkAES study area for water/wastewater, telecommunications, and health care projects. The total loan amounts vary widely by region, and the value of individual loans range from less than $2,000 for individual homeowners to $165 million for the remodel of the Yukon-Kuskokwim Health Corporation's Bethel hospital.

[101] AEA compilation of USDA loan data 2009-2015.

CHAPTER 3: ENERGY COST DRIVERS

Key Takeaways

1. Most study area communities are dependent on imported diesel fuel, the price of which is largely determined by world markets
2. The large distances between communities cause high costs for delivering fuel and supplies
3. Non-fuel costs are important factors for the cost of electricity
4. Most communities have insufficient energy consumption to create an economy of scale
5. Local decisions by unregulated utilities and fuel suppliers play a very important role in determining energy costs
   - Management decisions and technical capacity impact how infrastructure is maintained and thus its usable life and generation efficiency
   - Retail electricity and heating oil prices are largely unregulated and there is a wide range of pricing decisions made at the community level

Only by understanding the factors driving the total cost consumers pay for energy is it possible to understand what costs can and cannot be changed. This chapter pulls together the best research and data AEA has been able to compile to understand the complex mechanisms that lead to a customer's energy bill. Chapters 6 continues this work to evaluate opportunities.

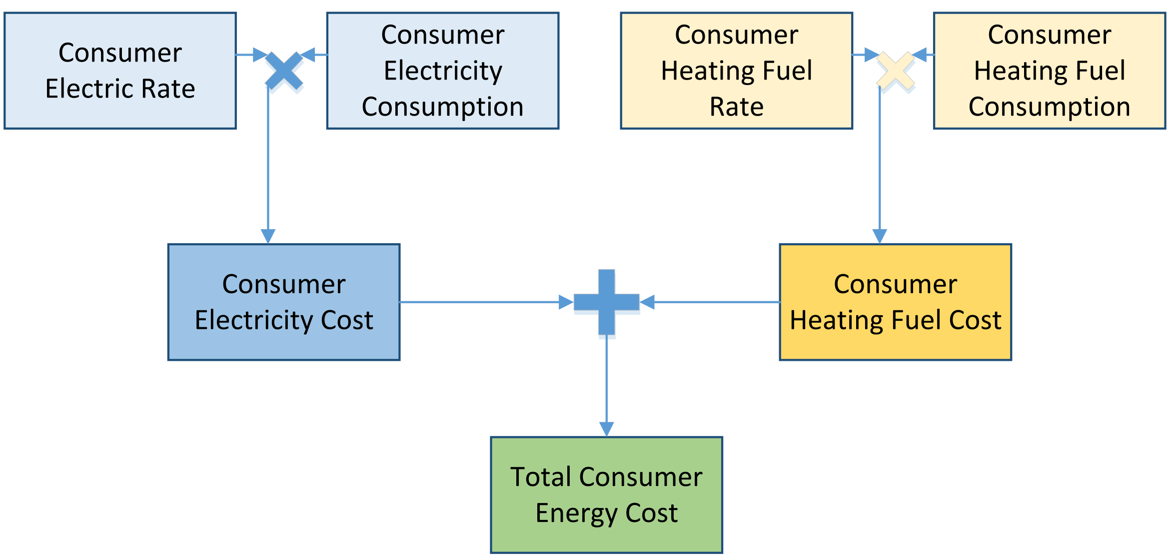


Figure 25: Diagram of the components of consumer energy costs

Figure 25 will be used as a reference for the analysis of what contributes to the total consumer energy cost. The total cost is the sum of the electricity and heating fuel costs. As seen in Chapter 2, in most cases, the heating costs outweigh the electricity costs. Costs for electricity and heating fuel are each a combination of the rate paid per unit (such as cents per kilowatt-hour or dollars per gallon) and the number of units consumed. The following sections will provide data and analysis to understand the factors that lead to both the rates for electricity and heating fuels as well as the consumption of electricity and heating fuels.

DRIVERS FOR THE DELIVERED COST OF DIESEL

As shown in Chapter 2, diesel is the primary fuel for electricity generation and heat for most of the communities in the AkAES study area. This section will outline factors that drive the cost of liquid fuels in communities. Later sections will then explore drivers for consumer electricity and heating fuel prices. For simplicity's sake, this section will use "diesel" to refer to diesel for electricity, heating oil for heat, and gasoline/aviation fuels for transportation.

For much of Alaska, bringing more affordable energy to communities involves either reducing the cost or reducing the amount of diesel consumed. These are the primary factors for determining economic benefits of projects.

Before going into a description of the individual drivers of the delivered cost of diesel, we will begin by looking at the way that AEA translates crude oil prices to diesel prices at the community level. As stated in Chapter 2, ACEP recorded individual fuel invoices submitted to the RCA for PCE reimbursement. Marking these against the crude oil price at the date of purchase from the refinery (the lift date), ACEP developed equations to predict the local utility price for diesel based on Brent crude price.[102]

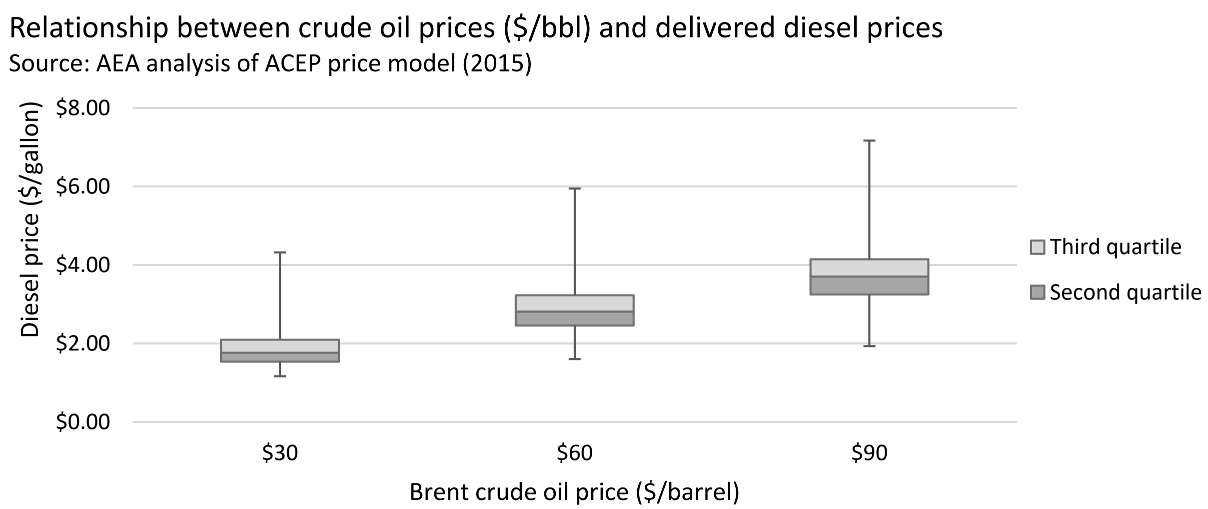


Figure 26: Relationship between crude oil price and delivered diesel price[103]

Figure 26 summarizes the range of delivered diesel prices that are expected across the AkAES region based on the international price per barrel of Brent crude. Although it may be counterintuitive, the community price for fuel does not increase at a one-to-one rate with the price of crude oil. Per the model, doubling

[102] Dominique Pride, Matthew Snodgrass, Antony Scott. "Correlating Community Specific Rural Diesel Fuel Prices with Published Indices of Crude Oil Prices, and Potential Price Projection Applications" June 2015. http://www.akenergyauthority.org/Content/Programs/RenewableEnergyFund/Documents/Round%209/RuralFuelModelReportFinalDraft.pdf

[103] AEA analysis of ACEP 2015 fuel price model

the price of crude oil does not double the delivered cost—not even tripling the price of crude oil results in a doubling of cost. For example, the highest cost community shown in Figure 26 goes from approximately $4.50 at $30/bbl to $6 at $60/bbl and $7.20 at $90/bbl, a 60% increase in diesel price resulting from a tripling of the crude oil price.[104]

In addition to input commodity, there are other cost drivers. Even if crude were free, it would still incur a cost to deliver the fuel. Some of those costs increase with the increase in crude price (such as cost of fuel to power the barges), but some costs are less elastic, such as labor costs, capital recovery, etc. Refining costs are not always related to cost of feedstock. The unit price of diesel for a utility includes the international price of crude oil, the cost of refining the crude oil to a consumable product, the transportation of the diesel to the community, any financing charges, and the cost of storing the fuel on site.

The spread of diesel prices from one community to another increases with the crude oil price, but the per-gallon cost for diesel in lower cost communities does not increase at the same rate as in higher cost communities. As seen in Figure 26, the spread between the minimum and maximum prices increases from $30/bbl to $90/bbl from about $3.50/gal to over $5/gal.

INTERNATIONAL MARKET AND COMMODITY COST

The price of crude oil, which is determined by international markets, is a primary driver of diesel costs. While forecasting the price of crude oil is fraught with uncertainty, doing so provides a useful baseline for understanding what might happen and allows for the comparison of potential projects. Chapter 2 Figure 18 on page 51 shows the historical yearly averages of Brent crude and the 2017-2040 forecast produced by the EIA.

Relying on three ISER studies performed between 2008 and 2011 exploring the components of fuel costs, the chart in Figure 27 will be filled in over the next several sections to illustrate components making up the cost of delivered fuel.[105,106,107] In this first iteration, only the costs of the crude oil and its refining are included in the figure. Figure 27 is a general depiction of what leads to the cost of diesel in a community; it will not be completely accurate for any given community and specifically assumes that the fuel will be delivered by barge, which is true for the majority of communities in the AkAES region but not all of them.

---

[104] The nonlinear increase that is seen here may be as much an artifact of the equation type chosen to model the data as an indication of the real response of local prices to external factors.

[105] Meghan Wilson, Ben Saylor, Nick Szymoniak, Steve Colt, and Ginny Fay. "Components of Delivered Fuel Prices in Alaska." June 2008. http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf

[106] Ginny Fay, Ben Saylor, Nick Szymoniak, Meghan Wilson and Steve Colt. "Study of the Components of Delivered Fuel Costs in Alaska: January 2009 Update." January 2009. http://www.iser.uaa.alaska.edu/Publications/fuelpricedeliveredupdate.pdf

[107] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

Components of the delivered price of diesel: crude oil & refining*
Source: AEA adapted from 2008-2011 ISER work

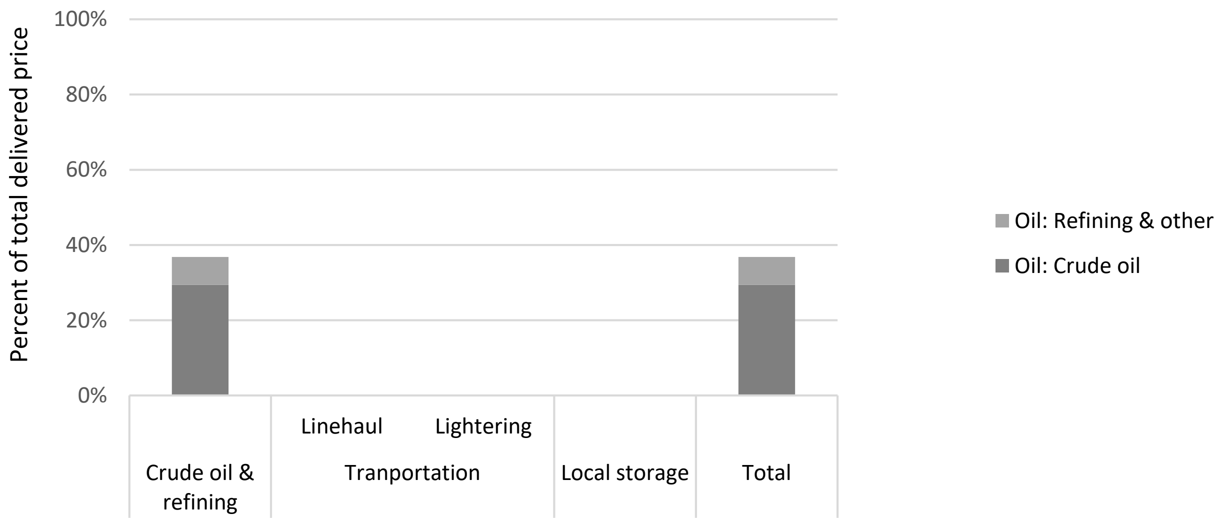


Figure 27: Components of delivered price of diesel: Crude oil & refining[108]
*Assumes $40/barrel crude oil

For this generalized case, it can be seen that commodity cost of diesel, depicted as the sum of the crude oil and refining, is nearly 40% of the delivered price. The rest of the delivered price is from the transportation and local storage of the fuel.

COST DRIVERS OF DIESEL FUEL DELIVERY

Fuel is delivered by three main modes throughout Alaska: by airplanes, road, and barges to communities on the coast or river system. Researchers have further distinguished barge deliveries to communities that are ice-free year round (such as Southeast, Kodiak, and the Aleutians) and those that are ice-bound during the winter months (communities north of the Alaska Peninsula and on Interior rivers). Each of these modes of delivery has a unique price structure. Figure 28 illustrates the range of per gallon prices by transportation mode and assumes $50 per barrel of oil.

[108] AEA adaptation from 2008-2011 ISER work on components of delivered fuel costs

Delivered price of fuel to PCE communities by transportation mode
Source: AEA analysis of 2014 ACEP model

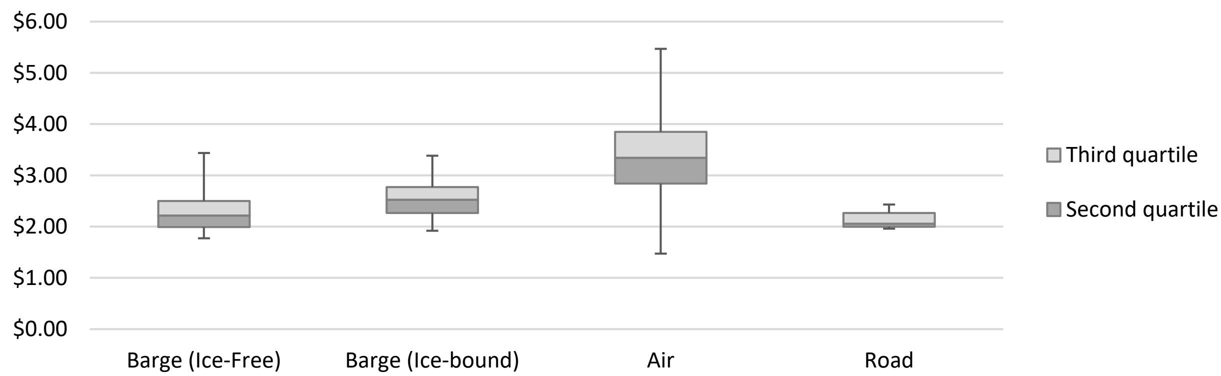


Figure 28: Delivered price of fuel to PCE communities by transportation mode (Assumes $50/bbl crude oil)[109]

There is less difference between ice-free and ice-bound deliveries than might be expected, especially given the large distances needed to supply fuel for northern and Interior regions.

Air has the greatest cost spread of any mode of delivery—in some cases it appears to be cheaper to fly fuel into communities than to deliver it by barge. The higher cost of air delivery is not always due to the costs of flying the fuel. The highest cost areas are impacted by the fact that their fuel is bought from an intermediary who plays a large role in determining price. For example, for some of the communities in the Kotzebue area, fuel is flown in from Kotzebue, paid for at the local retail rate in Kotzebue.[110, 111] The final delivered cost to the communities includes the price of the air delivery but also the cost of delivering the fuel to Kotzebue and the local markup.

Delivering fuel by Alaska's highways is very inexpensive, merely pennies per gallon. With frequent deliveries, often weekly, costs via road delivery parallel the crude price more closely. The price paid by the community changes to match the rise and fall of price on international markets. Generally, product being delivered by road does not need more than a couple of weeks of storage, which creates efficiencies while also making it unlikely to experience fuel emergencies due to low stocks.

Given the paucity of data and lack of access to proprietary information from fuel deliverers, it is difficult to know exactly what causes the price in any given community, but there are a number of potential drivers for the differences in community diesel prices.

One major cost factor is distance. Distance increases the hours of labor and fuel needed for transportation, and reduces the number of gallons of product to recover the cost of capital (the barge, truck, or airplane has to be paid for). The distance traveled also increases the unit cost for all of these components. For instance, to get to Nome, fuel coming from the Port of Anchorage has to travel

[109] AEA analysis of ACEP fuel price model (2015)
[110] Ingemar Matthiesen, personal communication, 4/4/2016
[111] Trevor Crowder, Fuel operations manager at Everts Air Fuel. Personal communication 4/25/2016.

approximately 700 miles to Unimak Pass (the first pass to western Alaska), then another 640 miles from Unimak Pass to Nome.

BARGE DELIVERY

The ice-free portions of the state (particularly Southeast) generally have easy access because they are close to large markets like Washington state. Furthermore, the amount of storage needed is lower than in the ice-bound region. Some areas may receive monthly deliveries, while smaller, more remote communities may only receive a couple of deliveries per year even though the community may be accessible year round.

For a number of reasons, the ice-bound areas of western Alaska and Interior rivers have the highest delivered cost of fuel in the state (and potentially anywhere in the U.S.).[112] The time constraints from the short open-water period, the subsequent low utilization of capital, the large distances, and relatively shallow rivers all exacerbate the costs people end up paying. Figure 29 summarizes the main drivers for the cost of delivering fuel into a small, remote community along the coast or on an Interior river. Each of the sections (linehaul, lightering, and other) is discussed in more depth in the following pages.

Components of the delivered price of diesel: Barge transportation*
Source: AEA adapted from 2008-2011 ISER work

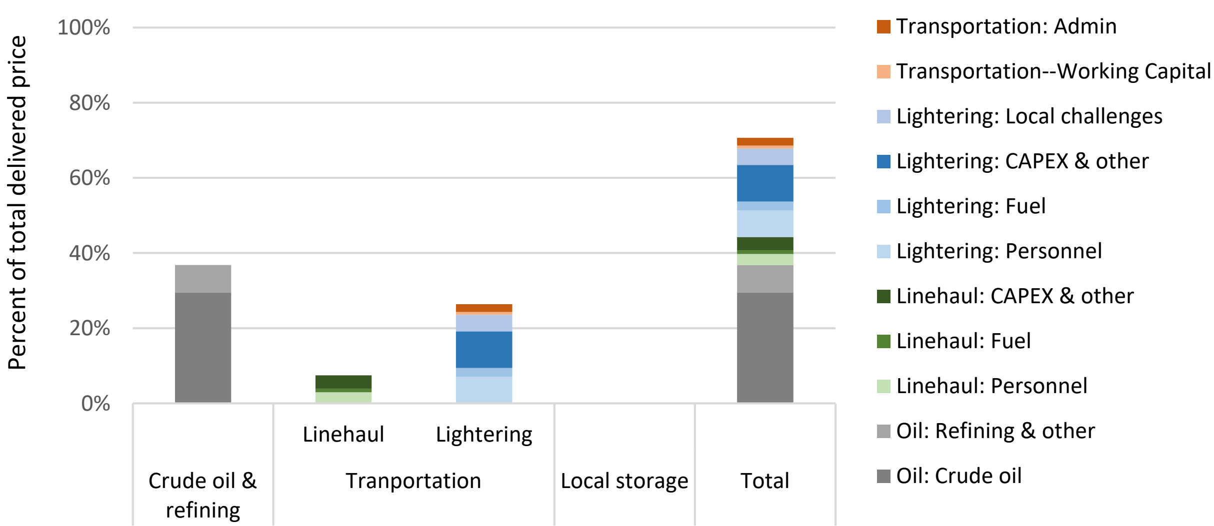


Figure 29: Components of the delivered price of diesel: Barge transportation[113]
*Assumes $40/barrel crude oil

Linehaul barges are relatively large, ocean-going barges that carry 2-3 million gallons in a trip from Southcentral Alaska or Washington state. The linehaul barges generally require 18-20' of draft, which is deeper than most of the ports in Western Alaska (Naknek and Nome are two of the few, even Bethel does

[112] Ginny Fay, Ben Saylor, Nick Szymoniak, Meghan Wilson and Steve Colt. "Study of the Components of Delivered Fuel Costs in Alaska January 2009 Update." Prepared for: Alaska State Legislature, Senate Finance Committee. January 2009. http://www.iser.uaa.alaska.edu/Publications/fuelpricedeliveredupdate.pdf
[113] AEA adaptation from 2008-2011 ISER work on components of delivered fuel costs

not have sufficient draft for an ocean-going barge). In the areas where the linehaul barges are not able to deliver to a port, the fuel is transferred to smaller barges, lightering barges, in protected waters off the coast.

Due to a grounding near Nunivak Island reported by the Alaska Dispatch News in June 2016[114], AEA became aware that fuel is delivered into Southwest Alaska by large tankers in addition to linehaul barges. It is unlikely the tanker would be able to dock any ports at to unload its fuel, since the draft of a tanker is greater than any port north of the Aleutians.[115]

Based on work by ISER, the cost of paying for the barge (CAPEX) constitutes the single largest cost for a barge company, comprising about 45% of the expenses that need to be recovered in delivering fuel. The operational expenses (OPEX) are broken out between the fuel to run the barge, the labor to operate the barge, and other expenses. Fuel is not as significant of an operational expense as might be expected—at $2.50/gallon, fuel accounts for less than 10% of the total cost of the linehaul delivery. Each dollar change in fuel price for the barge only changes this component by about a percentage point. Labor accounts for about 30% of the total cost of delivery, which is three times the cost of the fuel to operate the barge. Other operational expenses, such as insurance, make up the remainder.[116]

To get the fuel to the smaller communities, the fuel must be transferred to the lightering barges, sometimes directly and sometimes by first being transferred into a shore-side storage facility. Each of these touchpoints incurs time and costs. Wharfage fees for loading and unloading fuel can be up to $0.04 per gallon, and the labor needed to staff the unloading and loading of the barges can be up to $0.06 per gallon.[117]

While the lightering barges are smaller than the linehaul barges, they are more expensive to operate per unit than linehaul, primarily because they are utilized less and deliver fewer gallons over a season. The barges are frequently made specifically for Alaska's riverine and coastal environments and do not get used outside of the four- to five-month ice-free window. The capital and operational expenses have a very similar breakdown as the linehaul barges.[118]

The conditions in any given community can also incur greater costs. Issues such as the lack of moorage, multiple (or missing) marine headers to unload the fuel, and dangerous river conditions can all increase the time and risk of delivering fuel. These costs are generally passed along to the community.[119]

---

[114] Jeannette Lee Falsey. "Coast Guard: No spill in grounding of tanker carrying fuel to Southwest Alaska villages." Alaska Dispatch News. 6/25/2016. http://www.adn.com/alaska-news/2016/06/25/coast-guard-no-spill-in-grounding-of-tanker-carrying-fuel-to-southwest-alaska-villages/

[115] U.S. Army Corps of Engineers, Alaska District. "Fuel Transportation Improvement Report." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AEAfueltransportationreport101416.pdf

[116] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

[117] Szymoniak et al, 2010

[118] Szymoniak et al, 2010

[119] Szymoniak et al, 2010

The delivery companies have two other main costs that must be covered. The fuel that is being delivered to communities must be paid for; and, depending on the terms of the agreement, payment may not be made until delivery. If this is the case, the delivery company may be holding onto millions of dollars of product that must be carried with the risk of non-payment. This working capital is expected to cost about $0.02 per gallon. Other administrative services–billing customers, purchasing diesel from refiners, coordinating schedules between barges and communities, etc.–are expected to cost another $0.05-$0.10 per gallon.

All of these various expenses add more than a dollar to the wholesale cost of diesel from the refinery, as shown in the Figure 29.

OTHER FACTORS IN DELIVERED FUEL PRICE

As with any other private enterprise, it would be expected that the fuel deliverers would earn a profit. Investigation by both the Alaska attorney general (AG) office and ISER did not find "excess profits" from fuel distributors.[120,121] In 2009, as part of the AO 247 Rural Fuel Price Investigation, the AG's office found that the "average rate of return on capital was unremarkable".[122]

Anecdotally, credit risk and financing terms are another factor that leads to the final price that consumers pay. Since most communities will have access to the Bulk Fuel Loan, administered by the Division of Community and Regional Affairs (DCRA), it would seem that credit risk should now be minimal for most fuel deliverers as the risk of repayment has been transferred to the State. Conversations with fuel distributors have highlighted this benefit to fuel distributors.[123]

LOCAL STORAGE

The cost of storing fuel in the community can be a significant driver for local fuel costs, though whether or not that cost is always priced into fuel used for electricity generation or consumer heating oil is unknown. Figure 30 shows the added cost that local storage contributes to the total cost of diesel through the capital costs, operational costs, and working capital.

[120] Szymoniak et al, 2010
[121] Alaska Attorney General. "Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General's gasoline pricing investigation", 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf
[122] Alaska Attorney General, 2010.
[123] Trevor Crowder, Fuel operations manager at Everts Air Fuel. Personal communication 4/25/2016.

Components of the delivered price of diesel: Local storage*
Source: AEA adapted from 2008-2011 ISER work

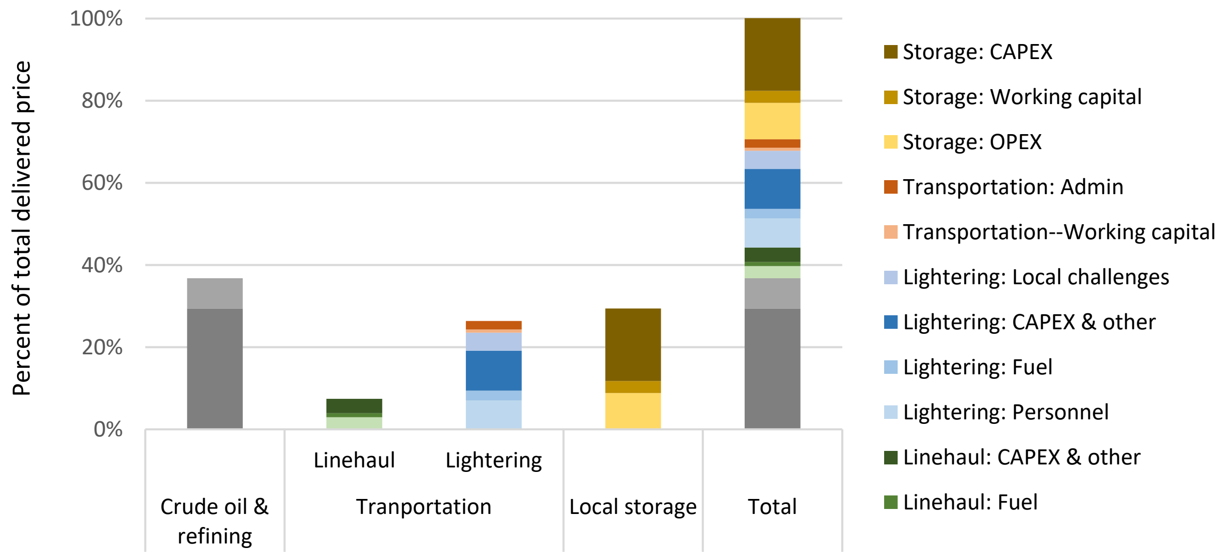


Figure 30: Components of the delivered price of diesel: Local storage[124]
*Assumes $40/barrel crude oil

Since many communities have been recipients of a bulk fuel tank farm from the State and/or federal government, the capital expenses (CAPEX) are generally not included in the retail price of the fuel.[125] The CAPEX component included in Figure 30 is from an AEA analysis of the Denali Commission bulk fuel database for the per-gallon costs of bulk fuel storage in communities. More details on this are included in Chapter 5 under the section on the Bulk Fuel Upgrade program.

Operational expenses (OPEX) include both regulatory compliance and the maintenance and labor for the tank farm. AEA does not have access to the actual operational expenses for the facilities, as they are not economically regulated. The RCA reports that some utilities use the Denali Commission/AEA business plans to account for bulk fuel operational expenses for PCE reimbursement.[126]

The working capital is the amount of money that is needed to cover the cost of holding a large amount of fuel for many months before the product can be sold to consumers. This working capital is equivalent to the amount of interest that would be paid over the winter for holding onto the fuel before selling it. Many communities invest hundreds of thousands to millions of dollars in bulk fuel purchasing; those funds will remain tied up, not available for other investments, until the fuel is sold.

[124] AEA adaptation from 2008-2011 ISER work on components of delivered fuel costs
[125] Per Denali Commission grant agreements, communities are supposed to have a business plan that charges customers for the eventual replacement of the bulk fuel facility.
http://denali.gov/images/documents/Other_Commission_Reports/RR_Report_FINAL_6-12-13.pdf
[126] Julie Vogler, Regulatory Commission of Alaska, personal communication, June 2016.

In cases where a community that used a Bulk Fuel Loan to purchase fuel ends up selling less fuel over the term of the loan than was purchased with the loan, the community has to find other funds to pay off the loan without the revenue from the fuel sales, which places a burden on the community.[127]

DRIVERS OF CONSUMER ELECTRIC RATE

The residential and/or commercial rate that people pay for electricity is determined by a number of complex interrelated supply chains and utility decision-making processes. While the price of fuel is seen as the primary driver of the consumer rate, fuel costs, generation and distribution efficiency, and the non-fuel utility management needs and decisions all contribute to the final rate customers pay. As seen later in this section, ratemaking decisions, an infrequently addressed part of the process, has a significant impact on residential rates as well as the total cost of electricity in communities. The Power Cost Equalization program blunts some of these rates to certain consumers, shifting them instead to the State.

UTILITY COST OF DIESEL FUEL

As seen in Chapter 2, the majority of utilities in the AkAES study area rely exclusively on diesel fuel for electricity generation. Fuel costs are a major component of the residential electricity rate for the majority of communities in the AkAES study area.

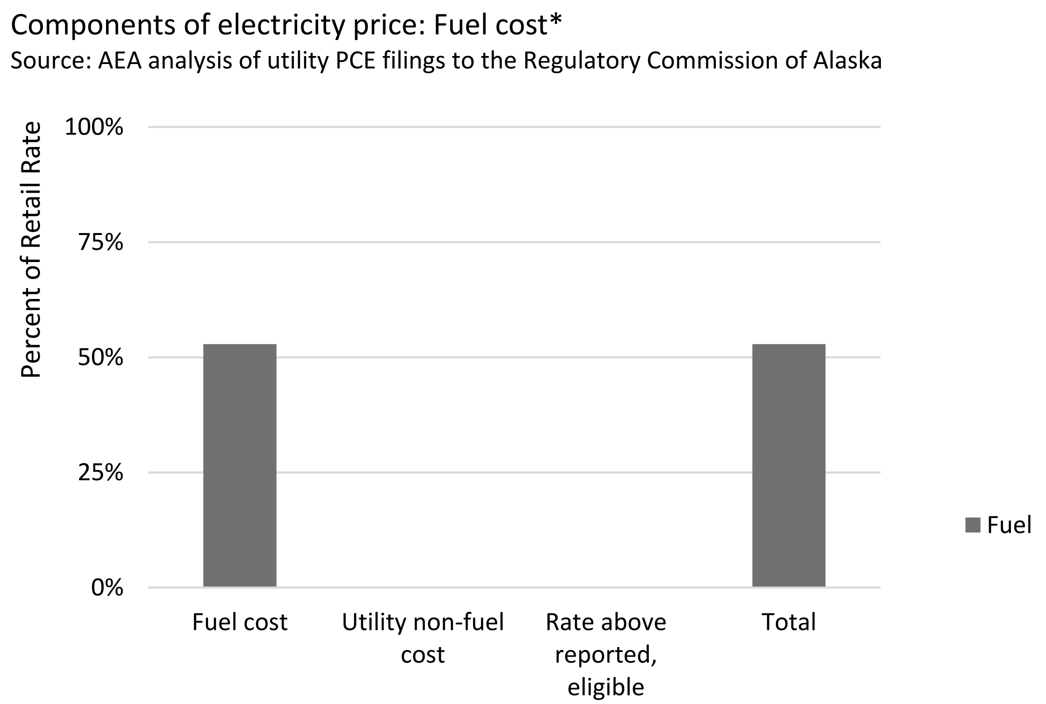


Figure 31: Components of electricity price: Fuel cost[128]

*Note: Assumes $3.50/gallon of diesel and 12 kwh/gallon

Figure 31 shows the percentage of 2013 residential rates that were based on the cost of diesel for those communities that participated in PCE. The other two categories, currently showing no data, will be

[127] Jane Sullivan, Division of Community and Regional Affairs, personal communication 11/14/2016.

[128] AEA analysis and calculations based on utility filings to the RCA for the PCE program and AEA PCE program data, 2000-2014.

addressed later in this chapter. Figure 31 assumes that fuel costs $3.50/gallon and that power generation efficiency is 12 kWh/gallon. Given these assumption, which is roughly average for PCE communities, fuel costs constitute approximately half of the residential electricity rate. This is obviously not the case for all communities, as is illustrated in Figure 32.

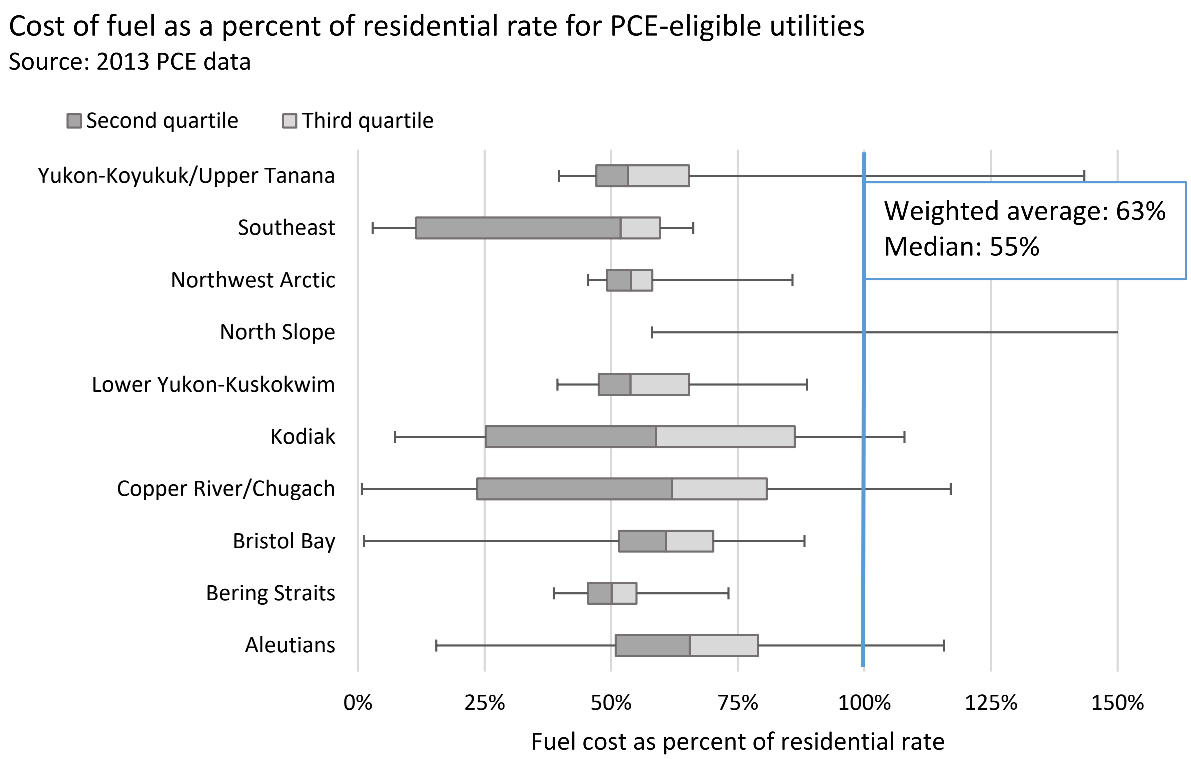


Figure 32: Cost of fuel as a percent of residential rate for PCE-eligible utilities[129,130]

One noteworthy anomaly illustrated by Figure 32 is that in some cases the residential rate does not cover even the fuel cost for the utilities—this is the case for all values above 100%. In some regions there is also a wide spectrum of variability in the degree to which fuel costs influence the residential rate. In some communities using hydropower, for instance, it is nearly 0%.

GENERATION AND DISTRIBUTION EFFICIENCY

Diesel costs are not fixed for a community. The unit price that a utility pays for diesel changes from year to year. The values in Figure 32 have likely changed with the reduction in oil prices, for instance, but 2013 is the most recent year for which AEA has cleaned data for this analysis. The consumption of diesel is also not fixed. Aside from changes in the consumption of electricity, the generation and distribution efficiency of the power plant also has a profound impact on a utility's fuel costs.

A utility's generation efficiency (generally measured in terms of kWh of electricity produced per gallon of diesel), the distribution efficiency (generally referred to as line loss and measured in the percent of

[129] AEA analysis of PCE data, accessed from Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)
[130] Figure does not include North Slope and non-PCE communities

generation not purchased by consumers), and the price of fuel (measured in dollars per gallon) all contribute to the cost of power. Generation efficiency, in particular, as shown in Figure 33, has a primary role in determining the cost of power.

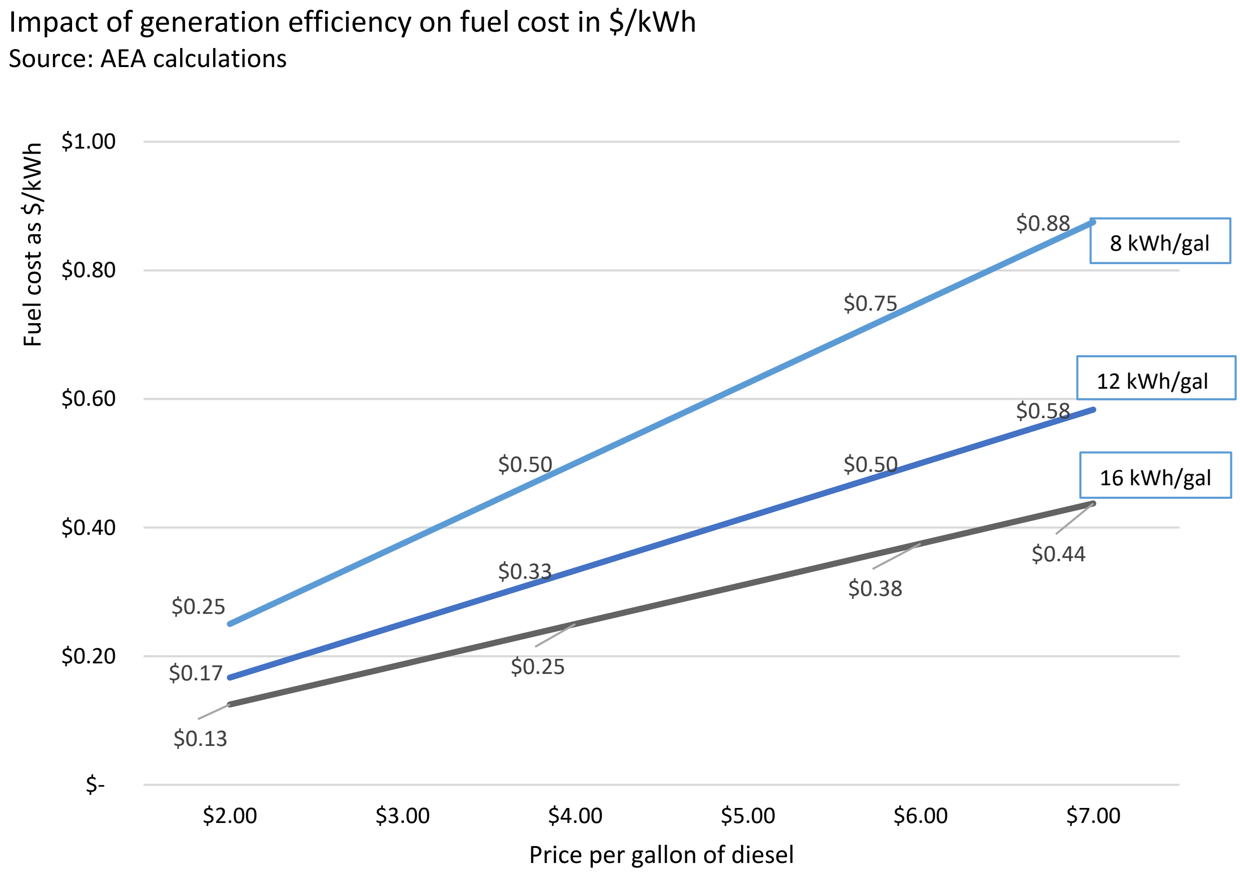


Figure 33: Impact of generation efficiency on fuel cost in $/kWh[131]

Differences in generation efficiency have less of an impact at lower prices. For example, the difference in the cost of power between the highest and lowest efficiency is $0.12/kWh at $2/gal, but $0.44/kWh at $7/gallon. Generation efficiency directly affects the cost consumers pay. Generation efficiency is limited by the type of gensets, and also a number of other factors including how well the genset is sized to the community's load (gensets run less efficiently at low loads), the age of the genset, and the maintenance performed on the machinery.

The cost of power is more volatile when generation efficiency is lower, as seen in Figure 34. Yearly averages for Brent crude prices are used to estimate the differences in $/kWh for the cost of power in a hypothetical community in Figure 34. Brent crude prices are converted to community diesel prices, using Bethel for the case study.

[131] AEA calculations

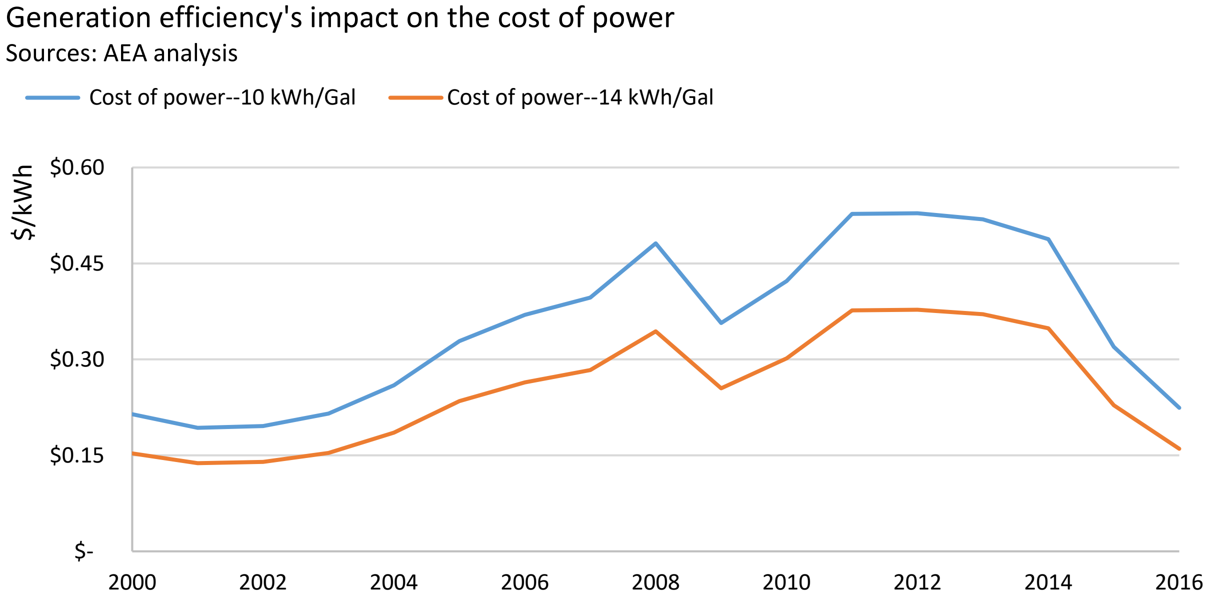


Figure 34: Generation efficiency's impact on the cost of power[132]

Figure 34 shows how the fuel cost, in terms of $/kWh, would have changed from 2000 through 2016 based on two different fuel efficiencies. The upper line is the efficiency at 10 kWh/gallon and the bottom line is for 14 kWh/gallon. It should be evident that the cost of power changes significantly over the years, and the two efficiencies respond very differently to the changes in the cost of diesel. The cost difference between the two efficiencies is only $0.06/kWh at the lowest crude oil price, but goes to $0.15/kWh at the highest oil price in 2011.

Price volatility is also greater when efficiency is lower. For example, between 2010 and 2011, the change in crude oil price translated to a $0.11/kWh increase for the lower efficiency scenario but only $0.08/kWh at the higher efficiency scenario. Translating this difference into total costs, if the utility sold an average of one million kWh per year, this $0.03 difference would mean a difference of $30,000 in cost to the community. Generation efficiency helps protect the utility and community from commodity volatility.

[132] AEA analysis based on ACEP fuel price model

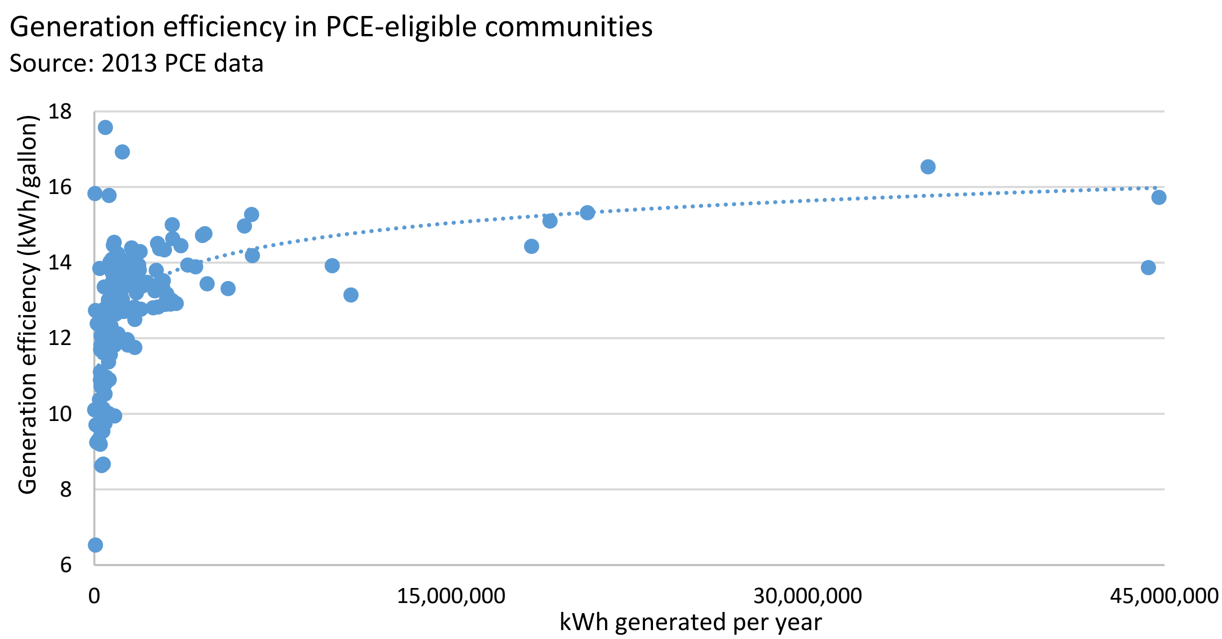


Figure 35: Generation efficiency in PCE-eligible communities[133]

The reported generation efficiency in PCE-eligible communities, as shown in Figure 35, does not show a strong correlation between community size and generation efficiency, particularly below 5 million kWh/year. While smaller communities do tend to have lower efficiency, some smaller communities have reported efficiencies close to large communities. The two efficiencies above 16 kWh/gallon and below 15 million kWh generated are likely due to reporting errors.

The cost effect of line loss works in a similar manner to generation efficiency. As electricity is distributed to consumers, there is an unavoidable loss of power through the power lines, at transformers, and other parts of the distribution system. Per RPSU design specifications, a local distribution should lose no more than about 8% of its power through these necessary components. A distribution system that has unknown faults, unseen bridging, or grounding may be losing energy–energy that must still be produced by burning diesel but that does not provide any benefit to the community. Not insignificantly, these losses may also be a safety hazard. Line losses drive up the costs to the consumers, as seen in Figure 36.

[133] 2013 PCE data, accessed from the Alaska Energy Data Gateway.

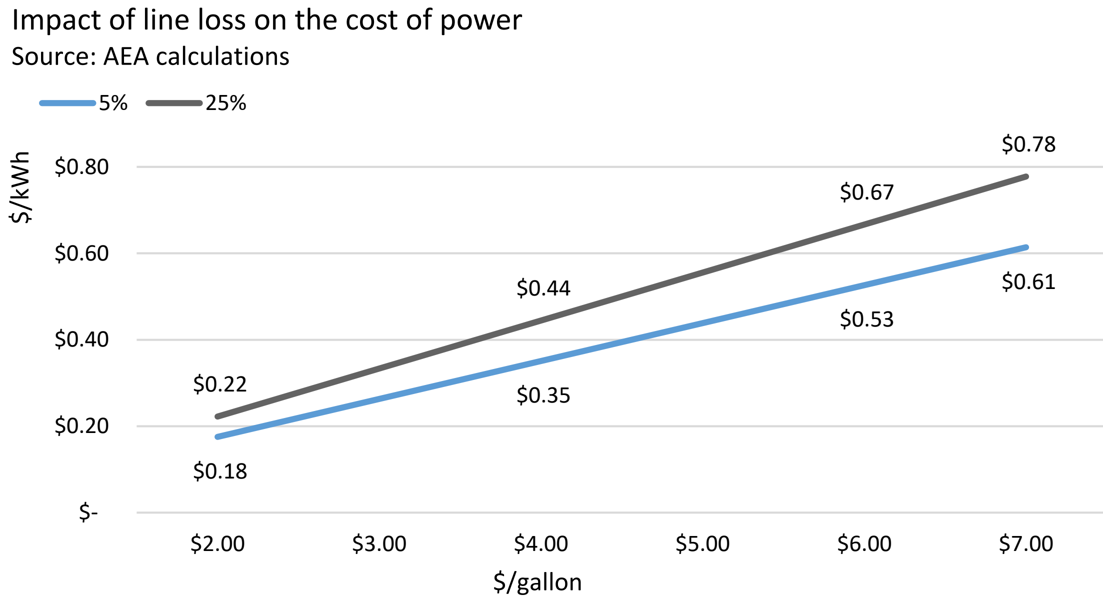


Figure 36: Impact of line loss on the cost of power[134]

Figure 36 uses a constant efficiency, 12 kWh/gallon, while looking at the trajectory of different line losses. At higher fuel prices, line losses become more expensive. At the low end of the fuel price spectrum, the difference between 5% and 25% line loss is only $0.04/kWh, but at $6/gallon the difference equates to $0.17/kWh. Some utilities have reported line losses greater than 30%, which contributes to unnecessary costs to consumers.

When diesel is cheap, inefficiency is much less expensive. The price of crude, currently low, is but one factor that leads to the utility's price for diesel. If anything, the other factors that lead to the delivered price of fuel, such as labor and capital costs, would be expected to increase in the future.

UTILITY NON-FUEL COSTS

While fuel costs make up, on average, 63% of residential electricity rates across all PCE communities, non-fuel costs are also substantial. For this analysis, AEA used unpublished data supplied by the RCA on non-economically-regulated utilities that participated in PCE from 2007 to 2014. In order to be reimbursed by the PCE program, the RCA evaluates all reported expenses to ensure that they are allowable under RCA regulations. Utilities can only be reimbursed for expenses that are reported to the RCA, which creates a strong incentive for utilities to report any and all expenses. Some of the data would indicate that not all utilities report all expenses, but without auditing every utility, it is impossible to be certain.

What follows are those that the RCA determined to be allowable expenses. There may be expenses that are actual utility expenses that were deemed to be ineligible by the RCA for various reasons—anecdotally, old fuel debt is a commonly disallowed expense.

[134] AEA calculations

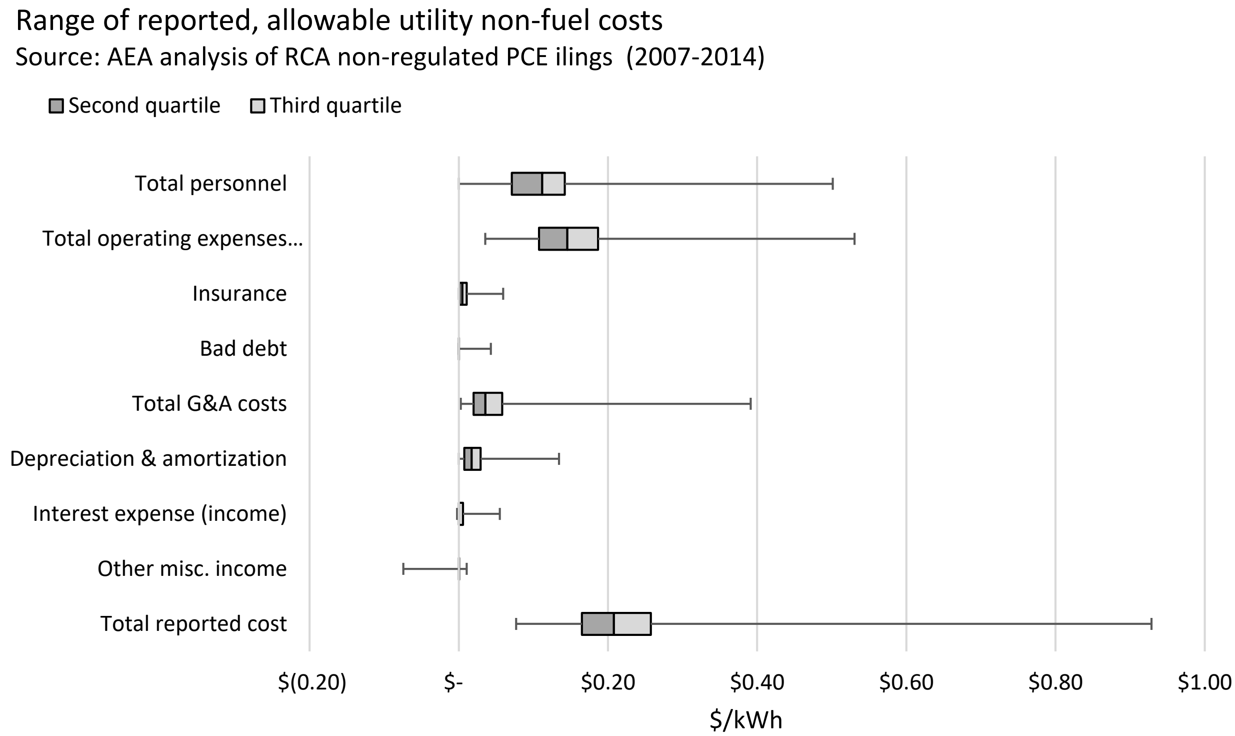


Figure 37: Range of reported, allowable non-fuel utility cost[135]

Total reported utility non-fuel costs, seen on the bottom of Figure 37, range from approximately $0.10/kWh to more than $0.90/kWh.

Median cost of utility personnel across the dataset is approximately $0.12/kWh, which is more than the total cost per kWh in some Alaska communities, including several in the study area. Outlying personnel expenses range up to $0.50/kWh. Most utilities did not separate out the personnel expenses for the operators versus the office personnel or utility clerks versus management. It is difficult to know from the available data which of these positions is the primary driver of personnel costs.

Total utility operating expenses are almost entirely personnel costs. Maintenance activities, at least those not captured in the personnel expenses, represent a minimal sum to utilities. Given the importance of maintenance in reducing the need for early replacement of gensets, which are capital costs that have historically not been typically born by the utilities, it would be useful to know how these costs fit with expectations for these utilities. Current data availability does not allow for that analysis, however.

Bad debt is an expense from uncollected bills that are being written off by the utility. Anecdotally, bad debt has been identified as a major strain on utilities. Although this may be an issue of utilities underreporting an allowable expense to the RCA, the available data does not indicate that bad debt is a major issue across the PCE utilities. Looking at the ledgers of a small sample of utilities showed that customer payments were not made regularly but that accounts were settled over time, so the real issue may instead be one of cash flow rather than one of having to write off customer debts. The issues caused

[135] AEA analysis of utility filings to the RCA for the PCE program and AEA PCE program data, 2000-2014.

by volatile cash flow have been one of the reasons why pre-paid meters have become more widespread across rural Alaska.

The category Total G&A costs includes other general and administration expenses including building rent, telecommunications, insurance, and other such expenses.

Almost all utilities in this analysis had some sort of depreciation and/or amortization, but few had anything sizeable. The vast majority of the infrastructure assessed was paid for by grants from the State and/or federal government. Other miscellaneous income came mainly from heat sales and pole rental for telecommunications. It is possible that utilities are not fully exploiting other revenue sources that could reduce the cost to consumers.

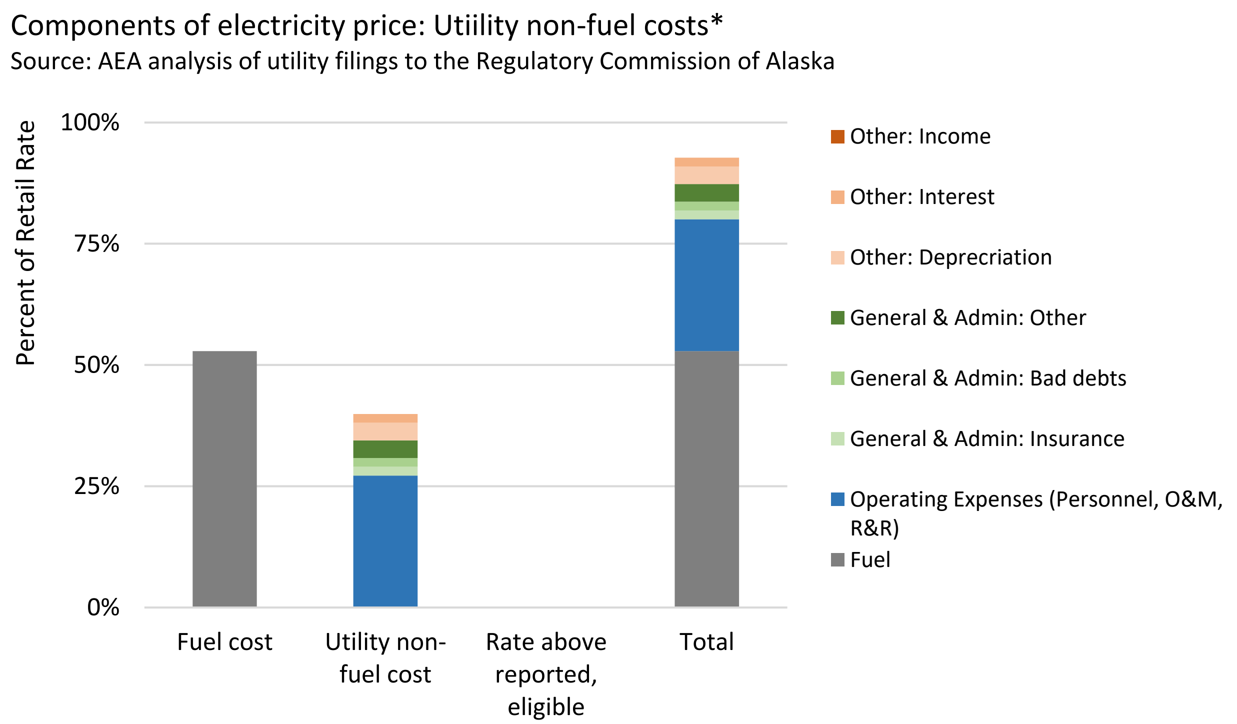


Figure 38: Components of electricity price: Utility non-fuel costs[136]
*Note: Assumes $3.50/gallon of diesel and 12 kwh/gallon

Figure 38 shows how utility non-fuel costs, which were displayed in Figure 37, add to the total costs of the utility. It should be apparent that the non-fuel costs are an important contributor to the overall cost that consumers pay. Operational expenses, primarily personnel costs, contribute about a quarter of all costs. These costs are why electricity prices are much less sensitive to changes of crude oil prices than are diesel prices.

It is uncertain if the reported non-fuel costs are sufficient to cover the utilities' needs. There are indications of deferred and or neglected maintenance in many communities. At least some of the operational costs are subsidized by State programs, including the Electrical Emergency Assistance and

[136] AEA analysis and calculations based on utility filings to the RCA for the PCE program and AEA PCE program data, 2000-2014.

Circuit Rider programs.[137] The rates in many communities would likely need to be raised to cover the actual expenses to maintain the infrastructure for its expected economic life.

THE IMPACT OF ORGANIZATIONAL STRUCTURE ON NON-FUEL UTILITY COSTS

The non-fuel costs generalized in Figure 38 are far from uniform across utilities. It would be assumed that rural utilities should experience some economies of scale, since as the utility increases in size in terms of sales, the costs to run the utility will be spread out over more kWh of sales. Figure 39 shows the relationship between the non-fuel cost per kWh and the kWh sold for the PCE communities, including some that are economically regulated.

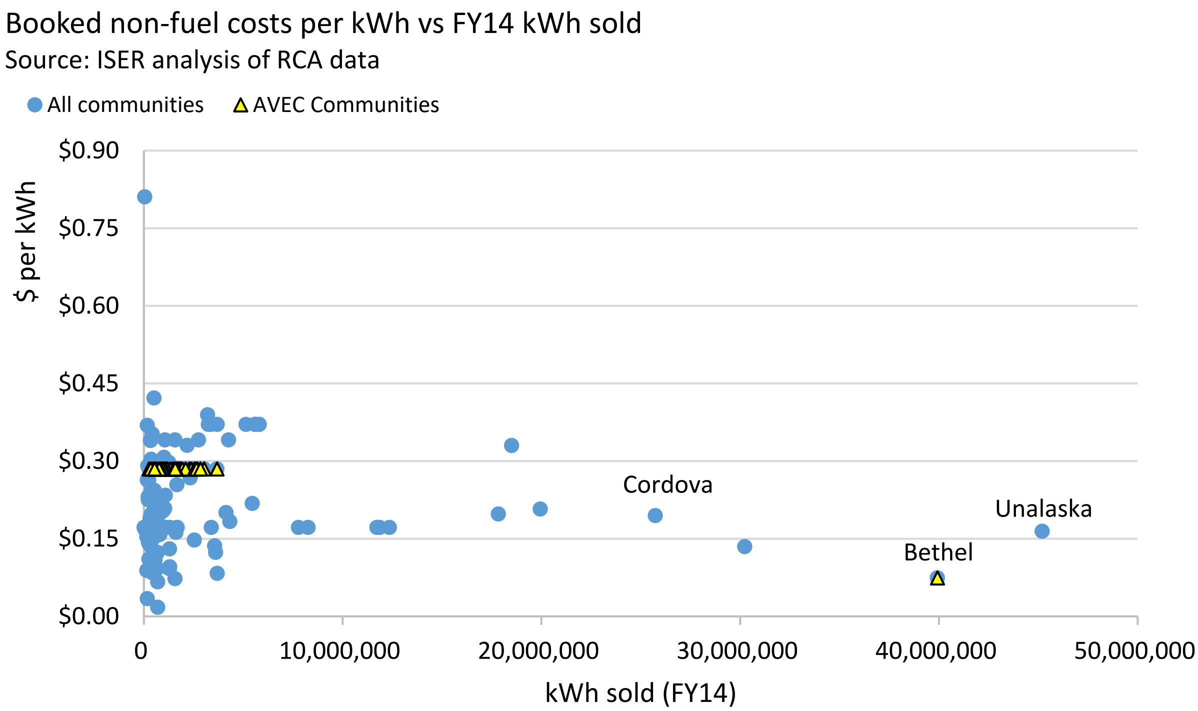


Figure 39: Utility non-fuel costs per kWh vs. kWh generated[138]

As is evident in Figure 39, the spread in booked, non-fuel costs among the smaller utilities, particularly those with sales under 10,000,000 kWhs, is very large. The reported, allowable non-fuel expenses go from under $0.05/kWh to over $0.80/kWh. It may be that some of the smaller utilities do not have the resources or bookkeeping to accurately report the actual expenses at the utility. Some communities may provide internal subsidies, where the community clerk or manager may also perform work for the utility

[137] Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm.

[138] Steve Colt and Mark Foster. "True Cost of Electricity in Rural Alaska and True Cost of Bulk Fuel in Rural Alaska." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESTrueCostElectricityFuel102616.pdf?ver=2016-10-27-083402-423

but not be on the utility's books. If these anecdotes are correct, communities are missing out on potential State funds that might be available to the community through PCE reimbursement.

Above 10 million kWhs of sales, there is a factor of four difference between the lower bound ($0.07/kWh) and the upper bound ($0.33/kWh). In this analysis, the largest utility, the Alaska Village Electric Cooperative (AVEC) has very average non-fuel costs.

It should also be remembered that most of these utilities do not have significant capital expenses due to the historical abundance of state and federal grants for utility infrastructure. If these costs were included, non-fuel costs for almost all utilities would be significantly higher, as is shown in Chapter 5.

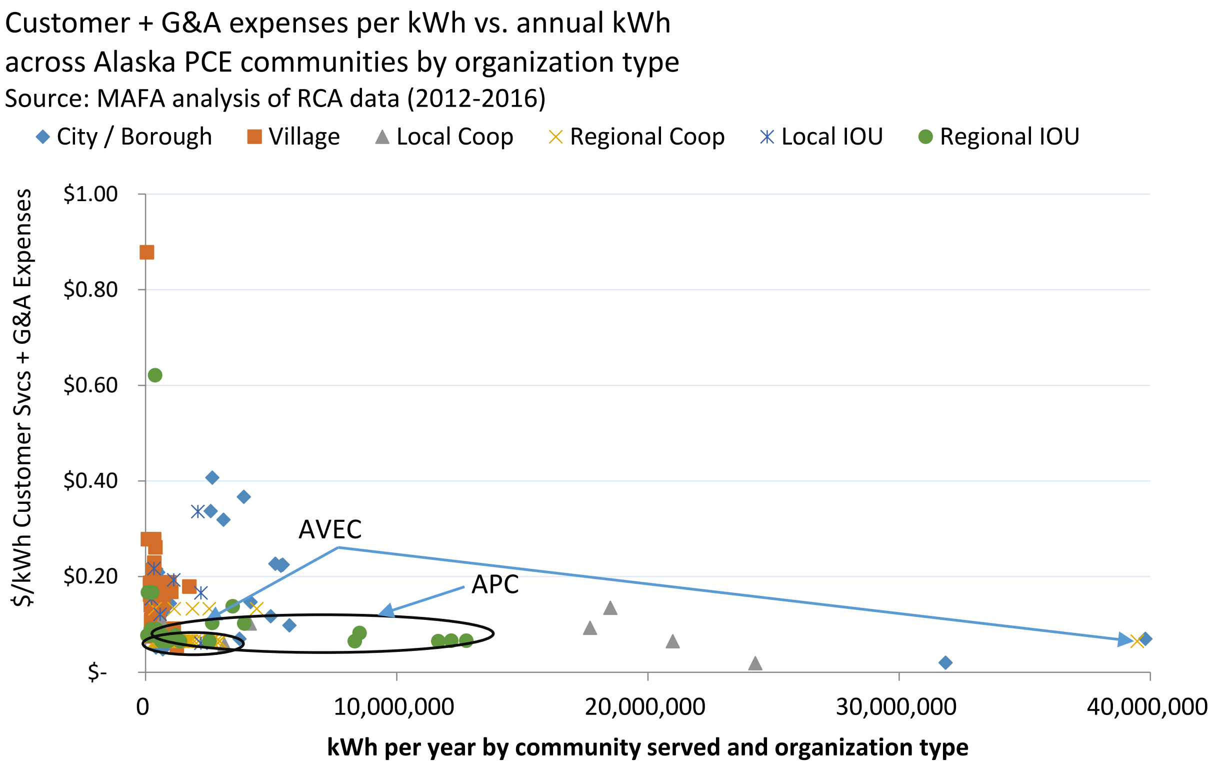


Figure 40: Non-generation expenses vs. annual kWh sales by organization type[139]

Figure 40 slices the data in a slightly different way in order to understand the organizational efficiency of utilities. In this chart, the costs associated with generation have been removed, which creates a fair comparison between utilities. For example, Alaska Power Company (APC) has significant hydro generation while AVEC is almost exclusively reliant on diesel. Even without including the cost of fuel, diesel power requires more operations and maintenance (O&M) than hydropower. In this analysis, as opposed to Figure 39, AVEC shows significant economies of scale. Except for the most extreme outliers, this is up to $0.30/kWh less expensive than some of the other utilities.

[139] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017.
http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

A large spread of costs is seen for the utilities, with some pronounced differences by the type of utility. In this analysis, larger utility structures, including regional co-ops and regional investor owned utilities (IOUs), see significant economies of scale. Other types of organizational structures including local co-ops, municipal/borough run utilities, village utilities (defined as municipal run utilities with sales less than 1 million kWhs/year), and local IOUs, are generally more expensive.

Distribution of non-generation expenses by organization type
(Distribution + Customer Service + G&A Expenses per kWh)
Source: MAFA analysis of RCA data (2012-2016)

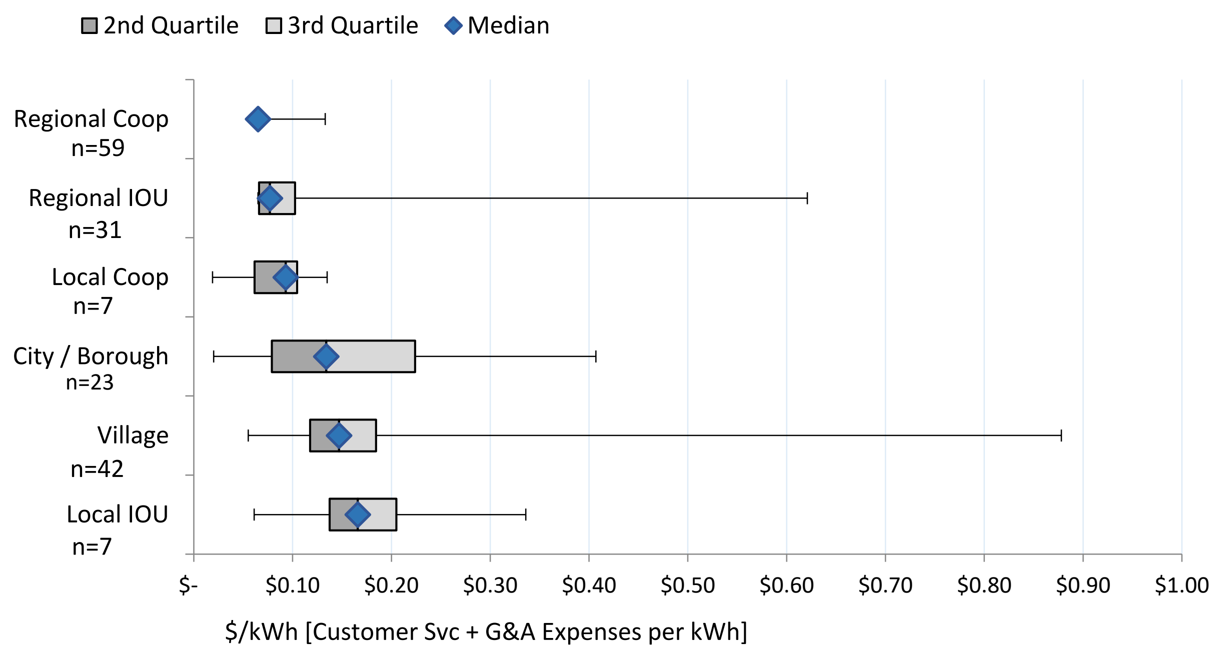


Figure 41: Distribution of non-generation expenses by organization type[140]
NOTE: "n" is the number of communities within the utility type

Figure 41 shows the range of non-fuel costs by the type of utility organization. Large regional utilities, both co-ops (such as AVEC) and IOUs (such as APC), have the lowest median costs at $0.065/kWh and $0.077, respectively. Local Community Co-ops, which tend to serve larger communities (12 million kWh/year average), are marginally more expensive at a mean cost of $0.083/kWh.

The last three organizational structures deliver higher median costs to serve rural communities – ranging from $0.11/kWh for city/boroughs to the $0.16-$0.18/kWh range for stand-alone villages and local IOUs. The overall range of costs is wide, even for the middle 50% of utilities. For example, the city/borough group, the middle 50% of utilities, range from $0.07/kWh to $0.23/kWh.

---

[140] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017.
http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

Larger regional utilities, both co-ops and IOUs, tend to be more efficient than other organizational structures. The most efficient large regional co-op, AVEC, includes a large regional hub and dozens of smaller villages.[141]

UTILITY RATES

For those utilities that are economically regulated by the RCA, the utility's profit is based on the approved return on equity. For all other utilities, which constitute the majority of PCE eligible utilities, the utility is able to charge whatever rate they deem appropriate.

In addition to customer charges, fees (such as connection fees), and other revenue (such as heat sales or pole rental), non-fuel rates should cover fixed and variable utility costs. Fixed customer charges are generally minimal ($5/month in almost all communities with applicable data). Since the quantity of electricity sold in any given year cannot be predicted and small changes in consumption or the loss or gain of a limited number of customers can have a large effect on sales, small utilities can be put in a difficult financial position purely due to a change in sales.[142]

In Figure 42 the rates reported to the RCA by each utility are compared to the utility's reported, allowable expenses (in terms of $/kWh). There is only one entry per utility—so even if one utility covers multiple communities, it will only be counted once. It is important to recognize that this does not include non-booked costs, in particular the grant-funded capital costs for infrastructure. The consumers' rates would be significantly higher if the State and federal governments had not paid significant amounts of the infrastructure costs.

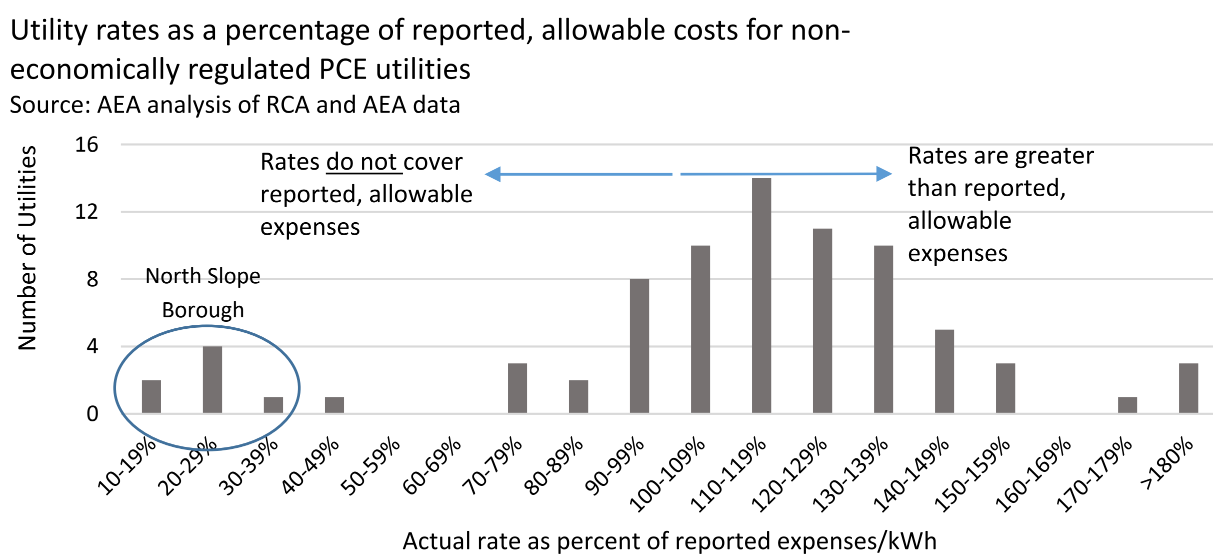


Figure 42: Utility rates as a percentage of reported, allowable costs[143]

[141] Foster and Townsend, 2017.
[142] University of Alaska Center for Economic Development. "Utility Financial Analysis and Benchmarking Study." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/Utilityfinancialanalysisandbenchmarkingstudy.pdf
[143] AEA analysis and calculations based on utility filings to the RCA for the PCE program and AEA PCE program data, 2000-2014.

PCE will not reimburse an amount over the rate set by the utility. For example, if the reported allowable expenses are $0.80/kWh but the customer rate is only $0.15/kWh (as is the case in many North Slope Borough communities), PCE will only reimburse based on the $0.15/kWh rate and not the full reported, allowable rate. PCE will also not reimburse for rates above the reported, allowable expenses. Thus, if the reported, allowable expenses, including fuel, equal $0.30/kWh but the rate is $0.45/kWh, PCE will only reimburse on the basis of the $0.30/kWh reported, allowable expenses and utility customers will pay the difference. This is why the effective rate in most communities is not at the PCE minimum. Residential electricity rates are higher than is needed to cover the reported, allowable expenses in 57 of the 78 non-economically regulated utilities.

Figure 42 includes the cost of power adjustment (COPA)—essentially the fuel cost—for the most recent year available, generally FY2014. Thirteen utilities did not have rates that covered all reported, allowable expenses; six of those utilities are located in the North Slope Borough (NSB). The NSB provides a $0.50-$0.75/kwh subsidy to the communities, effectively negating potential reimbursements from the PCE program. Several other communities and utilities also provide subsidies to their customers, presumably from local resource taxes.

The majority of the 45 non-economically regulated utilities have rates that are between 110% and 140% of the reported, allowable expenses. It appears that anecdotes about small, rural utilities undercharging their customers are not supported by the data.

There are specific instances where legitimate expenses are not allowed and which must be paid for by customers. Because of this, some argue that all reported costs should be used instead of the allowable costs as these may be more reflective of actual utility expenses.[144] In some cases, utilities have past fuel debt that must be repaid, but these expenses are not allowed under current PCE regulations. This may explain the extreme outliers of rates that are set nearly twice as high as the reported, allowable expenses submitted to the RCA. As shown in Figure 43, the weighted average of the component of the non-fuel rate that is above the reported, eligible expenses is about 7% of the residential electricity rate. An inspection of Figure 42 may make one expect that this value would be larger, but since Figure 42 does not break it out by individual community, and the largest utilities have rates closest to the reported, eligible expenses, the average across all non-economically regulated utilities is much less than might be expected.

[144] Steve Colt and Mark Foster. "True Cost of Electricity in Rural Alaska and True Cost of Bulk Fuel in Rural Alaska." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESTrueCostElectricityFuel102616.pdf?ver=2016-10-27-083402-423

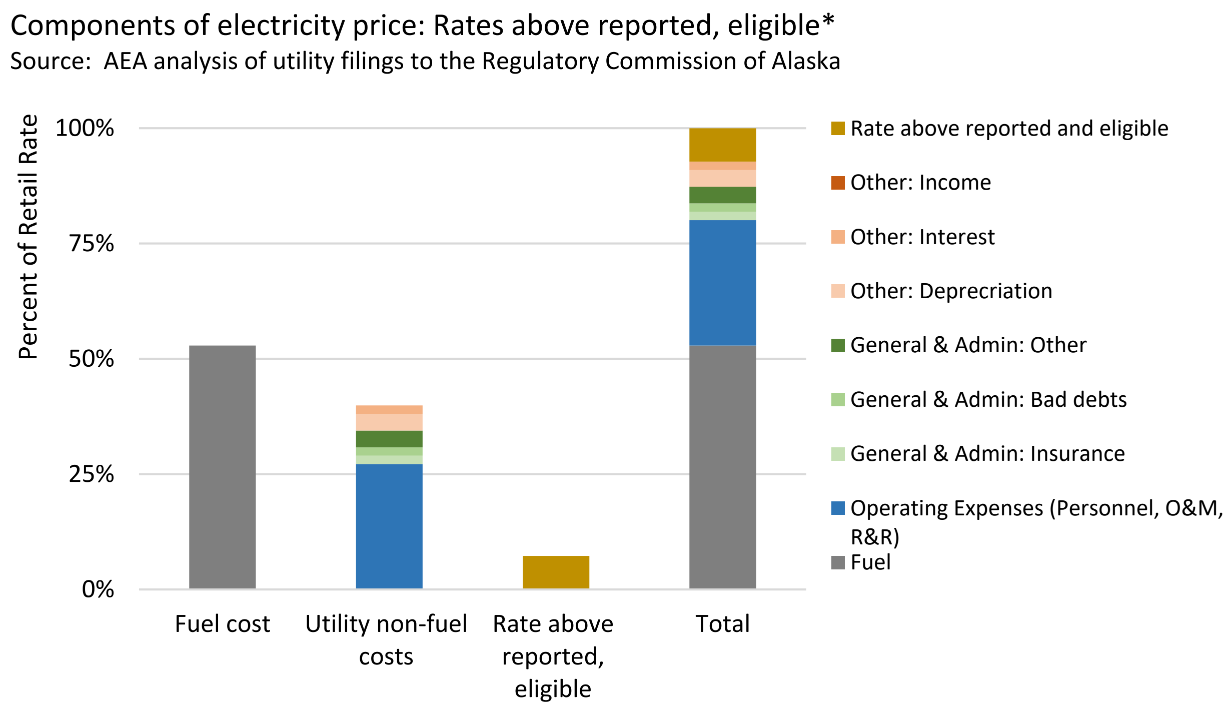


Figure 43: Components of electricity price: Rates above reported, eligible[145]

*Note: Assumes $3.50/gallon of diesel and 12 kwh/gallon

A reserve fund for renewable and replacement (R&R) is another common potential expense that is not allowed. In order to prepare for major repair and replacement of infrastructure in the future, many believe that utilities should save money in a reserve account, perhaps because these accounts were required per the Denali Commission grant agreements that built many of the utilities' powerhouses. The reserve accounts were meant to allow for sustainable operation of the facilities and not create a future liability for the state or federal government. In 2012, the Denali Commission's Inspector General was unable to determine if these accounts were set up and being funded through ratepayers.[146] It seems unlikely that the rates that are significantly above the reported, allowable expenses are being used to fill these accounts.

From the utility's perspective, there is likely no advantage for having a reserve account specifically for replacing the infrastructure as opposed to taking out a loan at the time of plant replacement. In fact, charging current customers for future investments runs directly contrary to fundamental principles of utility regulation, which is why the deposits into R&R accounts are not eligible expenses. The used and useful principle, which underlies utility regulation, requires that physical assets are both used by and

[145] AEA analysis and calculations based on utility filings to the RCA for the PCE program and AEA PCE program data, 2000-2014.

[146] Office of Inspector General, Denali Commission. Analysis of R&R Accounts as Highlighted in the FY2012 Second Half Semi-Annual Report to Congress. June 12, 2013. http://oig.denali.gov/wp-content/uploads/2015/01/SAR-2012-09.pdf

useful to current ratepayers to reduce costs or ensure the quality of service before they can be required to pay for the assets.[147,148]

Of the factors shown in Figure 43, approximately half of them respond slowly to changes in demand—the utility non-fuel costs and the rate above reported, eligible—and half of them are variable—the fuel cost. As the price of fuel and the efficiency of the generation and distribution system changes, the relative weights of all of these factors change. Since the non-fuel costs respond slowly to changes in demand, it would indicate that more of these fixed costs should be recovered in a customer charge instead of in rates. This would reduce some of the difficulties of setting a rate based on uncertain sales to cover the fixed cost of operating the utility.

COST OF CAPITAL FOR ELECTRIC UTILITIES

The cost of capital was not included in the previous analysis, due to insufficient data. Cost of capital includes both the cost of debt, the interest paid, and the cost of equity, which is the profit on the capital investments made by the utility. Economically regulated utilities in Alaska are only allowed to earn a profit from their equity, otherwise their rates are limited by the RCA to the reported, allowable costs. The utilities that are not economically regulated are able to charge whatever rate they choose.

In most markets, utilities have a combination of debt and equity on their books. In most of the communities in the AkAES study area, utilities have both limited debt and limited equity because either the State or federal government granted the infrastructure to the community or utility.[149] The grant-funded infrastructure does not count as equity for the utility and they are not allowed, if it is an economically regulated utility, to earn a return on the government's investment.

The cost of equity increases with the amount of risk experienced by the utility. Smaller utilities, because of uncertainty associated with the volatility of consumption and potential cash flow issues, will have a higher cost of equity than larger utilities. The weighted cost of capital is the combination of the cost of debt (the interest rate paid to finance the infrastructure) and the cost of equity (the expected return on the investment). Figure 44 provides an illustration of the weighted cost of capital for the range of utility sizes for PCE-eligible utilities.

[147] Wikipedia. "Used and Useful Principle." https://en.wikipedia.org/wiki/Used_and_Useful_Principle

[148] Jim Lazar. "Electricity Regulation in the US: A Guide." Second Edition. The Regulatory Assistance Project. 2016. http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf

[149] Steve Colt and Mark Foster. "True Cost of Electricity in Rural Alaska and True Cost of Bulk Fuel in Rural Alaska." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESTrueCostElectricityFuel102616.pdf?ver=2016-10-27-083402-423

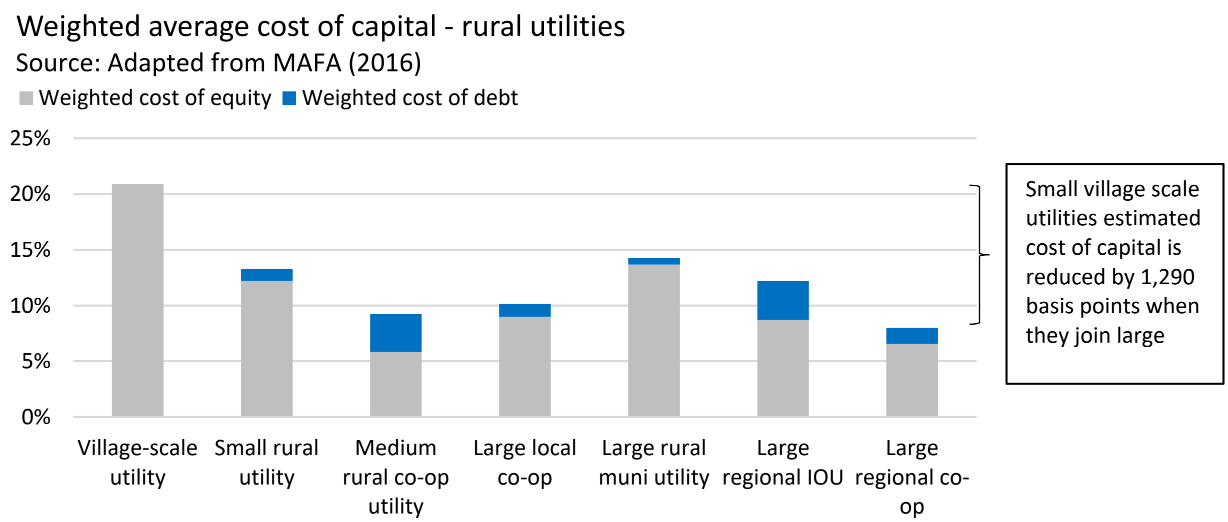


Figure 44: Weighted average cost of capital for PCE utilities[150]

Most PCE eligible utilities do not have sizeable debt or equity, due to State and federal grant-funding of infrastructure. In addition to grants, consumers' costs are also lower because of the reduced cost of capital.[151] Per the above analysis, a private utility or independent power producer (IPP) in the PCE region that does not have grant-funded infrastructure would likely require a return on equity (ROE) between 16% and 22%. If the entity is an IPP investing in small communities, in order to reduce consumer costs and still earn a return on investment, the IPP would have to be significantly more cost-efficient than the status quo. For reference, large utilities' ROE in the Lower 48 are generally close to 10%.[152]

RETAIL COST OF HEATING OIL

Although the factors that lead to the delivered cost of fuel, including heating oil, is relatively well understood, finding a way to correlate the delivered and retail costs has been problematic because of the variety of local pricing decisions. In 2010, ISER found that the majority of fuel price variability resulted from pricing decisions by the local fuel retailer.[153]

In 2010, the State of Alaska attorney general investigated causes of the high fuel costs in rural Alaska communities. The AG's office had access to proprietary data that AEA and other researchers have not had access to. After determining that fuel deliverers were not extracting unusual profits, the AG's report looked into local decisions that led to the sometimes large retail differences in a geographically close area. The AG report found a range of local mark-ups: from just a few percent to 100% mark-up. The factors that the AG noted for why these differences exist included: the fuel had previously been sold at a loss, a lack

[150] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017.
http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

[151] Foster and Townsend, 2017.

[152] Castalia Strategic advisors. Estimating WACC for Regulated Utilities in the United States. April 2014. http://www.castalia-advisors.com/files/updated_2014/TP_WACC_Sub_Attachment_B_Castalia_Estimating_WACC.pdf

[153] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010.
http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

of local competition, as a source of revenue to pay for public projects or other community needs, and no apparent justification for the different retail prices. The AG was unable to determine the amount of profit by the local fuel distributors.[154] ISER also found anecdotal evidence of communities marking up the fuel cost to raise revenue for other local services, acting as a de facto tax.[155]

Given the challenges noted in previous work, AEA did not attempt to gather additional data on local markups. Instead AEA tried multiple ways to come up with a mathematical relationship between utility diesel and retail heating oil prices. Likely due to the inconsistency in local pricing strategies, no statistically significant method was found that worked for the majority of communities.

AEA ended up generalizing the local mark-ups on a regional basis by comparing the reported utility diesel cost, as reported to PCE, to the retail heating oil prices in communities. Diesel and heating oil are similar fuels, sometimes the same fuel, delivered by similar or same means. While other factors, as noted earlier, may lead to different prices for different purchasers in the same community, this method allows for some interesting analysis, as shown in Figure 45. Two regions are highlighted to show the change in this difference over time.

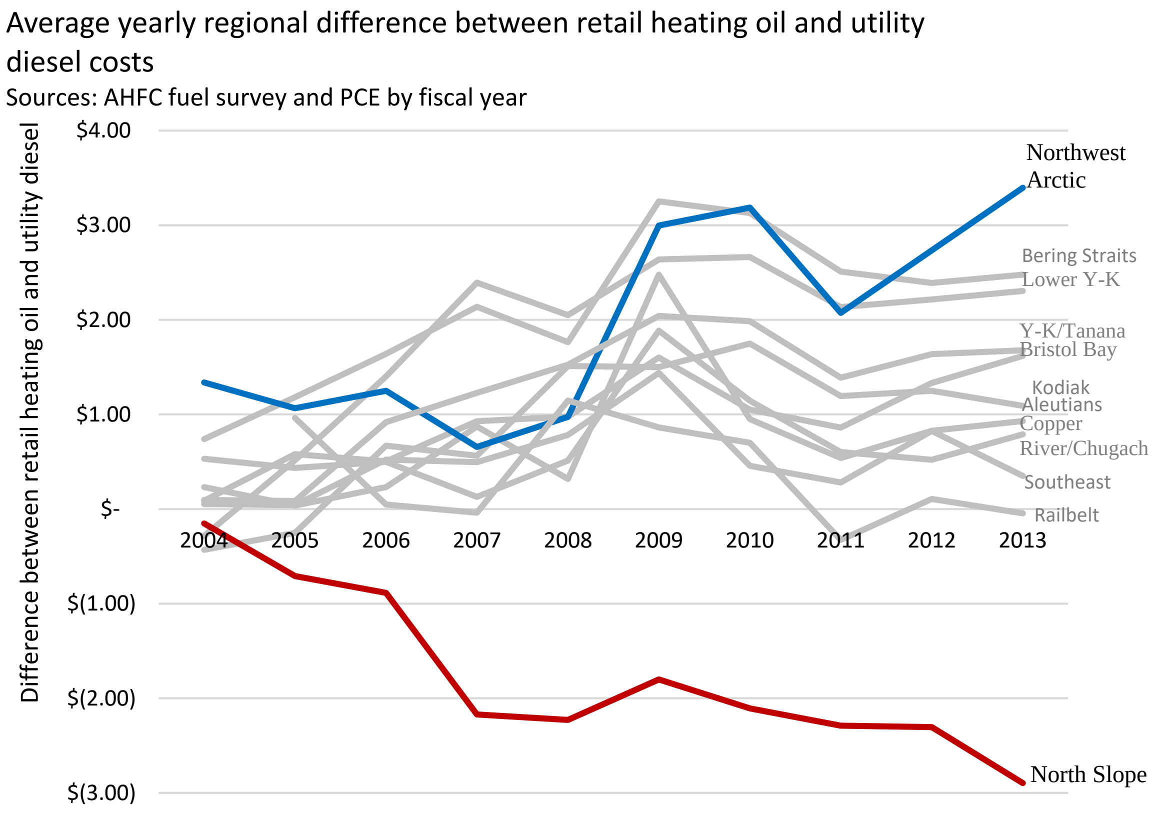


Figure 45: Average yearly difference between retail heating oil and utility diesel unit cost by AEA energy region[156]

[154] Alaska Attorney General. "Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General's gasoline pricing investigation", 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf

[155] Szymoniak, et al 2010.

[156] AEA analysis of PCE and Alaska Housing Finance Corporation and Division of Community and Regional Affairs fuel price surveys. Accessed through Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/).

AEA compared reported utility diesel cost to the retail heating oil prices in study area communities, using an average across all communities in the AEA energy region. The expectation of this analysis was that the difference between the utility price of diesel and the retail price of heating oil would provide an indication of the price to operate the bulk fuel storage facility and small margin for profit. AEA had expected to find little difference between the regions over time, as it was assumed that a community would have similar expenses to cover, independent of where it was located. AEA found that there were large regional differences in the costs of heating oil versus utility diesel cost and that those differences changed over time.

To help illustrate how the difference between costs of heating oil and costs of diesel for power generation has changed over time, two regions, the North Slope and Northwest Arctic, are highlighted in Figure 45. The Northwest Arctic region, highlighted in blue, had a relatively steady markup over time: approximately $1/gallon from 2004 through 2008. This change is consistent with analysis on what it should cost to operate a bulk fuel facility.[157] Then, after 2008, the difference between the utility diesel and retail heating oil price diverged significantly to more than $3/gallon. Other regions experienced similar divergences.

The North Slope region illustrates a contrary example. The steep decline for the North Slope shows the impact of the subsidy for residential customers provided by the North Slope Borough.

Figure 46 includes an average local markup to complete the illustration of all costs contributing to the retail cost of heating oil in study area communities. The cost of the fuel is only one of many factors making up the high energy costs paid by many Alaska communities.

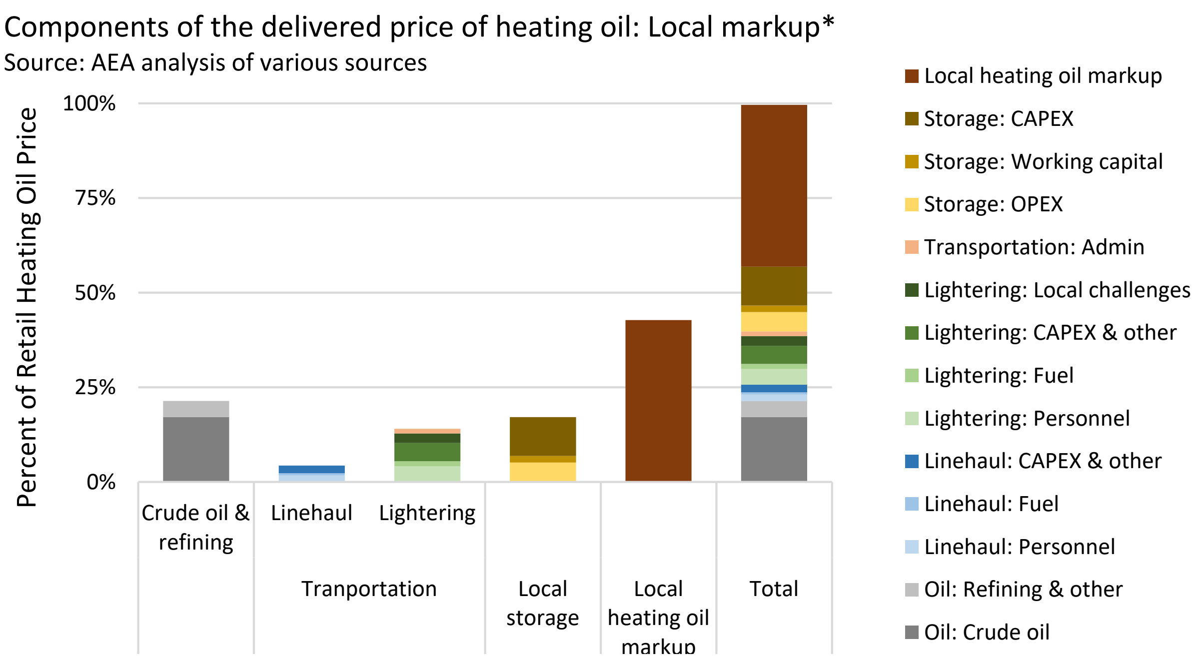


Figure 46: Components of delivered price of heating oil: Local markup[158]

[157] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

[158] AEA adaptation from 2008-2011 ISER work on components of delivered fuel costs

*Note: Assumes $3.50/gallon of diesel and 12 kwh/gallon

One additional factor was not included in Figure 46: taxes. In FY16, the State of Alaska enacted a $0.01/gallon heating oil tax, which is less than the $0.08/gallon State tax on motor fuels. At well under 1% of the retail cost of fuel, the penny-per-gallon tax would not show up on the chart. The tax is not collected in a way that allows for knowledge of heating oil consumption at the local level.

Though some communities in the AkAES study area have a local sales tax up to 8%, more commonly local tax is less than 5%. However, these local taxes are still relatively uncommon, and as a small percentage of the total cost, they were also left off of Figure 46.

All of the factors summarized in Figure 46 illustrate why heating oil is only moderately sensitive to changes in the price of crude oil, as was shown in Chapter 2's Figure 18 on page 51.

DRIVERS FOR HEATING FUEL AND ELECTRICITY CONSUMPTION

In almost all AkAES study area communities, the primary factor contributing to consumer energy cost is population. In addition to the basic relationship (more people will consume more energy), a community's population will change how energy is consumed. Generally speaking, larger communities have more and larger buildings that consume energy, particularly electricity, differently than smaller communities.

This last section of Chapter 3 will investigate the factors, including population, that impact energy consumption, specifically the heating and electricity consumption for residential and non-residential buildings. This section provides an analysis that allows for a general understanding of the factors that lead to differences in energy consumption. The Alaska Affordable Energy Model (AAEM) presents a more detailed set of data to develop consumption estimates for all communities in the AkAES study area.[159]

Chapter 6 will look at changes that can be made to reduce energy consumption; this chapter aims to describe factors that currently impact energy consumption.

COMMUNITY THERMAL LOADS

To be comfortable for the building users, buildings must be heated for much of the year in Alaska. A number of factors, including the local climate, size of building, type of use, as well as the building efficiency (insulation, heating efficiency, and building tightness) affect the consumption of heating fuels.

[159] The Alaska Affordable Energy Model will be available through AEA's website

CLIMATE

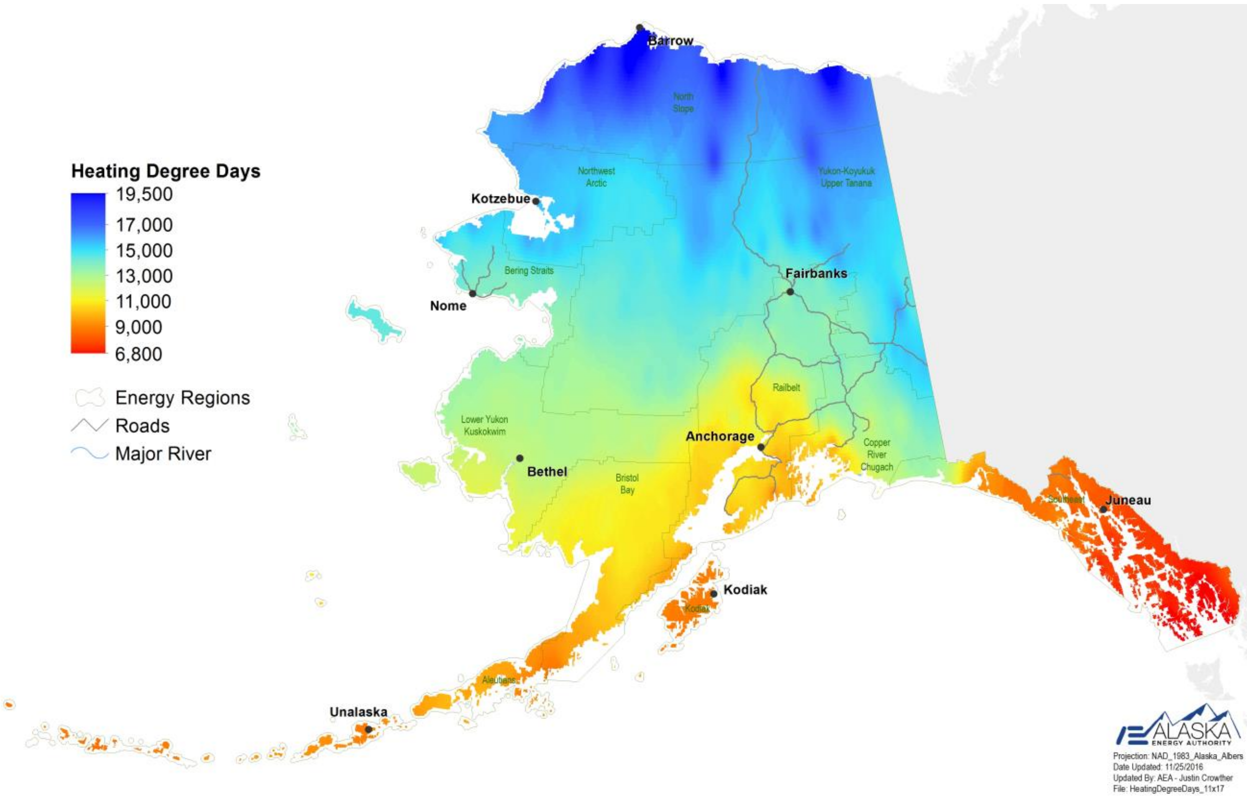


Figure 47: Heating degree days[160]

Heating degree days (HDD) is a useful way to quantify how cold an area is over the entire year and is calculated by taking the difference between 65 degrees Fahrenheit and the outdoor temperature. For example, if the average outside temperature in a community is 20 degrees for a given day, there would be 45 heating degree days for that particular calendar day. By adding these across the entire year and averaging it over multiple years, the total HDD for a year can be estimated. The HDD is also a convenient way to estimate relative thermal requirements. For a given structure, a doubling of HDD roughly corresponds to a doubling in the amount of heating oil (or other fuel) needed to maintain the same interior temperature. Locations with colder average temperatures throughout the year require more energy to maintain the same interior temperature.

Southeast Alaska has the most temperate climate in Alaska, with less than 7,500 HDD, and the North Slope with more than twice that, with over 18,000 HDD. While many other physical factors can go into actual heating needs–including the amount of sun, the speed and direction of wind, the use of the building, the number of people occupying the buildings, etc. –when all else is equal, a building in Ketchikan would consume about half of the heating oil than if that same building were in Barrow.

NUMBER OF BUILDINGS PER COMMUNITY

The number of buildings in a community, both residential and non-residential, is strongly influenced by the community's population. Other factors, such as the economic vitality of the community, also influence

[160] AEA mapping of Cold Climate Housing Research Center (CCHRC) analysis of 1980-2010 climate data

the number of buildings. Although information associated with community-level income is not always statistically significant, it appears that wealthier communities have more residential and non-residential buildings.

The number of buildings in communities, which is a dataset in the AAEM, was collected from a number of sources including the Alaska Native Tribal Health Consortium (ANTHC), local property taxes, and various State, federal, and NGO personnel who traveled to communities.

Building size

In addition to having more non-residential buildings, larger communities also generally have larger non-residential buildings. The data collected in Table 8 comes from an AEA analysis of more than 1,000 non-residential buildings in the AkAES study area. The table represents a sub-set of the data used by the AAEM to estimate non-residential energy consumption.

Table 8: Average non-residential building square footage by building type and community size[161]

	Population less than 300	Population between 300 and 1,200	Population greater than 1,200
Education	10,921	20,463	62,095
Health care - hospitals	2,157	3,802	6,779
Public assembly	2,842	3,296	9,257
Public safety	2,463	2,302	12,602
Warehousing	1,883	2,869	3,950
Average—not including education	2,304	3,649	7,706

Building square footage influences both the heating and electricity consumed. As can be seen in Table 8, the average square footage of the building type increases with the community size. Most notably, education buildings double in size between communities with a population of less than 300 to communities with up to 1,200 people, and then triple in size for the communities with the largest populations.

Residential sizes

In general, larger residences require more heating fuel to keep them at the same interior temperature. While house sizes vary within a community, the average sizes vary more significantly from community to community. By using this average community size, AEA was able to develop an estimate for the total heating fuel consumption in a community.

Figure 48 aggregates data from the Alaska Retrofit Information System (ARIS), AHFC's database, which houses all of the data from the residential audits performed for the Weatherization, Home Energy Rebate

[161] AEA analysis of multiple sources

(HER), and New Home Rebate programs. The amount of data available in ARIS by community extends from 0% to nearly 100% of the residential buildings in the community.

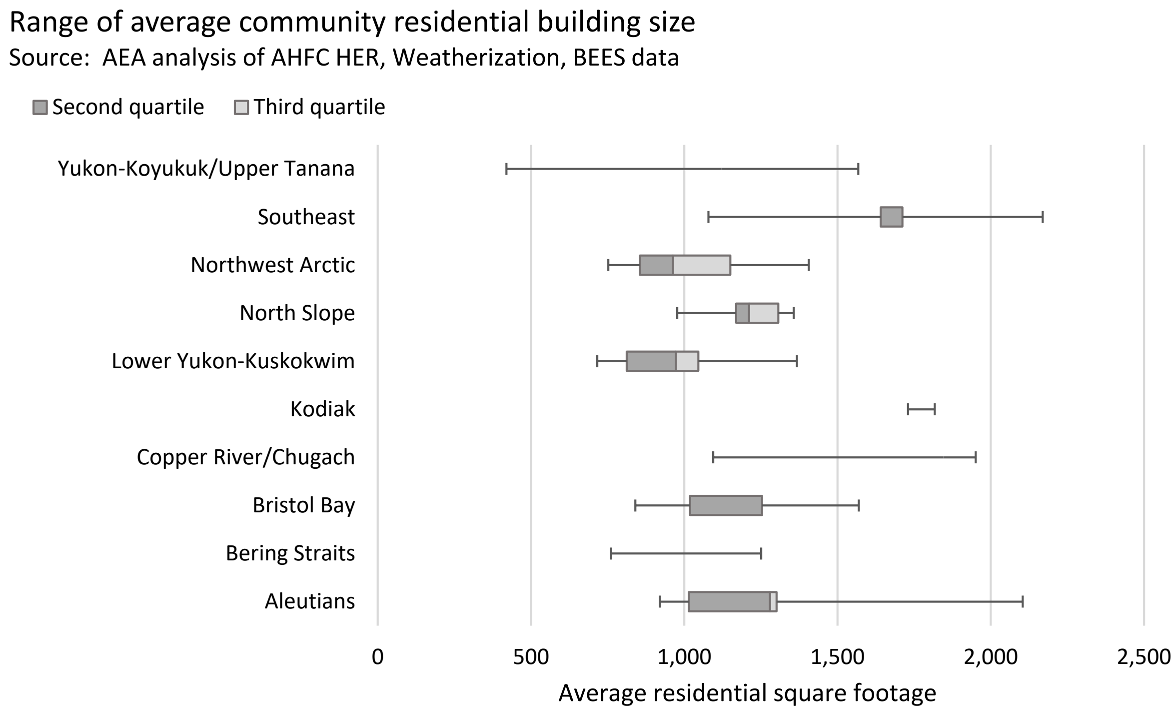


Figure 48: Range of average community residential building size[162]

The majority of study area communities have residences with an average size under 1,500 square feet, with many under 1,000 square feet. For instance, both the Lower Yukon-Kuskokwim and Northwest Arctic median average size is less than 1,000 square feet. Some communities typically have much larger houses; both the Southeast and the Aleutians regions include communities that averaged more than 2,000 square feet per household. Good data was not available for all communities to adequately assess the range of average home size.

Building quality

After the climate and building size, the building quality, specifically with regards to its thermal efficiency, has a profound effect on how much energy is consumed.

Figure 49 provides a comparison of how building quality, climate, and local energy rates affects the total energy costs for a residential consumer. In the figure, the same 1,400-square-foot residential building was modeled using AHFC's residential energy modeling software, AkWarm, to three levels of energy efficiency: One Star, Three Star, and Five Star. A One Star has little insulation in the walls and attic, single pane windows, and is very drafty. A Three Star house is moderately insulated in the walls and attic, has double-pane windows, and is somewhat drafty. A Five Star house is well insulated in the walls, attic and floor; has

[162] AEA analysis data from Alaska Retrofit Information System, accessed Fall 2014.

high efficiency windows and heating system; and few air leaks. This house was evaluated in two communities with different climates: Bethel (12,542 HDD) and Unalaska (8,899 HDD).

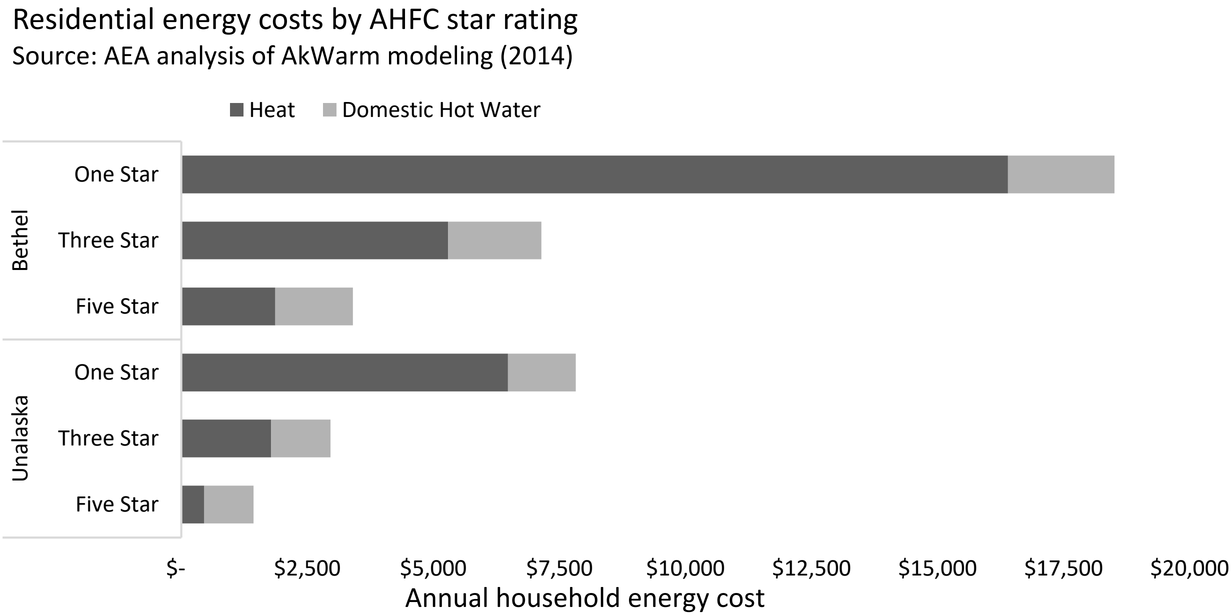


Figure 49: Residential energy costs per AHFC star rating for three communities[163]

It is evident that there are large differences in consumer costs between locations and the building's efficiency. Improving the efficiency of the housing can lead to large cost reductions, nearly $15,000 per year in heating costs could be offset by improving a One Star house to Five Stars (based on 2014 energy prices). The figure also shows that energy cost savings will not be the same between locations, as the local energy rates and climate affects the costs. The modeled cost for heat and domestic hot water in Bethel for a Five Star rated house is roughly equivalent to a Three Star house in Unalaska.

BUILDING USE

Building occupant behavior and energy use is another primary factor leading to total energy consumption. Data regarding energy consumption is non-random and may therefore include systematic biases that may over- or under-estimate the consumption. The AkAES used the best data available.

Non-residential consumption

Across the study area's approximately 1,000 non-residential buildings for which AEA was able to find reported annual heating fuel consumption, the average was about one gallon, plus or minus a half a gallon, per square foot across all building types. Although some individual buildings consumed significantly more heating fuel than others, likely due to occupant behavior and or poor building quality, there were not huge differences between buildings types.[164]

---

[163] AEA analysis of AkWarm modeling (2014)
[164] Richard Armstrong. "A White Paper on Energy Use in Alaska's Public Facilities." 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf

Based on data compiled by AEA, more than 90% of non-residential thermal energy is supplied by heating oil. In Southeast, a higher percentage of non-residential buildings use electric resistance heating where low-cost hydropower is available.[165] Biomass and heat recovery both supply a small percentage, and each has greater potential. Southeast has a handful of non-residential (air- and ground source-) heat pumps, and Barrow and Nuiqsut have locally available natural gas.

Residential consumption

Unlike non-residential buildings, residential consumption is based on estimates from the AkWarm residential energy model and not from reported consumption by building occupants. The results in this section are based on approximately 17,000 pre- and post-retrofit energy audits using the AkWarm model. So as to provide a common unit of measure, the energy consumption values included in Figure 50 have been converted into gallons of heating oil equivalent.

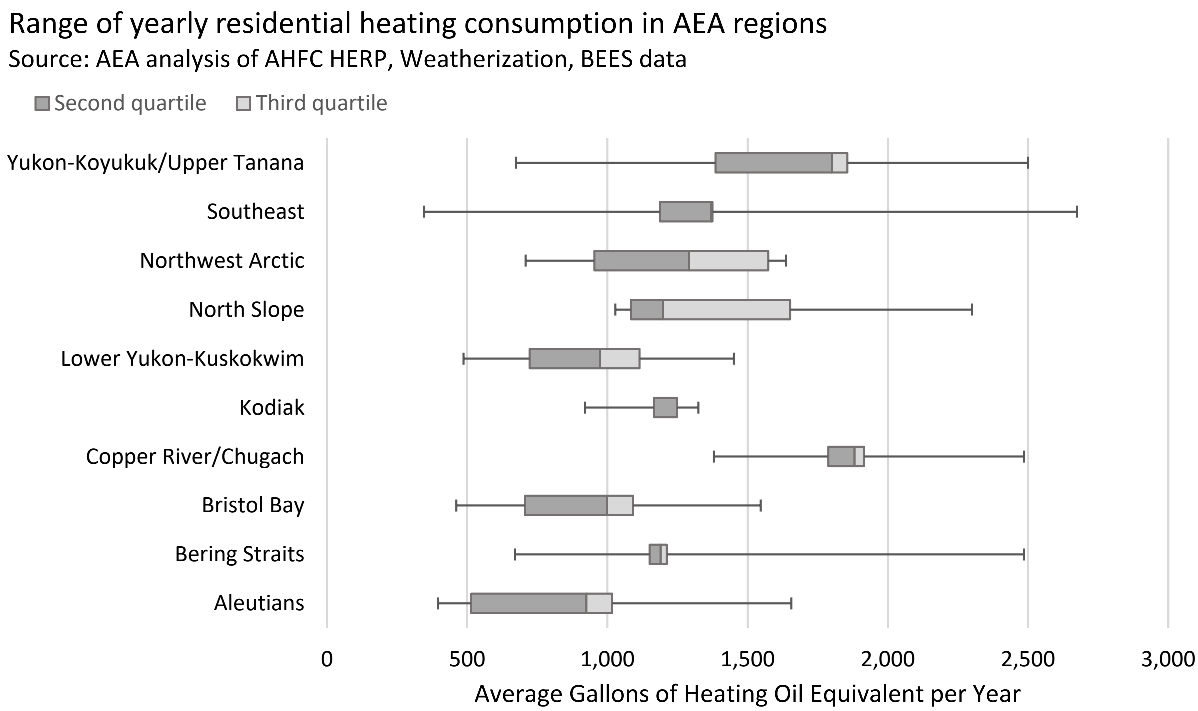


Figure 50: Range of residential heating consumption (in gallons of heating oil equivalent)[166]

Based on the results of the analysis, the majority of households in the study area consume between 500 and 2,000 gallons of heating oil equivalent. Regional differences are apparent—the Aleutians, Bristol Bay, and Lower Yukon-Kuskokwim average between 500 and 1,000 gallons of heating oil equivalent. A comparison of Figure 48 to Figure 50 shows interplays between local climate and building size and end-use efficiency. It is apparent that climate can play a big role in consumption. Surprisingly, the community with the largest average consumption is in the Southeast, as is the community with lowest average consumption.

---

[165] Black & Veatch. "Southeast Alaska Integrated Resource Plan." July 2012. http://www.akenergyauthority.org/Content/Publications/SEIRP/SEIRP-Vol1-ExecSumm.pdf

[166] AEA analysis of ARIS data

As stated earlier, Figure 50 converts all fuels into an equivalent number of gallons of heating oil. In some areas wood is a common fuel, and in others, primarily the Southeast, electricity is also used as a primary source of heat.

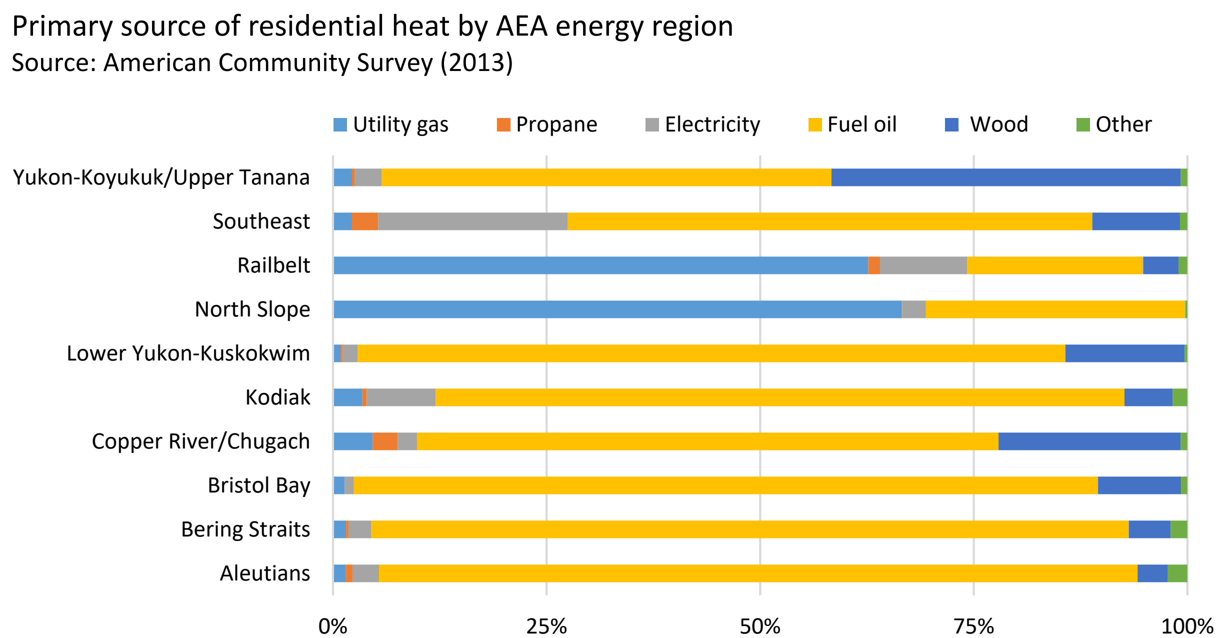


Figure 51: Fuels consumed for residential heating[167]

Unlike in non-residential buildings, there appears to be more diversity in the fuel sources for residential buildings. Based on work done by the U.S. Census, as found in the American Community Survey, Figure 51 shows the estimated use of various fuel types. The data is not perfect, as can be seen in the utility gas column; the only communities in the AkAES study area that have access to natural gas are Barrow and Nuiqsut. Figure 51 provides a more qualitative snapshot of residential heating fuel type, but it also shows that residences in some regions, particularly the Yukon-Koyukuk/Upper Tanana region, may be less affected by heating oil prices as occupants have chosen to burn wood instead of heating oil.

ELECTRIC CONSUMPTION

As was shown in Chapter 2, there are regional and community differences in residential electric consumption. No data is available for what leads to the differences, although socioeconomic differences, appliance efficiency, the number and kind of consumer goods, and different levels of energy conservation practiced by occupants all likely play a role in the level of residential electricity consumption.

Residential customers respond to seasons by consuming more electricity in winter than summer, approximately one-third more in January than in June.

[167] United States Census Bureau. "B25040: House Heating Fuel [10]". 2008-13 U.S. Census Bureau's American Community Survey Office, 2013. Web. January 2015 <http://ftp2.census.gov/>.

More data is available for non-residential electricity consumption; AEA was able to find electric consumption data for about 1,000 buildings in the study area. A portion of these results, categorized under the same three community sizes as Table 8, is included in Table 9.

Table 9: Non-residential electric consumption per square foot by building type and community population[168]

	Population less than 300	Population between 300 and 1,200	Population greater than 1,200
Education - K - 12	6	7	9
Office	9	6	9
Public assembly	4	5	20
Public safety	10	8	12
Retail - other	21	24	22
Average (not including education)	8	10	12

Although there are not huge differences between community size and heating oil consumption, differences are evident in electricity consumption. Non-residential buildings in larger communities appear to consume more electricity per square foot than in small communities. The difference in consumption by building size may be due to factors such as different ways in which the building is used (such as the number of hours and type of services), the cost of electricity, or some other unknown factor.

Based on the average of all PCE communities, the non-residential electric consumption pattern is different from the residential electric consumption. The extremes are not as pronounced as for residential. Seasonal consumption patterns are not currently included in the modeling.

[168] AEA analysis of multiple sources

CHAPTER 4: RISKS AND BARRIERS TO SUCCESSFUL ENERGY PROJECT IMPLEMENTATION

Key takeaways

Mitigating risks at each phase of project development will maximize potential project benefits.

1. General risks include lack of resources including skilled labor in villages and limited pool of specialized contractors in Alaska; lack of leadership or stakeholder buy in; immature or inappropriate technology; challenging economics and financing; poor project management or maintenance; and weather or climate-related events.
2. Risks, including future operational and financing risks, should be thoroughly addressed in project selection criteria. Many communities have pursued projects that are not likely to be cost-effective.
3. Project funding should be committed to projects that have community support and have examined other potential technologies.
4. Programs should use standardized criteria to approve projects at each stage of development before the decision is made to move forward.
5. All projects should have clear financing and business plans, from conception through operation.
6. The risk of project performance or economic life not meeting expectations applies to all project and technology types, but can be mitigated through proper maintenance and training. Inadequate maintenance is the chief barrier to performance.
7. Climate change is expected to increase the need for infrastructure funding in many parts of the state.

Successful energy projects require a clear understanding of potential risks. For the purposes of the AkAES, project success is defined as the development of a project that reduces the cost of energy in communities by meeting project performance and economic life expectations. Any project development activity contains risks, identifying these risks as early as possible improves the potential for success. When a project fails to move forward because it is determined to be too risky or not economically viable the developers can face criticism for money that was spent in the evaluation process. However, projects that do not continue to construction can still provide useful information to communities and the State; halting development avoids unnecessary additional expenditures.

Understanding energy project risk will help maximize project benefit for communities, consumers, and the State. Unmitigated project risks can compromise the cost-effectiveness of a project by increasing its cost and/or reducing its benefits. This can happen through reduced performance, a shorter economic life or selection of a less-than-optimal project that stall before completion. Since the State's limited energy funding could be spent on many alternative projects, it is important to use the money as wisely as possible, especially as those funds shrink.

Understanding and mitigating project risk becomes even more important in moving toward more loan-based financing where energy projects must pay for themselves within their economic life. Without a clear financing plan from conception through operation, projects are at much greater risk of being stalled or cancelled. Energy projects will be unable to access financing unless risks are nearly completely mitigated or the developer is pledging significant assets. Being able to pay back a long-term loan will require that projects achieve the performance and economic life consistent with the expectations of the loan.

Note that reducing costs is not the sole motivation for community energy project developers. Projects may be pursued for a number of reasons, not all of which will save consumers money. Some communities may be willing to invest in a project to reduce their reliance on imported diesel fuel, typically increasing price stability in the process, or they may want to create more jobs in the community. In each of these cases, residents may be willing to pay more for energy if these other values are met. The tools developed through the AkAES project will assist communities in achieving their energy goals, whatever they are, at the least cost.

DOCUMENTING AND ANALYZING ENERGY PROJECT RISKS AND BARRIERS

Risks and barriers to community energy projects in Alaska have not been formally documented for most of Alaska's energy programs. Although a number of best practice checklists have been developed, lessons learned have generally been captured through an informal process.[169] Moving forward, a more formal and consistent method of program evaluation would help to solidify best practices and ensure more parties beyond funders and project managers are involved in their development. Good examples of focused learning through doing and sharing lessons learned exist within AEA's biomass program and the Alaska Wood Energy Development Task Group, which has organized many statewide meetings and tours to demonstrate different biomass solutions and share successes and failures. Including requirements for evaluation, measurement and verification (EM&V) at the program level would contribute to the body of knowledge; however, there is a cost to EM&V programs that should be recognized and planned for.

Analysis of energy project risks and barriers in this chapter is primarily based on data from Alaska's Renewable Energy Fund (REF). No other state-funded Alaska energy program has as high a level of data available from all phases of the project life cycle: from reconnaissance and feasibility through design, development, construction, and operation. Additional datasets used in the AkAES risks and barriers analysis include AEA's Rural Power Systems Upgrade (RPSU) program, Emergency Assistance and Preventative Maintenance program, and AEA's former Bulk Fuel Loan program (now at the Division of Community and Regional Affairs). These programs have captured some of the operational and financial risks associated with existing diesel-based energy systems.

AEA examined REF projects throughout their project development life cycles starting with its initial analysis of the project during the grant program's competitive scoring process. The rest of this chapter explores risks and barriers to energy project success through project selection, implementation, financing, and operations. Additional insights are included from non-REF project analyses.

[169] http://www.akenergyauthority.org/Programs/RenewableEnergyFund

One caveat is that no information is available about how or why projects were selected by REF applicants. Lacking this, the risks and barriers analysis provides a retrospective look at the projects proposed for REF funding, without comparison with projects that were not proposed. To more fully understand how to reduce risks across the entire energy project lifecycle, considering initial project choice is critical, since project selection limits the pursuit of other options.

CATALOGING THE MOST COMMON RISKS

Table 10 catalogs the most prevalent risks to successful energy project development and operation, based on an analysis of state energy programs and other sources. While it may appear that risks increase with each phase, the actual risk decreases since the risk at any given phase includes the risks associated with all subsequent phases. The following risks, which are developed from data in the rest of this chapter, are not presented in any particular order.

Table 10: Risks and barriers to successful energy projects

Development Risks	Financial Risks	Operational Risks
Sub-optimal project selection	Funding availability	Resource availability
Resource availability	Cost overruns	Integration with current system
Site control	Risk of no return	Fuel costs & availability
Project development skills	Economic analysis	Load changes
Community conflicts	Future fuel costs	Staff skills
Permitting & regulatory	Power sales agreement	Availability of parts
Not optimizing design	Future load	Business management
Skilled workforce	Financial management	Failure of machinery
Weather delays	Lack of collateral	Actual life of infrastructure
Supply chain & logistics		Availability of infrastructure
Geotechnical issues		Staff turnover
Transportation		Planning for and performing maintenance
Competing projects		Weather events
Transmission constraints		Planning for repair and replacement
		Competing projects
		Technology maturity

LEAST COST PLANNING FOR COMMUNITIES

Unlike many states, Alaska does not currently have any requirements for utilities to perform long-term resource planning that considers all generation and efficiency resources at least-cost service to customers and consistency with State policy goals. Current rules allow economically regulated utilities to submit to a prudency review after a project has been built, and unregulated utilities do not require any approval from the Regulatory Commission of Alaska (RCA).

Through required procedures such as integrated resource and integrated distribution-system planning, many other states provide a mechanism for utilities to identify, analyze, and pursue optimal projects to ensure least-cost service to consumers. Integrating the supply- and demand-side resources available in a community reduces costs to consumers, ensures a fair rate of return to the utility, and assists the State in reaching policy objectives.[170]

Many states have a pre-approval process, generally referred to as "siting authority", and a post-construction approval process, a prudency review, to ensure that infrastructure is used, useful, and prudent. "Useful" means that without the infrastructure either the service will be diminished or the costs will be higher; "used" requires that the infrastructure provides service to customers, and "prudent" that it was constructed properly, within a reasonable budget, and sized properly for the customer base. Since utilities are natural monopolies and consumers do not have access to a perfect substitute or perfect information, regulation provides a layer of consumer protection.[171]

Alaska's ex-post-facto approval of new infrastructure diminishes the decision-making process for non-standard infrastructure, particularly for identifying efficiency and demand-side management (DSM) solutions for communities, and potentially increases costs to consumers unnecessarily. Most states allow for either a return on the capital investment or performance-based return for efficiency or DSM investments.[172]

PROJECT DEVELOPMENT

For the purposes of this chapter, project development is broken into two main activities: project analysis and selection, and project implementation. Analysis and selection include the pre-construction activities that help determine if a project should be built. Implementation covers construction and related requirements.

PROJECT ANALYSIS AND SELECTION

As already noted, the AkAES risks and barriers study analyzed the projects applicants chose to submit for REF funding. Future research into the process through which energy projects are proposed by communities could offer valuable insight for improving energy project selection and how the state can best assist communities and other project proponents in the earliest stages of project development.

Economic analysis

The metric AEA has used to determine cost-effectiveness in REF proposal evaluation is the benefit-cost ratio (B/C ratio), which is equal to the present value of the project's lifetime benefits divided by the present value of its lifetime costs. Under this methodology, costs and benefits to all participants are considered equally, so State grant funds are not treated differently than community matching funds, and savings to the State's PCE program are not treated differently than fuel cost savings to the community.

[170] Jim Lazar. "Electricity Regulation in the US: A Guide." Second Edition. The Regulatory Assistance Project. 2016. http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf
[171] Lazar, 2016.
[172] Lazar, 2016.

A project with a B/C ratio greater than one is considered cost-effective, because the benefits outweigh the costs. A project with a B/C ratio less than one is not cost-effective, because the benefits are less than the costs. A B/C ratio equal to one means that the benefits equal the costs; this could be seen as equivalent to a direct subsidy if the State were to provide all funding, in which the state's investment (the cost) equals the benefits (the subsidy) to the recipients. Investing in a project that is not cost-effective (a B/C less than 1) means that the State could have provided more benefit to the community by simply giving a direct subsidy.

Because it is a ratio, the result of the B/C analysis does not provide information about the magnitude of the benefits or costs. For instance, a small project with a B/C of 3.0 may only save the community a few thousand dollars, whereas a large project with a B/C of 1.2 could potentially save a community millions of dollars over its lifetime. That said, a number of factors in addition to the B/C ratio must be considered when evaluating which projects will have the greatest impact on the community. It is also important to note that the economics of projects evaluated for REF funding are based on a comparison with the status quo, not other options within a community.

Any economic analysis of an energy project requires a number of assumptions to be made about the project and the circumstances surrounding its construction, operations, and maintenance. These assumptions may change over time as new information is available. For example, over the past 10 years, crude oil price forecasts have varied dramatically. These assumptions can have a large impact on the estimated benefits of a project, particularly as most REF projects are evaluated by the value of diesel displaced over the proposed project's lifetime.[173]

Figure 52 shows the results of an analysis of all REF grant applications submitted in the first eight rounds of project funding, from 2008 through 2016. Project B/C ratios were grouped into three categories—economic (greater than 1.3), marginal (1 to 1.3) and uneconomic (less than 1). The marginal range represents a conservative estimate of economic viability. The REF evaluation process does not generally include financing costs, return on investment, or taxes, all of which would increase the costs of a project. The uncertainty of future diesel prices, and the fact that the annual Energy Information Administration (EIA) fuel price projection has turned out to have been optimistic for each year of the REF, suggest that the actual benefits are likely to be less than forecasted.

[173] For more information on the REF proposal evaluation process please see http://www.akenergyauthority.org/Programs/RenewableEnergyFund

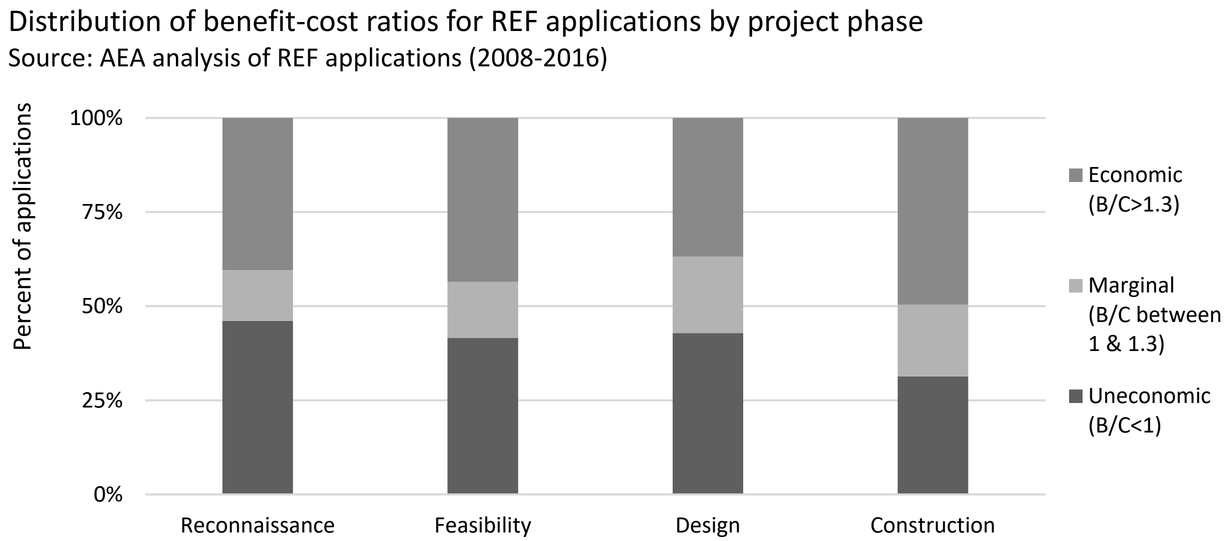


Figure 52: Distribution of benefit-cost ratios for REF applications[174]

As can be seen in Figure 52, almost as many REF applications were for uneconomic as for economic projects. A much smaller number were found to be marginal. This could either indicate that it is difficult to find economic energy projects or that applicants have difficulty identifying them.

While there is a reduction in uneconomic applications moving from reconnaissance to feasibility and construction, it is expected that uneconomic projects would be more thoroughly weeded out by applicants. The fact that the REF is a grant program means that applicants may propose projects they might not otherwise consider. On the other hand, a community, utility or IPP must still spend the time and money to apply for a REF grant, which they could have spent pursuing other potentially more economic projects.

Technical risks and barriers to project success

In addition to the economic analysis of each REF application that is performed by AEA staff and contracted economists, a technical review is also performed. While the quantitative technical scoring is useful for understanding the soundness of individual projects, a qualitative analysis of reviewers' comments is invaluable for understanding the wide range of potential barriers to successful completion and operation faced by energy projects in Alaska. For the purposes of this risk and barriers study, the comments from the first eight rounds of funding have been analyzed and summarized in Figure 53. Barriers can be grouped into five main categories:

1. **Project management** issues constitute the largest category of identified barrier. Specific barriers included incomplete prior phases (14%), poor project scoping (11%), poor cost estimates (5%), and lack of experience/expertise (5%);
2. **Project identification** was the next most prevalent category of barriers. Barriers included projects that were not economic (17%), a better option for the community existed (7%), and adverse impact on current system (6%);

[174] AEA analysis of Rounds 1-9 of REF economic analyses

3. **Technology or resource** barriers included: not technically feasible (3%), insufficient resource (4%), and pre-commercial technology (9%);
4. **Potential business issues** included no power sales agreements with utilities 12%, and lack of business plan (6%); and
5. **Access to the site** included environmental permitting (8%) and site control (4%).

Percent of proposed projects with identified barrier*
Source: REF Stage 2 Comments, AEA project managers (Rounds 1-9)

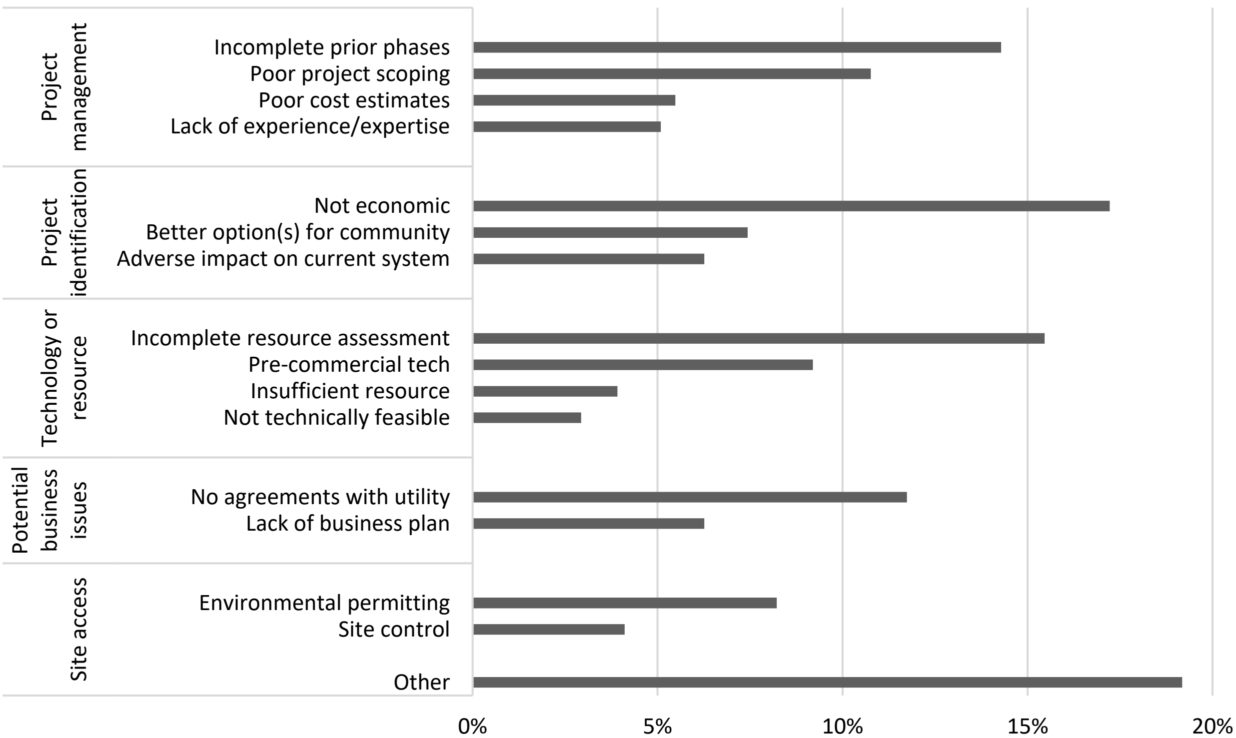


Figure 53: Identified barriers of REF proposals[175]
*Note: More than one barrier was allowed per proposal

Over 40% of all applications—from all phases, technologies and resources—had identified barriers. While the identification of a potential barrier does not automatically mean a project would not be successful.

It should be noted that, as a grant program, the requirements of the REF are not as strict as they would be for a project seeking loan financing. Although some REF projects have accessed debt financing to supplement their REF grant, a successful REF application should not be seen as an indicator that a project would be successful in securing debt financing. In keeping with AEA's mission to reduce the cost of energy in Alaska, the REF has been willing to take risks to help lower the cost of energy in the communities it serves. The REF's willingness to accept risk in service of its mission is likely to be greater than that of other potential investors.

[175] AEA interviews with REF project manager and REF review comments

PROJECT IMPLEMENTATION

After REF project proposals were evaluated and ranked, a second ranking was done to balance the projects across regions. This step, required by statute, means that some projects received funding which otherwise would not have. The Alaska Legislature makes the final decision on which projects to fund, but in most rounds, the Legislature has accepted AEA's recommendations.

The following three figures break down the risks faced by REF projects across different dimensions to understand what influences the chances of an energy project becoming operational. The factors that proved most insightful were sorting the risks by project phase and project type, and cataloging the identified barriers.

RISK BY PROJECT PHASE

In Figure 54, the status of projects is broken down into: 1) operational, 2) active (the grant is still open and the REF project phase is not complete), and 3) not continuing to operation. Each of these determinations was made by the project manager.

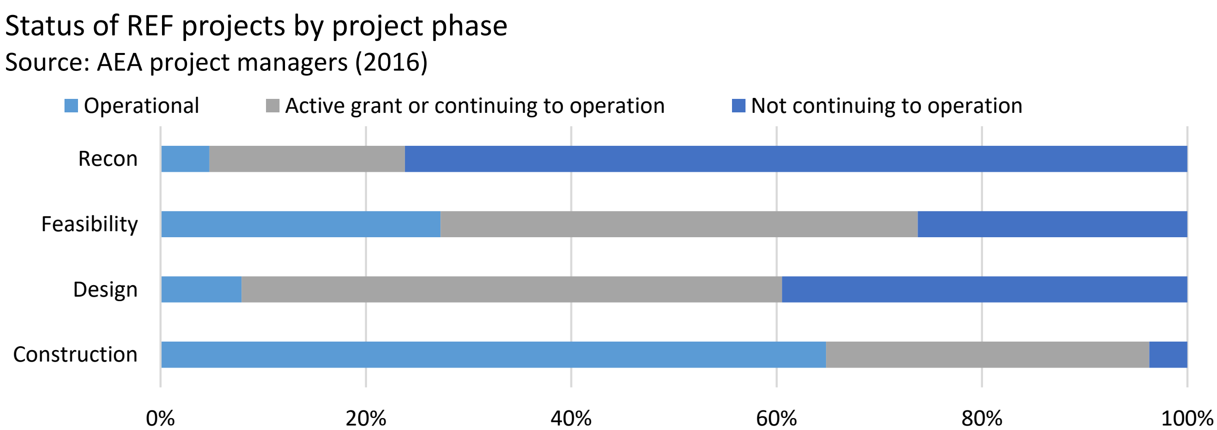


Figure 54: Status of REF projects by project phase[176]

The percentage of REF projects that become operational generally increases as the project phase gets closer to construction. It is expected that many reconnaissance projects are not found to be viable. In fact, using the best-case scenario assumption—that currently active projects continue to operation—approximately 75% of reconnaissance projects will not lead to successful construction and operation. Thus, statistically speaking, to get one operational project, four projects will need to be funded at the reconnaissance level. Even for projects that have made it to construction, a small percentage will not become operational.

It is a natural in any project development process for only a minority of projects to move through each successive stage and eventually become operational. This is not unique to renewable energy projects but is indicative of any endeavor that includes uncertainty. A careful and thorough review process is needed

[176] AEA analysis of interviews with REF project managers

at each stage to reduce that uncertainty and determine whether a project should proceed or be counted as an opportunity that did not prove viable.

One unexpected result of the analysis shown in Figure 54 is the anomaly of increased risk at the design stage, where the percentage of projects not continuing to operation increases relative to the previous (feasibility) phase. This is likely due to a large number of projects stalled at the design phase for lack of funds to continue to construction. Since financing plans for REF proposals are only required to cover the project's current phase (the phase the application is written to fund), many applicants may not have planned for financing beyond the REF. This is a deficit that should be addressed in any future framework to support and encourage Alaska energy projects.

Risk by resource type

Breaking the same results out by resource type, Figure 55 provides interesting insight into the potential risks of different types of energy projects. As might be expected, different resources come with varying levels of uncertainty and risk. The least risky project types are additions to existing infrastructure, such as hydro to heat, wind to heat, heat recovery, and heat pumps. Other resource types, especially geothermal and hydrokinetic, are associated with significant uncertainty and high risk.

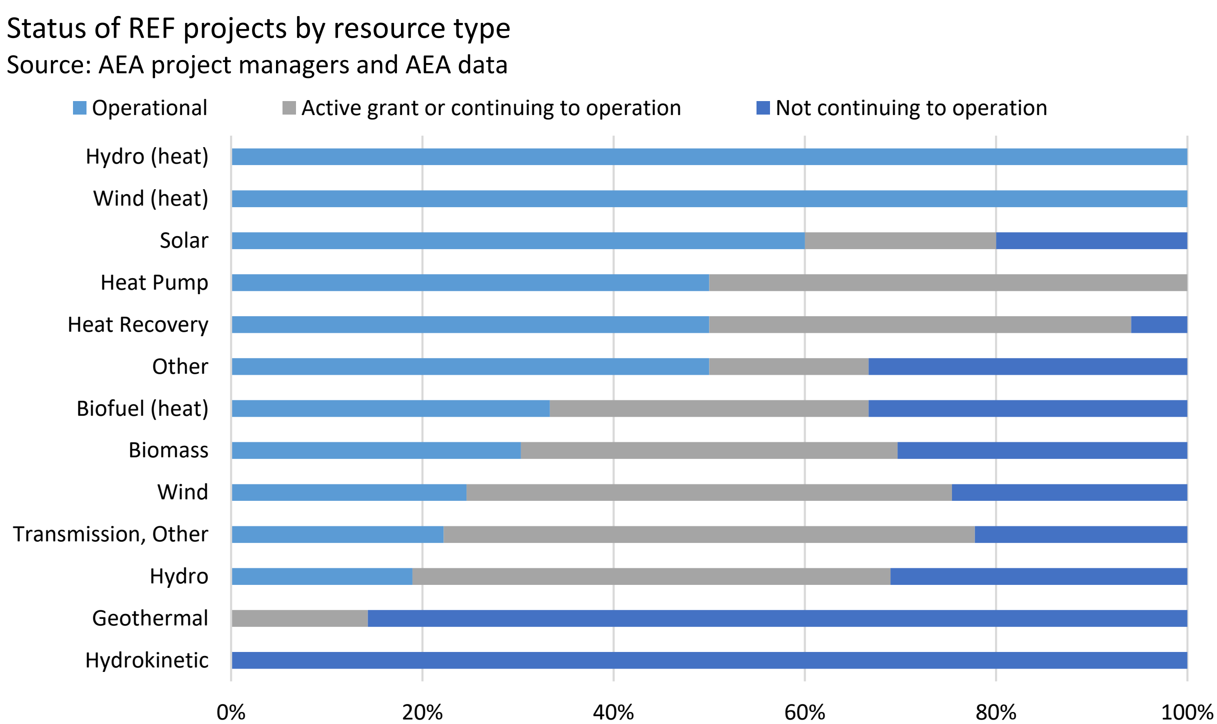


Figure 55: Status of REF projects by technology type[177]

Figure 55 illustrates that, regardless of project phase or resource type, there are a number of general factors that will keep an energy project from becoming operational. In the case of hydrokinetics, it is often a technology risk—a resource might be known and identified, but the technology is not sufficiently mature. In other cases, the resource itself may be insufficient, which is not an uncommon reason for wind

[177] AEA analysis of interviews with REF project managers

and hydro projects not to proceed. Other factors cut across all project and resource types, including financial and management issues and complications of integrating a new project into an existing system. The data for this analysis came from AEA project managers and grant close-out documentation; more than one reason was allowed per project.

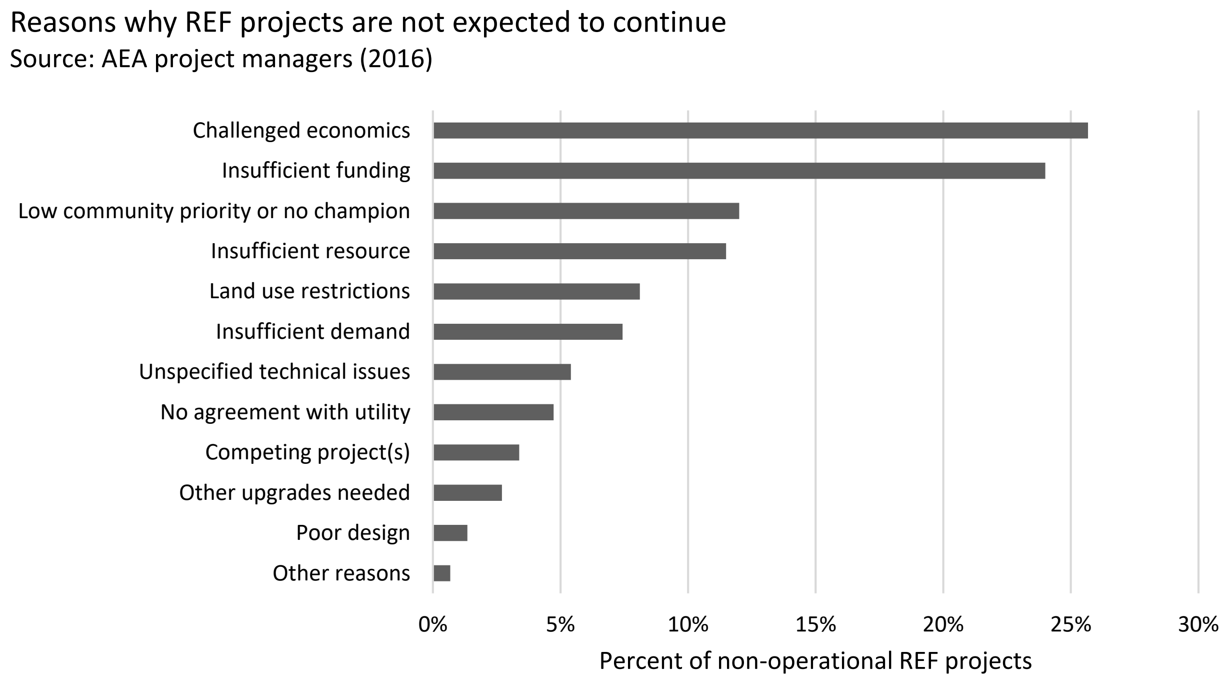


Figure 56: Reasons for REF projects not continuing to construction[178]

Comparing Figure 56 with Figure 53 on page 105 which shows a similar analysis for REF applications, the real barriers to energy project success become apparent. The most common single reason for Alaska energy projects not to continue to operation is challenging economics. Other common reasons included land use restrictions, lack of agreement with the utility, competing or better projects in the community, and adverse impacts or other upgrades needed to the current system. Some of these risks can be mitigated, while others require careful consideration and objective analysis to determine if a fatal flaw exists at the earliest possible stage in the project development cycle.

In many cases, the most important lesson learned with regards to reducing project risk is to simply ensure project managers, consultants, and contractors have sufficient experience and a demonstrated track record of completing successful projects to be able to address the risks in Figure 56.

Cost overruns during construction also increase the risk that a project will not be cost-effective over its economic life. Because REF grants are generally awarded for a single phase of a project, data on the total cost of the project is not always available, making it difficult to know the prevalence of project cost overruns. Even within the funded phase, cost overruns may be covered by the grantee and not reported to AEA if they exceed required matching funds. Efforts to retroactively collect total project cost data from

[178] AEA analysis of interviews with REF project managers

REF grantees have not been a priority until recently. Closeout documents for the past year or two have reported the total project cost for construction projects.

FINANCIAL RISKS

Financial risk covers many types of risk typically associated with project financing, including the uncertainty of return and the potential for financial loss or default on a loan. Here we include the risk of a project not proceeding to construction due to failure to find funding. The second most common reason for REF projects to stall or be cancelled is insufficient funding—an indication that many projects relied on REF or other grant funding to bring the project to completion. This means that without a clear financing plan, from conception through operation, the money spent on a project could have been spent more productively elsewhere.

Financial literacy and capacity has been identified as a major impediment for private investment in rural communities.[179, 180] State loan programs have reported that applicant financial reporting was frequently insufficient to provide loans without significant assistance.[181] Analysis of utility reports to the RCA, IRS, and/or the State showed inconsistencies in financial reporting.[182]

An analysis of debt ratios for 30 utilities, which provide power to over 90 communities, showed that many communities within the AkAES study area had limited experience with project financing other than grant-funded projects. Additionally, the study noted that over 40% had reported operational losses, which make it difficult for the utility to access debt financing.[183]

In many cases, the assets a utility or community carries on its books are be counted as collateral for the purposes of qualifying for a loan. For example, in order to receive a Bulk Fuel Loan from the State of Alaska, additional security is required in the form of the assignment of payments from other State programs. This is because fuel is not easily sold or moved once it has been delivered to a community. Even with this requirement, AEA declined approximately 20% of Bulk Fuel Loan applications between 2000 and 2013. Figure 57 shows the reasons why applications were declined.

---

[179] Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. "Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects." Alaska Center for Energy and Power. December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280

[180] Riley Allen, Donna Brutkoski, David Farnsworth, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska.' December 2015. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf

[181] University of Alaska Center for Economic Development. "Utility Financial Analysis and Benchmarking Study." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/Utilityfinancialanalysisandbenchmarkingstudy.pdf

[182] UACED 2016

[183] UACED 2016

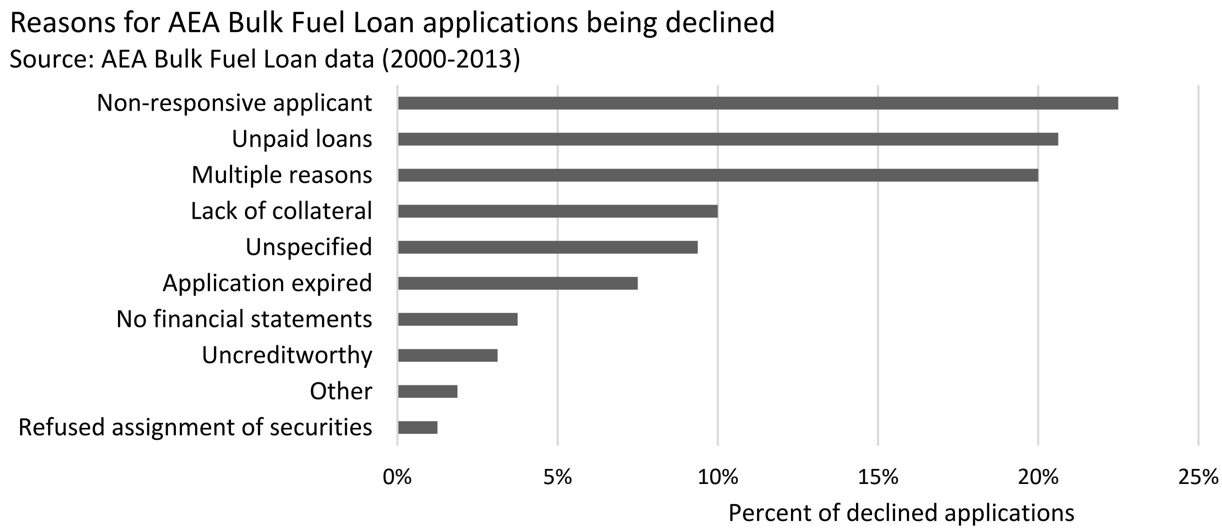


Figure 57: Reasons for AEA Bulk Fuel Loan applications being declined[184]

Over 120 communities are included in the Bulk Fuel Loan dataset, so it provides a good cross-section of the communities within the AkAES region. It is a fair assumption that the difficulties experienced by the Bulk Fuel Loan program would also be experienced by other entities that would consider lending to the same communities and utilities, especially as a State program, the Bulk Fuel Loan program is less risk averse than a private lender would be.

As can be seen in Figure 57, numerous reasons exist for why loans were declined, all of which would make it difficult for these entities to access private financing. From not paying back previous loans to not having a way to secure the loans, to a general lack of financial information to evalute the creditworthiness of the applicant, a number of improvements to financial and managerial practices are needed if the State expects that more communities will be able to access debt financing.

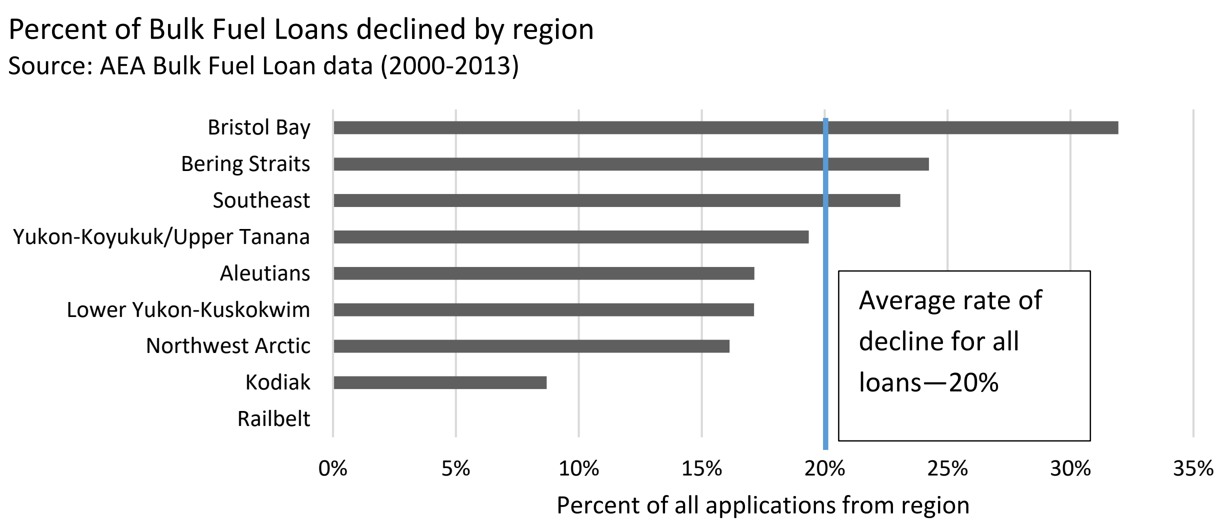


Figure 58: Percent of Bulk Fuel Loans declined by region[185]

[184] AEA analysis of Bulk Fuel Loan program data (2000-2013)
[185] AEA analysis of Bulk Fuel Loan program data (2000-2013)

There appear to be some regional differences in the rate of applications being declined, shown in Figure 58. The Bristol Bay and Bering Straits regions were the most likely to be declined and the Kodiak and Railbelt regions the least likely.

Trying to develop an economy of scale for energy projects in a community may encounter new financial complications. In 2014-15, Nuvista Light and Electric Cooperative worked to create a model to finance efficiency projects in multiple non-residential buildings with the aim of developing an economy of scale. Numerous complications were encountered, some of which are unique to rural Alaska. There was a general lack of financial capacity from potential applicants, particularly the non-profit participants. The entities that did have financial capacity, for-profit businesses and Native corporations, were unwilling to take on the financial risks of those with less capacity. For numerous reasons, building owners do not necessarily own the land the building rests on which made it difficult to get a loan. Since most commercial loans do not accept the savings associated with efficiency upgrades as a way to secure a loan, the unsecured loans that were available required 12-14% interest, which made many efficiency measures uneconomic. Nuvista is still actively working to solve these issues.[186]

Other State and federal energy programs, such as the RPSU, budget a sufficient amount to cover the entire scope of the project, thus reducing the risk that a project will stall due to insufficient funding, but placing the entire financial burden and risk on the State and/or federal funding agency.

Cost of equity as a measure of risk

Another way to understand the financial risk associated with energy projects is to look at the return an investor would require in compensation for that risk. Although limited empirical data is available from Alaska to help understand the risks for different project types and areas, other methods exist to estimate the cost of equity. Work performed for the AkAES uses the volatility of sales among Alaska's rural utilities as a basis of analysis, since the cost of equity is a measure of the market and revenue risk associated with a utility.[187] A higher cost of equity indicates greater risk and can be expected to increase costs to consumers.

---

[186] Tiffany Zulkosky, former executive director of Nuvista Light and Electric Cooperative, personal communication December 16, 2016.

[187] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

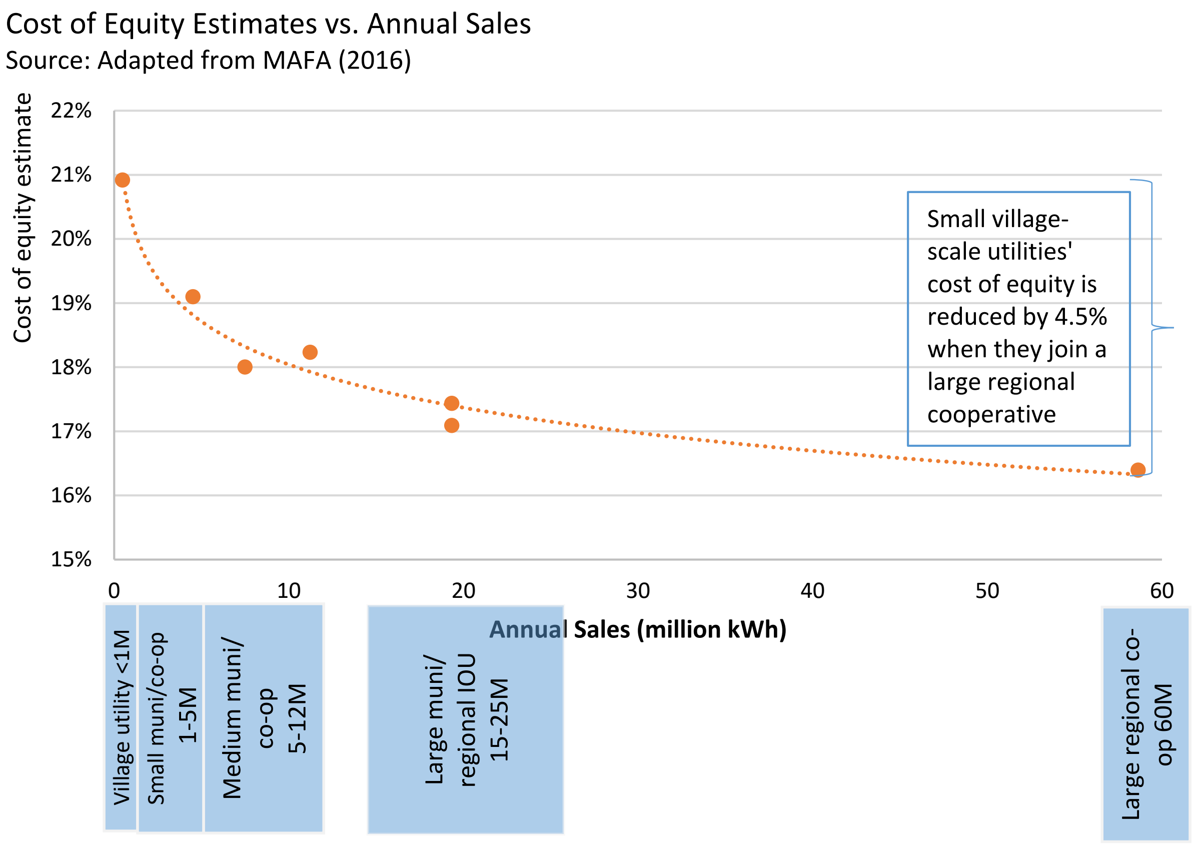


Figure 59: Cost of equity estimate vs. annual sales for PCE utilities[188]

Figure 59 shows that smaller utilities often have a higher cost of equity (COE). The increased COE is based on the higher expected uncertainty in net revenue and cash flow. In order to cover these risks and attract private capital, a greater return on equity is required by investors. In grant-funded projects, the risks are absorbed by the state or federal government that is granting the infrastructure to the utilities.[189] Since the utilities do not have equity in the project, a return on equity is not needed. If grant-funding decreases and utilities have more equity invested in future infrastructure projects, the risk from net revenue and cash flow volatility can be partially mitigated through various rate-setting mechanisms, and/or different types of insurance could be made available to reduce the risks associated with cash flow and net revenue volatility.

There are two main potential solutions for reducing risk associated with revenue: 1) increasing fixed charges or 2) move from a rate-based to a revenue-based system. Although passing fixed costs as a fixed charge will remove some of the revenue volatility, it would disproportionately affect low-income consumers, who tend to use less electricity, and remove some of the incentive of conserving energy.[190] A revenue-based system, also referred to as "decoupled," ensures that the revenue needed to operate the

[188] Foster and Townsend, 2017.
[189] Foster and Townsend, 2017.
[190] Janine Migden-Ostrander. "Technical Conference: Alternative Cost Recovery Mechanisms." Presentation to Maryland Public Service Commission. October 20, 2015. http://www.raponline.org/wp-content/uploads/2016/05/rap-jmo-mdpsc-altcostrecmech-2015-oct-20.pdf

utility can be earned, even with volatile or declining sales. A revenue-based system can also provide for greater incentives for utilities to increase the efficiency of their customers, and incentives that do not exist with traditional rate-making. Downsides of decoupling are the care required in determining the revenue requirements for utilities and the greater amount of involvement needed to adjust rates to achieve the required revenue.[191]

As Figure 59 shows, consolidating utilities into larger organizations also decreases the cost of equity by effectively spreading the risk over the entire system. There are some circumstances in which the risk cannot be mitigated through fixed changes and/or insurance and make it such that private investments are not viable at any rate of return.

Figure 59 also estimates the amount of return on equity that an independent power producer (IPP) may require in communities eligible for PCE. Unless the project decreases generation costs, the required return on equity would increase cost to consumers.

PROJECT OPERATION

The economic analysis performed as part of the evaluation of all REF grant applications makes certain assumptions about the expected performance and economic life of the project. If it does not perform as expected or its useful life is shorter than expected, the project may not end up being cost-effective. Performance risks include the risks that the project, when complete, fails to perform as intended or fails to meet business requirements that justified it. Poor design or technology choice, inadequate maintenance and poor management all increase performance risks, as well as other factors that may be beyond a utility's control. If the project was primarily grant-funded, this may not create financial difficulties for the community. However, if the underperforming project was partially or completely debt-financed, the community or utility may have to continue to pay for infrastructure that is inoperable or does not generate enough revenue to pay back the loans.

For many of the State's energy programs, there is not sufficient long-term tracking of projects to understand other factors that influence long-term performance. The State is generally not the owner of community energy systems, and grant agreements typically give the infrastructure to the grantee. After the State has transferred grant-funded project to the community or utility, the State is no longer responsible for it, and the performance and longevity are the responsibility of the utility.

REF grant agreements mandate performance reporting at a fairly coarse level for the first 10 years of operation (five years for earlier projects), so AEA can determine if the project is meeting performance expectations. The reporting has not always been consistent with the specific infrastructure paid for by the grant. For example, a community might report all the power produced by a wind farm even if the REF only funded one of the turbines.

If a project is to be loan financed, it is especially important to be able to accurately estimate its future performance. Any modeling is only as good as the inputs and assumptions, and operational projects are the best source for predicting how future projects will perform. While REF-funded projects have not been

---

[191] Jim Lazar. "Electricity Regulation in the U.S.: A Guide." Second Edition. The Regulatory Assistance Project. 2016. http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf

operational long enough to know if their full economic lives will be reached, there are a minority of operational projects that have already experienced issues affecting their performance, as shown in Figure 60.

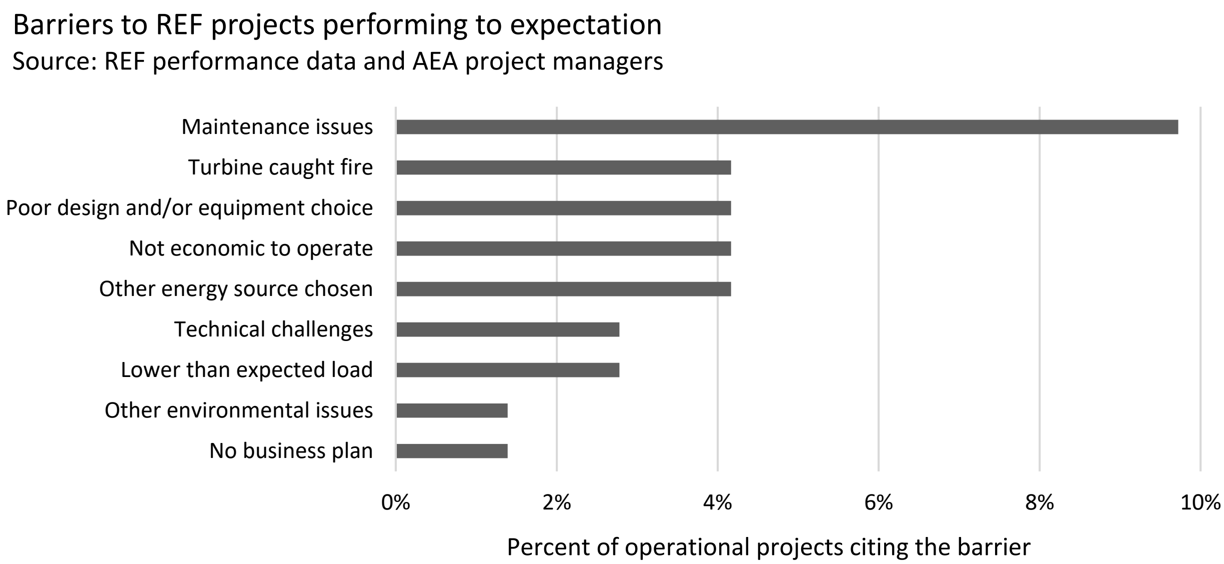


Figure 60: Reported barriers to REF project performance[192]

Approximately 35% of operational REF projects were identified as not meeting performance expectations, either through performance reporting or interviews with AEA project managers. The primary reason for projects not meeting expectations is maintenance issues, which is consistent with anecdotal evidence collected from other state energy programs. Failures with wind turbines catching fire are prevalent enough to be tied as the second most common issue along with poor design/equipment choice, poor economics, and the community or utility choosing a different energy source. Some of the barriers reported in Figure 60 have led to projects not being operational. While none is completely external to the project, the steep drop in oil prices has led to the curtailment of at least one project. Almost all the identified barriers could be successfully mitigated through pre- or post-operational planning by the project owner.

Non-REF renewable energy projects have also shown operational risks if preventative maintenance is not performed. Recently, Sitka had to shut down its Green Lake hydroelectric power plant, forcing it to switch to backup diesel generators, to fix an issue, at least partially caused by inadequate inspections and preventative maintenance.[193]

Operational risks of diesel power plants

The Rural Power System Upgrade program (RPSU) is an another state program that yields insight into the operational risks facing rural energy infrastructure projects. The RPSU program provides a good baseline

[192] AEA analysis of interviews with REF project managers and REF performance reports
[193] Emily Kwong. KCAW. "Green Lake dam awaits replacement part to get back up and running." December 26, 2016. http://www.alaskapublic.org/2016/12/26/green-lake-dam-awaits-replacement-part-to-get-back-up-and-running/

for analysis, because we know when a powerhouse was constructed. This helps eliminate the variable of infrastructure age and focus the analysis on how operations and maintenance impact performance.

RPSU projects are intended to provide safe, stable, and reliable power to communities. Improving the efficiency of electric generation is a close second priority, but not the primary goal of the RPSU. AEA analyzed 32 RPSU projects commissioned between 2001 and 2009. Overall, the RPSU projects analyzed were more efficient after the project, with a 10% average increase in efficiency. After projects were commissioned and transferred to the community, the trends were more site-specific, with about half of communities experiencing a general positive trend for efficiency and the other half experiencing declining efficiency.

Line loss is another performance measure that can be partially analyzed with available data. The design specification is 8% loss. Line loss is reported through the PCE program, but is defined as the amount of unsold electricity (the difference between generation and sales). If there are reporting errors for either sales or generation, the utility's line loss number will be affected, regardless of the amount of actual loss in kWh delivered through the utility's distribution system. Given the numerous ways in which distribution systems can lose energy, it is not always easy to identify and address the causes of line loss. For the 32 projects analyzed, only one utility met the long-term line loss expectation of 8%; others ranged up to 31% loss. Because there was significant year-to-year variability, no meaningful trends in line loss could be found at the community level. Despite potential reporting errors, line loss appears to be a significant yet fixable performance issue that, if addressed, would reduce the cost of energy in AkAES communities. This data reinforces the need for access to skilled technicians to assist communities with diagnosing and fixing distribution issues.

Replacing a powerhouse or distribution system is generally not done for economic reasons, but to ensure the safety and reliability of the power system. Nonetheless, diesel efficiency and line loss are performance issues that must be taken into account when evaluating opportunities to make energy more affordable, and they are important measures of whether an energy project will be cost-effective.

The expected operational life of a properly maintained powerhouse is 30 years. An analysis of AEA's Electrical Emergency Program showed that 23 of 32 RPSU projects built between 2000 and 2009 experienced emergencies after completion that were unassociated with project design or construction, at a reported cost of almost $800,000. This data validates the institutional knowledge that proper training for utility operators and managers is critically important.

Figure 61 shows an analysis by issue type of all electrical emergency response events from 2005 to 2015, not just those associated with an RPSU project. Few of the emergency response calls can be ascribed to natural causes. Engine failure and generator issues are most commonly due to poor maintenance. Some distribution faults could be due to storms or other weather events, but it is difficult to know from the data.

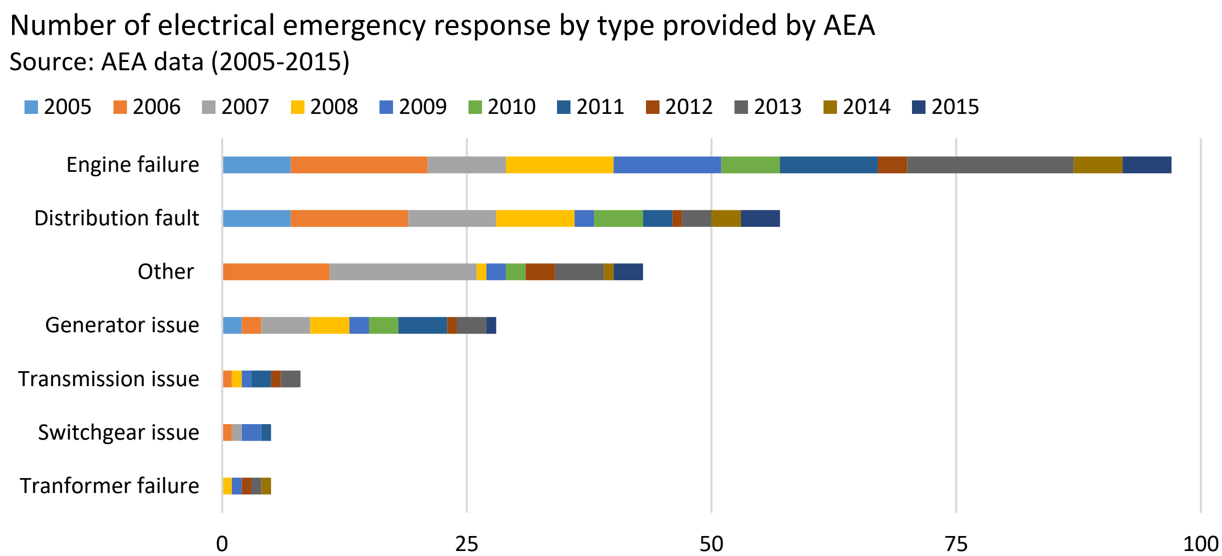


Figure 61: Number of electrical emergency response by type provided by AEA[194]

Operational risks of energy efficiency projects

Building energy efficiency projects are subject to fewer project development risk factors, but potential operational risks still need to be recognized and mitigated. Few evaluations of completed energy efficiency projects have been performed in Alaska, and while it can be dangerous to extrapolate from just a few case studies, the analyses of two Village Energy Efficiency Projects (VEEP) in Nightmute and Shishmaref offer useful insights.

Nightmute underwent a whole village retrofit (WVR) in 2008 to 2009 that included retrofits to residential and non-residential buildings. In November 2014, AEA sent a team representing state and regional organizations that had been involved in the retrofits to learn what had worked and what could be improved about the whole village retrofit concept. Overall, the team found that the WVR has been successful, though it recommended a number of improvements that are relevant to this AkAES study.

One barrier to evaluating the effectiveness of the WVR project was lack of data. Baseline energy use data from before the WVR was almost wholly lacking for both heating and electricity. In many cases, post-retrofit consumption data was also not available. Still, an energy auditor was able to conduct walk-through inspections of the retrofitted buildings and perform blower door tests, the results of which were compared with tests and inspections done after the WVR was completed. Based on these findings, most of the efficiency measures, both thermal and electric, were still performing as expected five years later. In both residential and non-residential buildings, it was apparent that ongoing maintenance was needed to keep air leakage at a minimum. This is a particular problem in areas known for building foundation movement.[195]

[194] AEA analysis of AEA's emergency response program (2005-2015)

[195] Katie Conway. "Nightmute Whole Village Retrofit—then and now." Alaska Energy Authority. January 15, 2015. http://www.akenergyauthority.org/Content/Efficiency/Veep/Documents/NightmuteWVR20082014FINAL11515.docx

The 2010-2011 VEEP project in Shishmaref was evaluated in 2013 with Denali Commission funding. In this case, the evaluators did not find that all the expected savings had been realized. They found that savings were initially overestimated, particularly by not valuing the lost heat resulting from increased electric efficiency. They also found that the building occupants had changed their behavior and were consuming more energy, primarily through increased hours of operation. This does not negate the savings from increased efficiency, but it does highlight a risk that if electrical bills do not go down, building occupants may discount a project's effectiveness, particularly if post-retrofit evaluations are not performed. The Shishmaref case study underscores the need for realistic savings estimates and thoughtful messaging to occupants.[196] Some of the same operational issues, such as inadequate maintenance, that were evident in the Nightmute case study were also present in Shishmaref.

CLIMATE CHANGE

It is likely that the impacts of rising sea levels, loss of sea ice (which protects coastal communities from winter storm surges), and thawing permafrost will have significant, but currently unknown, impacts on Alaska's energy infrastructure. AEA's work has been to identify specific challenges to infrastructure that have the potential to increase costs and risks due to climate change.

Several of the bulk fuel tank farms built with Denali Commission funds since 2000 have been impacted by flooding and coastal erosion that climate change has likely exacerbated. In Port Heiden, a 221,000-gallon tank farm, constructed in 2002 for $1.3 million, was relocated due to coastal erosion in 2015 at an estimated cost of $1.6 million.[197]

In 2009, the federal General Accountability Office (GAO) reported that 31 Alaska villages face imminent threats from flooding and erosion. In 2009, 12 of these communities were exploring relocation options. Relocation will require moving or rebuilding a community's energy and sanitation infrastructure including powerhouses, transmission and distribution lines, heat recovery loops, tank farms, and water and sewer infrastructure. It is expected that the threats to communities will increase if Arctic temperatures continue to rise as predicted.[198]

In areas with permafrost, damage to buildings due to the ground warming is well documented. Even without a warming climate, buildings can warm and melt the permafrost, an issue that can be mitigated in building design but could be exacerbated by rising temperatures. As seen in Nightmute, building maintenance is an important part of preserving the effectiveness of weatherization activities and livability of the housing stock.[199]

---

[196] Armstrong, Richard. "Measurement and Verification Review of 2010/2011 VEEP & EECBG Energy Efficiency Retrofits." December 17, 2013.
[197] Alaska Energy Authority. "Bulk Fuel Inventory Assessment Report." 2016.
[198] General Accountability Office. GAO-09-551. "Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion." 2009. http://www.gao.gov/new.items/d09551.pdf
[199] Conway, 2015.

Commonwealth North expects that energy infrastructure costs will increase, at least in response to climate change.[200] In 2008, a group of engineers and economists from Alaska and Colorado estimated the additional community infrastructure costs due to climate change through 2030. Their model, which included more than just energy infrastructure, estimated that climate change would likely increase infrastructure costs 10 to 20% above normal wear and tear, amounting to an additional $3.6 to $6.1 billion in needed infrastructure investment across Alaska.[201] Using the estimates for power plants and bulk fuel facilities developed in Chapter 2, this would indicate that climate change could require an additional $3.5 to $7 million in annual energy infrastructure spending in the communities with less than 2,000 people.

[200] Commonwealth North. "Energy for a Sustainable Alaska: The Rural Conundrum." February 2012. http://www.commonwealthnorth.org/download/Reports/2012_CWN%20Report%20-%20Energy%20for%20a%20Sustainable%20Alaska%20-%20The%20Rural%20Conundrum.pdf

[201] Larsen, P.H., et al., Estimating future costs for Alaska public infrastructure at risk from climate change. Global Environmental Change (2008), http://climatechange.alaska.gov/aag/docs/O97F18069.pdf

CHAPTER 5: THE IMPACT OF PROGRAMS ON ENERGY AFFORDABILITY AND STATE ENERGY POLICIES

Key takeaways

1. Federal capital grants and State and federal direct consumer subsidies have had the biggest impact in reducing energy costs in the AkAES study area to date.
2. Programs that have increased energy affordability in the study area include the Rural Power System Upgrade (RPSU), Bulk Fuel Upgrade (BFU), Renewable Energy Fund (REF), Power Cost Equalization (PCE), Alaska Heating Assistance Program (AKHAP), and the Weatherization and Village Energy Efficiency Program (VEEP) energy efficiency programs.
3. State energy programs that have primarily served the Railbelt and urban areas include the Home Energy Rebate/New Home Rebate programs and the Sustainable Energy Transmission and Supply (SETS) loan.
4. Some State energy programs provide their primary benefits to AkAES communities and help protect the State's investment by ensuring the safety and reliability of rural energy infrastructure, including RPSU, BFU, Circuit Rider, Electrical Emergency Response, and other training and technical assistance programs.
5. There is an opportunity to capture greater and more lasting generation efficiency improvements by creating new incentives or requirements for lifetime operations and maintenance, including ongoing performance tracking and reporting for publicly funded projects.
6. Loan and other debt financing programs, by themselves, are unlikely to incentivize new renewable energy or energy efficiency projects until technical, communication, and financial barriers to participation are addressed.
7. More robust community-level data is needed to better analyze the cost-effectiveness of State energy programs on affordability.
8. The State can make more progress on achieving the energy sustainability policy goals established in 2010 (15% increase in energy efficiency by 2020, 50% of renewable energy by 2025) if goals are supported by greater accountability, new reporting requirements to track progress, continued technical assistance, and more capacity building for rural projects.

This chapter investigates current and historical State energy programs to see how they have impacted energy affordability across the AkAES study area. The State has four primary mechanisms for achieving its policy objectives—direct funding, technical assistance, statutory or regulatory requirements, and disincentives (such as taxes). Given limited methods and financial resources for affecting change, it is important to understand how different types of programs have benefited communities so that methods can be improved and public funding used more efficiently over time.

In Alaska, more than a dozen individual State and federal energy programs assist communities with reducing energy costs. In many cases, the State and federal programs work in concert, with the State supplementing the federal program, or vice versa. This chapter will focus on State energy programs, with federal data included where appropriate. The chapter is organized into two main sections. The first section provides a brief analysis of core State energy programs. Based on the availability of data and previous evaluations, each program analysis includes a description of the total funding over time by source, the regional spread of funding, and the savings and benefits to those regions. The last section describes how those programs help advance the State's sustainable energy goals: the goal of improving per capita energy efficiency by 15% by 2020, and the goal of generating 50% of statewide electricity from renewable sources by 2025.

STATE ENERGY PROGRAMS

State energy programs are administered by seven agencies and divisions:

1. Alaska Energy Authority (AEA): Rural Power System Upgrade program (RPSU), Bulk Fuel Upgrade program (BFU), Renewable Energy Fund (REF), Power Project Loan fund (PPF), Village Energy Efficiency Program (VEEP), and administered the Bulk Fuel Loan program until 2013
2. Alaska Housing Finance Corporation (AHFC): Weatherization Assistance Program (Wx), Home Energy Rebate program (HER), Home Energy Loan, Alaska Energy Efficiency Revolving Loan Fund, and Energy Efficiency Interest Rate Reduction (EEIRR)
3. Department of Health and Social Services (DHSS): Low-income Heating Assistance Program (LIHEAP) and the Alaska Heating Assistance Program (AKHAP)
4. Department of Commerce, Community, and Economic Development (DCCED): Alternative Energy and Conservation Loan
5. Department of Transportation and Public Facilities (DOT&PF): Public Facilities Energy Efficiency Improvement Program
6. Division of Community and Regional Affairs (DCRA) at DCCED: Bulk Fuel Loan and Bulk Fuel Bridge Loan programs
7. Alaska Industrial Development and Export Authority (AIDEA): Sustainable Energy Transmission and Supply (SETS) program and commercial loan program

The Department of Natural Resources oil and gas tax programs, the Alaska Gasline Development Corporation, and the Regulatory Commission of Alaska, which regulates electric utilities and natural gas utilities in the study area, are not included in this program review.

Since the State cannot change federal programs, this section does not include analysis of federal programs, except where they supplement or are supplemented by State energy programs. The ability of communities to access federal programs and of the State to coordinate with them will be increasingly important as State energy funds become more scarce and federal funding assumes a larger role.

A short analysis of each State energy program follows, organized by type of funding:

1. State capital grant programs
2. State energy subsidies
3. State energy loans
4. Other state energy programs

The high-level analysis of program outcomes in this chapter is based on the best publicly available data and formal program evaluations, where available. Due to the challenges described in Chapter 1 of defining "affordable" in a way that works as an objective policy measure, programs were not evaluated against a single metric. Where no reliable quantitative data exists, gaps have been bridged with qualitative data, including information from program managers, staff, and beneficiaries.

Although the Railbelt is excluded from the study area, Railbelt data is included in some analyses in order to evaluate how effectively each program has addressed the needs of the AkAES target area and has contributed to progress on statewide sustainable energy goals.

State capital grant programs

Along with the Power Cost Equalization (PCE) Program, State capital grants have provided the majority of state energy funding in the AkAES region. These include grants for residential efficiency, electrical generation, renewable energy and bulk fuel storage. In many cases, State capital grants have been supplemented by funding from federal sources. Where possible, federal and local contributions were identified for each of the programs evaluated.

Rural Power System Upgrade program

Established under 3 AAC 108.100 – 130, AEA's Rural Power Systems Upgrade (RPSU) program provides financial and technical assistance to rural electric utilities, including grant funding for the construction of power generation and related infrastructure and utility operations training for eligible recipients. Upgrades may include powerhouse upgrades or replacements, intertie assessments, distribution lines to new customers, heat recovery, and repairs to generation and distribution systems. Funding for the RPSU program depends on State legislative appropriations, federal Denali Commission grants and other matching funds.[202]

RPSU projects must meet eligibility criteria, and they are ranked and chosen through a non-competitive process.[203] Every 10 years an inventory and evaluation of powerhouse infrastructure in eligible communities is performed; the most recent was completed in 2012.[204] To be eligible, communities must have a population between 20 and 2,000, not be predominately a military or industrial site, and not be connected to the Railbelt, Four Dam Pool, or Juneau power distribution systems.[205] Communities are then ranked by the condition of the power generation and distribution infrastructure. The financial ability of the community or utility to pay for the infrastructure is not a criterion for selection. Basing the non-competitive selection process on the age and disrepair of the generation infrastructure could create an unintentional incentive for not maintaining infrastructure.[206]

---

[202] AEA Rural Power System Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[203] 3 AAC 108.110, http://www.touchngo.com/lglcntr/akstats/aac/title03/chapter108/section110.htm
[204] See Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)
[205] 3 AAC 108.110, http://www.touchngo.com/lglcntr/akstats/aac/title03/chapter108/section110.htm
[206] Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm.

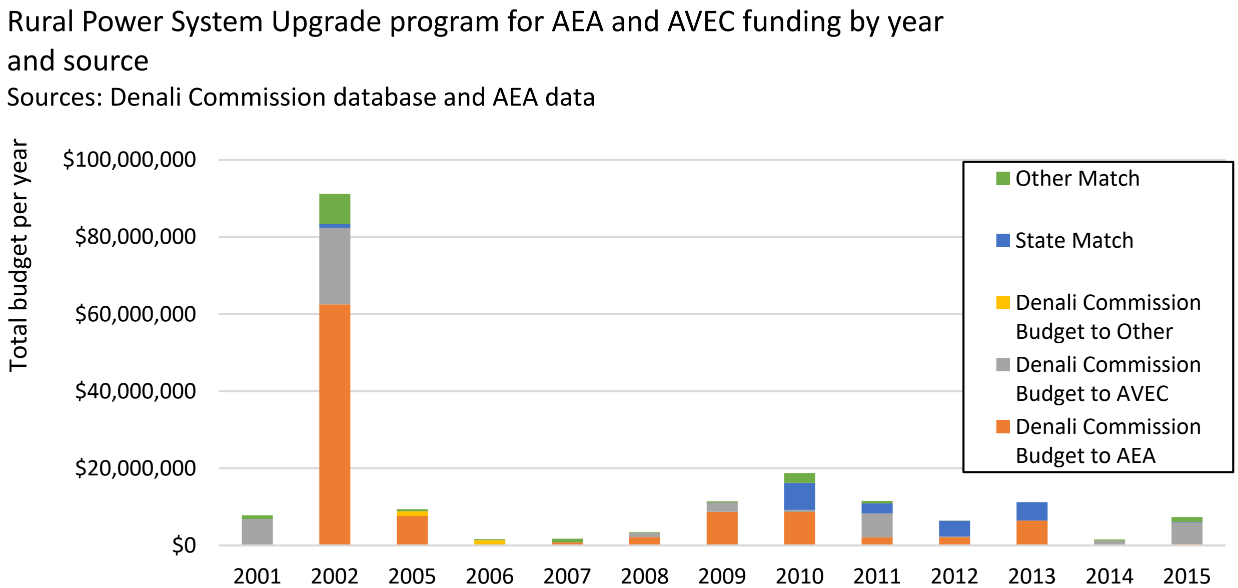


Figure 62: Rural Power System Upgrade Program for AEA and AVEC by funding by year and source[207]

Figure 62 includes all state and federal funding for rural power systems over the past 15 years. The Denali Commission provided over $170 million dollars to communities through AEA and the Alaska Village Electric Cooperative (AVEC). The State contributed another $19.5 million over the same period. Other matches include funding from the U.S. Department of Agriculture (USDA), local communities and AVEC. The total budget for these years was $183 million, an average of approximately $12 million/year.

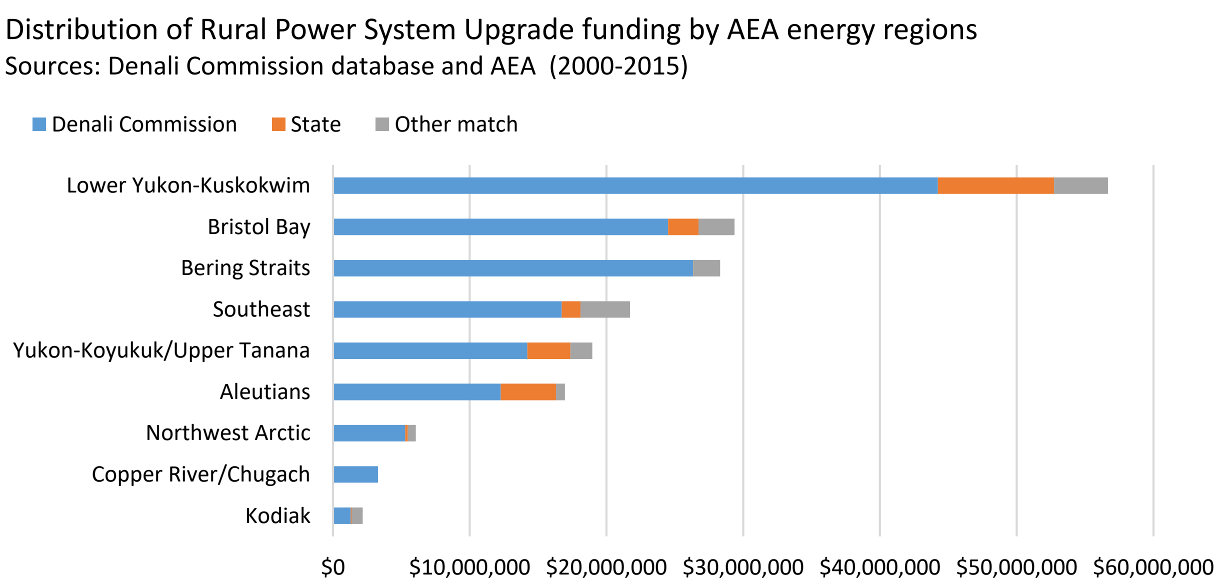


Figure 63: Distribution of Rural Power System Upgrade funding by AEA energy regions (2000-2015)[208]

With the largest population and the most communities, the Lower Yukon-Kuskokwim region also received the most RPSU funding, almost $53 million in federal and State funds. Bristol Bay, Bering Straits, Yukon-

[207] Data compiled from Denali Commission database and AEA financial data
[208] Data compiled from Denali Commission database and AEA (2000-2015)

Koyukuk/Upper Tanana and Aleutians received between $17 and $30 million over the 15 years. The Northwest Arctic, Copper River/Chugach, and Kodiak regions all received significantly less. Much of the Copper Valley/Chugach region is connected by intertie. Similarly, on Kodiak, the regional electric association serves the majority of the population, while five villages rely on small, independent powerhouses.

The program's impact on generation efficiency and residential rates can be analyzed using program data in combination with PCE data. AEA restricted its analysis to RPSU projects that would provide at least five years of operational data in order to identify longer-term trends. This included projects completed between 2000 and 2009. The costs for these projects ranged from $400,000 to $3.25 million. The majority involved construction of new powerhouses, but hydro and distribution projects were also funded during this time.

… reducing the cost of energy is not the main purpose of the RPSU program, and it would be unfair to evaluate the program solely through that lens.

It should be noted that reducing the cost of energy is not the main purpose of the RPSU program, and it would be unfair to evaluate the program solely through that lens. The RPSU program's primary mission is ensuring safe, reliable, and stable power by assisting rural electric utilities in upgrading their infrastructure. Prior to the RPSU program, many of the powerhouses in rural Alaska communities were unreliable, in poor condition, and in some cases, dangerous. Anecdotes from AEA staff indicate that it was not uncommon in the 1970s and 1980s for multiple powerhouses to burn down each year.[209]

While not the RPSU program's main goal, better generation efficiency and heat recovery are some of the main ways that the program can help make energy more affordable in the rural communities it serves. After a project has been completed and the equipment or other infrastructure transferred to the community, AEA is no longer responsible for the project. The performance and longevity of the new or upgraded infrastructure become the responsibility of the utility. As a result, the long-term effect on the operational efficiency of an RPSU project is heavily contingent on the day-to-day operations of the local utility.

The average long-term improvement in diesel generation efficiency from RPSU projects was approximately 10%, based on an analysis of PCE and RPSU program data for projects completed between 2001 and 2009. Figure 64 provides a regional look at the data. The results represent the difference between the average diesel efficiency for five or more years before and after a project was complete.

[209] Kris Noonan, personal communication. December 6, 2016.

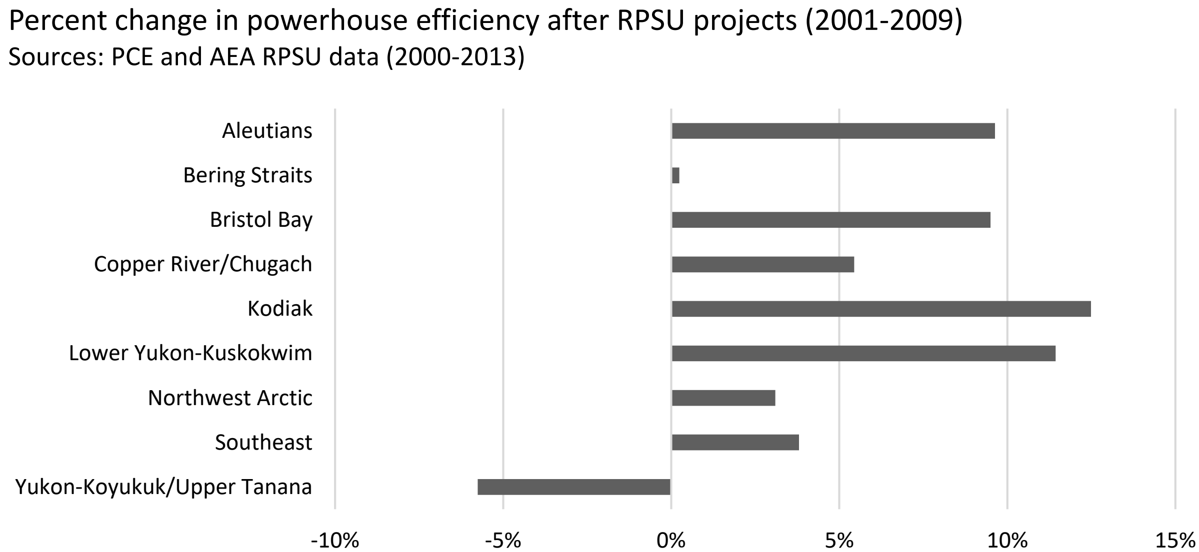


Figure 64: Change in powerhouse efficiency after RPSU project[210]

As Figure 64 illustrates, there is considerable variability in the long-term results. The biggest improvement by a utility was 30%, while several others actually saw reductions in generation efficiency in the years following their projects. Even among utilities initially experiencing big improvements, performance tended to decline over time, bringing the utility back nearer to its pre-RPSU baseline. This underscores the importance of following good operations and maintenance protocols. It also represents an opportunity to capture greater and more lasting efficiency improvements by creating new incentives or requirements for post-project operations and maintenance (O&M), including ongoing performance tracking and reporting.

Similarly, most communities did not maintain the line loss design expectation of 8% after infrastructure was turned over to the utility. Line loss has a direct impact on the amount of fuel consumed, which impacts electric rates (see Figure 36 on page 78). If all 32 RPSU projects commissioned between 2001 and 2009 had maintained the expected 8% line loss, fuel use would be reduced by 150,000 gallons per year, for an annual savings of over half a million dollars.[211]

The RPSU program has lowered electric rates in communities where projects have been performed. Some of the cost reduction is directly due to the improvements in generation efficiency. By getting more kWhs from every gallon of diesel, a utility's fuel costs are reduced. We make the assumption that at least a portion of these savings is passed onto the consumer through lower electric rates. Table 11 shows the average reduction by region in utility fuel costs following RPSU projects completed between 2001 and 2009. The fuel cost reductions are shown on a per-kilowatt-hour basis to show their potential impact on consumer electric rates.

[210] AEA analysis of Power Cost Equalization data (2000-2013), accessed from the Alaska Energy Data Gateway. (https://akenergygateway.alaska.edu/)
[211] AEA analysis of RPSU design documents and PCE data.

Table 11: Long-term reduction in fuel costs due to efficiency improvement after RPSU project[212]

Region	Number of projects in region	Minimum Fuel Cost Reduction ($/kWh)	Average Fuel Cost Reduction ($/kWh)	Maximum Fuel Cost Reduction ($/kWh)
Aleutians	3	$0.00	$0.04	$0.08
Bering Straits	2	-$0.02	$0.01	$0.03
Bristol Bay	4	-$0.05	$0.04	$0.12
Copper River/Chugach	1	$0.03	$0.03	$0.03
Kodiak	2	$0.01	$0.06	$0.11
Lower Yukon-Kuskokwim	12	$0.01	$0.06	$0.19
Northwest Arctic	2	-$0.03	$0.01	$0.05
Southeast	4	$0.01	$0.02	$0.04
Yukon-Koyukuk/Upper Tanana	2	-$0.12	-$0.04	$0.04

It is clear from Table 11 that fuel cost reductions attributable to RPSU efficiency gains have varied widely. The average per kWh savings in fuel costs for all 32 projects was $0.03/kWh. The largest reductions in fuel costs, on a per kWh basis, were in the Lower Yukon-Kuskokwim region, where average savings were $0.06/kWh.

A greater savings to rural utilities and electric consumers comes from grant funding capital infrastructure. Because consumers do not have to pay the capital or financing costs of new or upgraded infrastructure, they are likely to see little direct change in their electric rates following a major powerhouse renovation or expansion.

For most of the program's life, utilities that received an RPSU project funded by the Denali Commission were required to maintain a reserve account to pay for 40% of the expected capital cost for the eventual replacement of the powerhouse. The reserve accounts were meant to allow for sustainable operation of the facilities and avoid a future liability for the State or federal government. In 2012, the Denali Commission's Inspector General was unable to determine if these accounts were set up and being funded by ratepayers. [213] The following analysis assumes that these reserve accounts are not being capitalized.

Table 12 summarizes the average per-KWh savings by region from both the capital expense (CAPEX) and efficiency benefits of RPSU projects completed between 2000 and 2009.

[212] AEA analysis of Power Cost Equalization data (2000-2013), accessed from the Alaska Energy Data Gateway. (https://akenergygateway.alaska.edu/)
[213] Office of Inspector General, Denali Commission. Analysis of R&R Accounts as Highlighted in the FY2012 Second Half Semi-Annual Report to Congress. June 12, 2013. http://oig.denali.gov/wp-content/uploads/2015/01/SAR-2012-09.pdf

Table 12: Reduction in generation costs due to RPSU capital grants[214]

Region	Number of projects in region	Minimum total savings/kWh (CAPEX and efficiency)	Average total savings/kWh (CAPEX and efficiency)	Maximum total savings/kWh (CAPEX and efficiency)
Aleutians	3	$0.07	$0.49	$0.94
Bering Straits	2	$0.24	$0.25	$0.26
Bristol Bay	4	$0.17	$0.38	$0.53
Copper River/Chugach	1	$0.44	$0.44	$0.44
Kodiak	2	$0.10	$0.18	$0.25
Lower Yukon-Kuskokwim	12	$0.09	$0.33	$0.74
Northwest Arctic	2	$0.13	$0.16	$0.19
Southeast	4	$0.09	$0.30	$0.65
Yukon-Koyukuk/Upper Tanana	2	$0.38	$0.85	$1.31

By comparing Tables 11 and 12, it is clear that by far the largest cost savings to utilities and consumers comes from the offset in capital expenses. Average total savings (CAPEX and efficiency) varies by region from a low of $0.18 in Kodiak to $0.85/kWh in the Yukon-Koyukuk/Upper Tanana region. In some cases, per-kWh savings actually exceed the current residential rate. Ratepayers who are not eligible for PCE (e.g. private businesses) would see a sizeable increase in their electric rates if utilities had to pay the full capital cost of infrastructure. For the portion of residential and community facility kWhs covered by the PCE program, the increased cost to cover capital expenses would be mostly absorbed by the PCE program

It is more difficult to evaluate the RPSU's success in its primary mission, since there is little quantitative data available to track the safety, stability, and reliability of the state's many unregulated small utilities, including most in the study area. Even utilities that are economically regulated by the Regulatory Commission of Alaska (RCA) do not consistently report metrics related to safety and reliability.[215]

RPSU projects have not eliminated the need for electrical emergency assistance, as shown by a high-level analysis exploring the relationship between AEA's Electrical Emergency Response program and the RPSU program during the 10-year period from 2005 to 2015. In the years after an RPSU project was completed, recipient communities received approximately $800,000 in emergency services from the State, about one-quarter of the total number and cost of the emergency assistance program responded to over that time. The continued need for emergency assistance in these communities suggests that the age of infrastructure is not the primary cause of emergencies and that other factors, including proper training, maintenance, and management at the utility are also critical to keeping utilities safe, stable, and reliable.

The State does not have a statutory or regulatory obligation to replace powerhouses that have reached the end of their useful lives. A liability may exist if the powerhouses fall under the regulations associated

[214] AEA analysis of Power Cost Equalization data (2000-2013), accessed from the Alaska Energy Data Gateway. (https://akenergygateway.alaska.edu/)
[215] James Layne. Electric Utility Outage Reporting 2003 to 2013. Regulatory Commission of Alaska. April 22, 2015.

with the Electrical Emergency Response program and the critical energy infrastructure becomes unsafe and presents a public hazard.[216]

There are currently no standards requiring unregulated electric utilities to prove that they are operated in a way that provides safe, stable, reliable, and affordable energy once they have received a Certificate of Public Convenience and Necessity (CPCN). However, an opportunity exists to reduce community energy costs and State expenditures for emergency response by providing additional oversight of operations at small rural utilities (including proper training, maintenance, and management) and improved access to non-State financing for infrastructure upgrades and replacement.

Bulk Fuel Upgrade program

Before the Bulk Fuel Upgrade (BFU) program, many of Alaska's rural bulk fuel storage facilities had been constructed in the 1970s or earlier. Many of these facilities had reached the end of their useful life, leaked fuel, and did not comply with State and federal codes and regulations. Regulatory agencies, such as the Alaska Division of Fire and Life Safety, the Coast Guard, and the Environmental Protection Agency, could prohibit fuel deliveries to these facilities due to safety and compliance concerns, although this has not happened yet. Not all communities have been served by the program and some noncompliant bulk fuel storage is still in use.

The goal of AEA's Bulk Fuel Upgrade program is to upgrade non-compliant bulk fuel facilities in communities that meet community size, use, and geographic restrictions.[217] By providing adequate capacity for current and planned needs, communities may purchase fuel in larger quantities at a lower cost per gallon.[218] However, purchasing fuel in bulk comes with some market risk. Fuel prices may be significantly higher on the day the bulk order is shipped than the average price will be over the period in which the fuel is consumed. This happened to many communities between 2014 and 2015.[219]

Since 2000, BFU funding to replace community bulk fuel facilities has come from Denali Commission grants, direct legislative appropriations, Community Development Block Grants, Indian Community Development Block Grants, USDA grants and loans, owner-financing, and other sources. Due diligence is carried out to ensure that project participants meet Denali Commission and State of Alaska sustainability standards.[220]

---

[216] 3 AAC 108.200 – 240.
[217] 3 AAC 108.110.
[218] AEA Bulk Fuel Upgrade Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[219] Lisa Demer. "Bush Alaska locked into high gas prices for fuel delivered last summer and fall." Alaska Dispatch News. May 31, 2016. https://www.adn.com/rural-alaska/article/bush-alaska-locked-high-gas-prices-fuel-delivered-last-summer-and-fall/2015/01/01/
[220] Denali Commission Policy. Rural Alaska Energy Infrastructure Criteria for Sustainability. 2002.

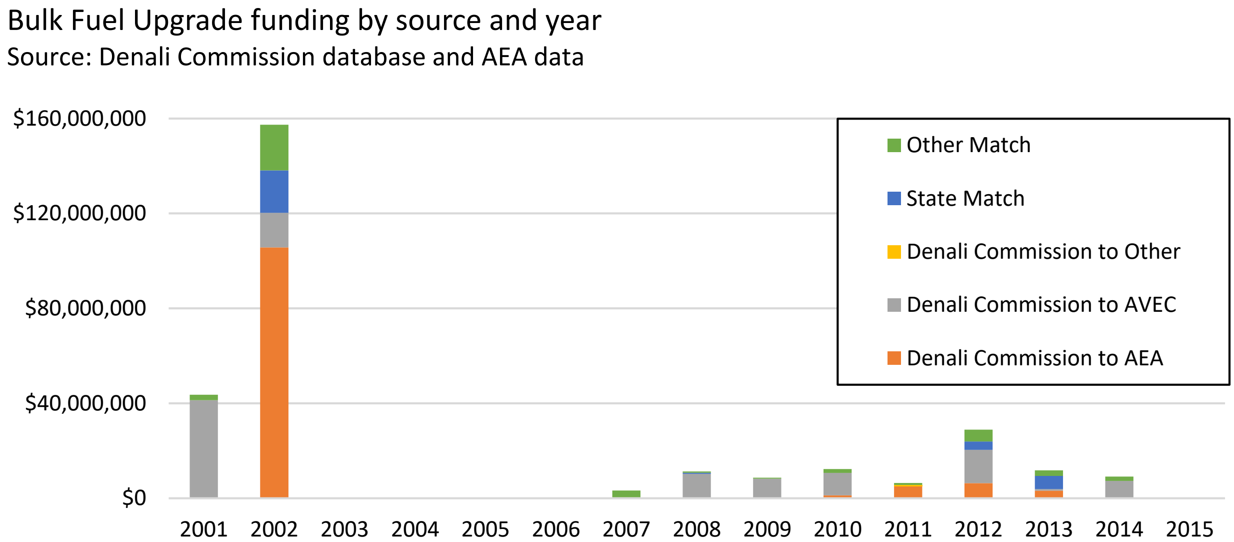


Figure 65: Bulk Fuel Upgrade funding by source and year[221]

Figure 65 shows all funds disbursed by the Denali Commission for bulk fuel upgrades, including those paid to AEA and to the Alaska Village Electric Cooperative (AVEC). Over 150 projects funded were funded from 2001 through 2015, including feasibility and conceptual design. The majority of the funding was allocated in 2002. The average annual budget for all years from all funding sources was nearly $20 million. The total budget for the 15 years was over $293 million.

As in the RPSU program, the allocation of BFU grants is decided by AEA through a non-competitive process. The status of bulk fuel facilities is assessed periodically in areas expected to have the most need. The most recent bulk fuel inventory was performed by AEA in 2015 with a review of 56 communities. The assessment found that a number of communities needed replacement of their bulk fuel facilities, but that others were in need of less expensive upgrades.[222]

Figure 66 shows project funding by AEA energy region. Like the previous figure, it includes BFU projects managed by AEA and AVEC. Over 40% of total funding went to the Lower Yukon-Kuskokwim. While this may appear unbalanced, it is only slightly more than the region's per-capita representation among BFU-eligible communities. Nearly 20% of the funding went to the Bering Straits region. With both a maritime climate and permafrost, it is unsurprising these regions demonstrated the greatest need. The lowest need in the AkAES study area was found in the Copper River/Chugach region, where most communities are on the road system and do not have tank farms.

[221] Denali Commission database and AEA financial data
[222] Alaska Energy Authority. "Bulk Fuel Inventory Assessment Report." 2016.

Bulk Fuel Upgrade funding by AEA energy region
Source: Denali Commission and AEA financial data (2001-2015)

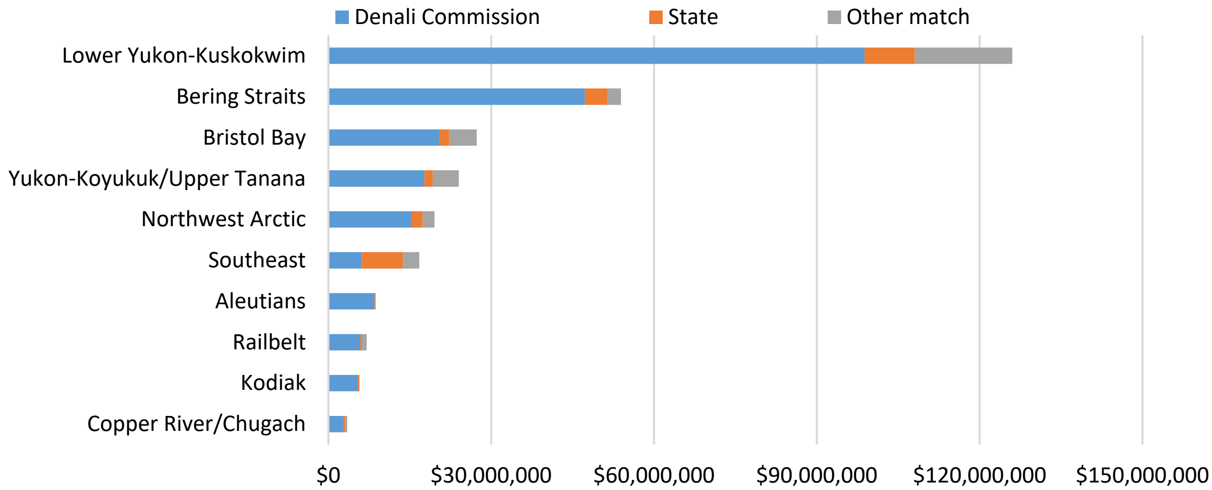


Figure 66: Bulk Fuel Upgrade funding by AEA energy region[223]

Bulk fuel construction projects include a business operating plan, which outlines the existing organizational structure, qualifications of responsible personnel, training opportunities, and estimated operation and maintenance costs.[224] Once a project is complete, there is currently no formal oversight for these facilities to ensure adherence to business plans.

An analysis of data in the Denali Commission database, accessed in summer 2015, showed that recipients of BFU projects represent a wide variety of public and private entities, including school districts, utilities (public, cooperatives, and private), seafood processors, and local fuel distributors (including cities, villages, village corporations, and private stores). BFU funding was used to install 20 million gallons of capacity between 2001 and 2015. Costs of new and/or refurbished storage ranged between $7 and $40 per gallon of capacity.[225]

BFU projects provide multiple benefits, including cost savings, training, and jobs for local workers, greater code compliance and resulting reductions in safety, health, and environmental risks. The focus of the AkAES analysis is on cost savings for communities. The savings from bulk fuel upgrades come from several factors, including:

- lower fuel transportation costs due to increased efficiency in fuel delivery,
- lower unit costs by being able to order more fuel at one time,
- reductions in fines, and
- capital costs for infrastructure that consumers do not have to pay.

[223] Denali Commission database and AEA financial data
[224] AEA Bulk Fuel Upgrade Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[225] Steve Colt and Mark Foster. "True Cost of Electricity in Rural Alaska and True Cost of Bulk Fuel in Rural Alaska." October 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESTrueCostElectricityFuel102616.pdf?ver=2016-10-27-083402-423

Negotiated fuel prices and delivery charges are proprietary, but public data is available to assess the economic benefit to communities from the last source of savings—the reduction in infrastructure costs.

BFU projects are saving AkAES communities an average of $0.43 to $1.76 per gallon on capital costs. Table 13 shows average community savings on bulk fuel infrastructure by region over the lifespan of the facility, expressed as savings per gallon. To calculate the offset capital costs enjoyed by consumers by the grant-funded infrastructure, Table 13 assumes the bulk fuel facility lasts 40 years, is financed through a loan at 5%, there is one delivery per year and all available tankage is sold during the year. These represent significant savings for rural fuel customers, including electric utilities, residential and commercial heating oil consumers, and transportation fuel consumers.

Table 13: Value of bulk fuel upgrades in $/gallon[226]

Region	Minimum equivalent $/gal	Average equivalent $/gal	Maximum equivalent $/gal
Aleutians	$0.32	$0.63	$0.81
Bering Straits	$0.39	$0.78	$1.40
Bristol Bay	$0.43	$0.94	$2.75
Copper River/Chugach	$1.76	$1.76	$1.76
Kodiak	$0.47	$0.69	$0.91
Lower Yukon-Kuskokwim	$0.13	$0.78	$1.81
Northwest Arctic	$0.50	$0.84	$1.44
Railbelt	$0.43	$0.43	$0.43
Southeast	$0.15	$0.93	$1.45
Yukon-Koyukuk/Upper Tanana	$0.50	$1.17	$2.47

The assumption in Table 13 of one fuel inventory turnover per year is not accurate for all communities. A few communities receive fuel by air and the number of turnovers is many times higher. Others receive barge deliveries twice a year—at the beginning and end of the ice-free season. For this reason, the savings shown should be considered an upper limit, as greater throughput will reduce the per gallon savings.

As with RPSU projects, most BFU grant recipients have been required to maintain an account to pay for 40% of the eventual replacement of the infrastructure. If these accounts had been maintained, and the cost of this replacement had been priced into the fuel, there would be still be a savings of 60% of the capital costs to the community. It does not appear that most grant recipients have been saving enough for the eventual replacement of the bulk fuel infrastructure.[227] Although bulk fuel facilities are not economically regulated, similar logic to electric utilities would dictate that current customers should pay for assets that are used and useful and not pre-fund infrastructure for future consumers.

[226] AEA analysis of Denali Commission database
[227] Denali Commission. "Analysis of R&R Accounts as Highlighted in the FY2012 Second Half Semi-Annual Report to Congress." June 2013.

The savings in bulk fuel capital costs also results in electricity savings. Each $0.50/gallon in the price of diesel translates into approximately $0.04/kWh in electricity rates, so any reductions in a utility's fuel costs can be expected to result in a smaller but real reduction in electricity costs for consumers and increased savings to the State through reduced PCE expenditure. In a study commissioned for the AkAES, it was estimated that one-third of new BFU fuel capacity was for fuels used in electric generation.[228]

As with powerhouse replacements, the State does not have a statutory or regulatory requirement to replace tank farms when they have reached the end of their useful life, though unsafe infrastructure poses health, safety, and environmental risks that the State has an interest in mitigating.

Renewable Energy Fund

The Alaska Renewable Energy Fund (REF) provides benefits to Alaskans by assisting communities across the state to reduce and stabilize the cost of energy through the appropriate integration of cost-effective renewable energy for power or heat.

The Alaska Legislature created the Renewable Energy Fund in 2008, with the intent to appropriate $50 million annually for five years.[229] The REF was part of a suite of programs, including the Home Energy Rebate program and the rapid increase in Weatherization funding, developed or expanded in 2008 in response to historically high oil prices. In 2012, the Legislature extended the program for an additional 10 years.

In 2008, global oil prices were at a record high and the State enjoyed increased revenues from royalties paid by oil and gas producers. These record-breaking energy prices were at the same time causing rural consumers considerable burden. These two factors combined to raise awareness of the problem while providing the resolve and means to find a solution. The REF, created to incentivize renewable energy production, was a key part of the solution.

To date, the program has leveraged hundreds of millions in non-state contributions for $257 million in State appropriations. State funding peaked in the first year of the REF program at $100 million. Since then REF funding has ranged from $5 million to $25 million per year, and received no funding in FY16, as shown in Figure 67.[230] The chart does not include direct legislative appropriations for renewable energy projects—those that did not go through the formal project application and vetting process. Several REF projects have received additional direct support from the Legislature, including $47 million for Sitka's Blue Lake hydroelectric expansion and $12 million for the Railbelt's Eva Creek wind project.

[228] Steve Colt and Mark Foster. "True Cost of Electricity in Rural Alaska and True Cost of Bulk Fuel in Rural Alaska." October 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESTrueCostElectricityFuel102616.pdf?ver=2016-10-27-083402-423

[229] Chapter 31 SLA 08 House Bill 152,
http://www.akenergyauthority.org/Content/Programs/RenewableEnergyFund/Documents/Chapter31_SLA08_HB152.pdf

[230] AEA Renewable Energy Fund Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications

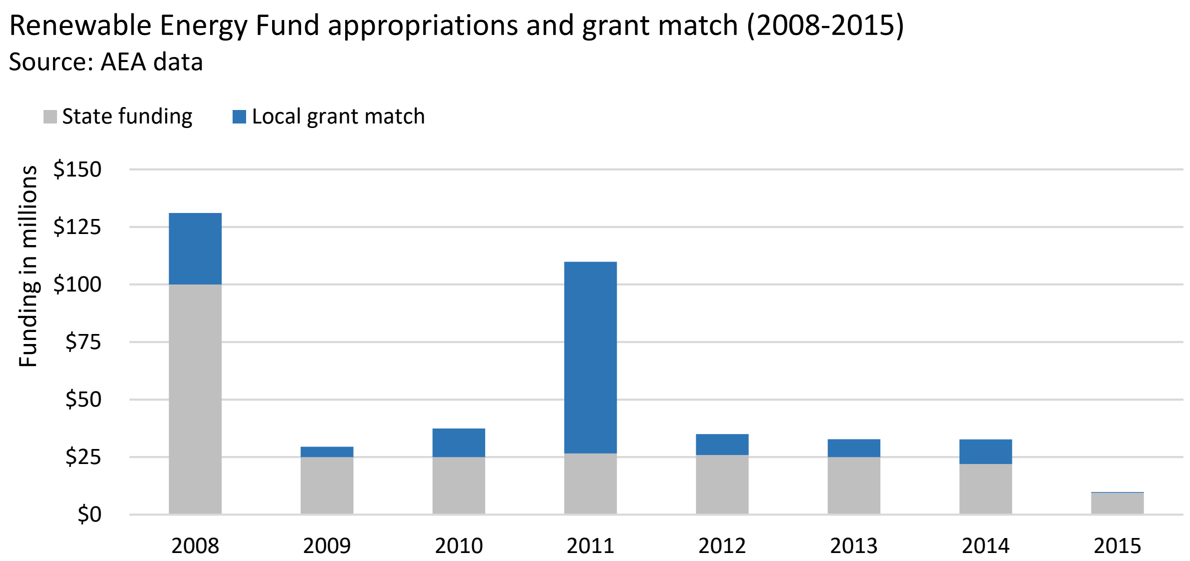


Figure 67: Renewable Energy Fund appropriations and match (2008-2015)[231]

The REF application review process has mechanisms, including preferential selection criteria for higher energy costs communities and regional spreading, to help ensure that the benefits of the REF are not concentrated in urban Alaska. The program has been successful in providing grant funds to communities off the Railbelt, as 89% of REF grant funds have accrued to communities in the AkAES study area.

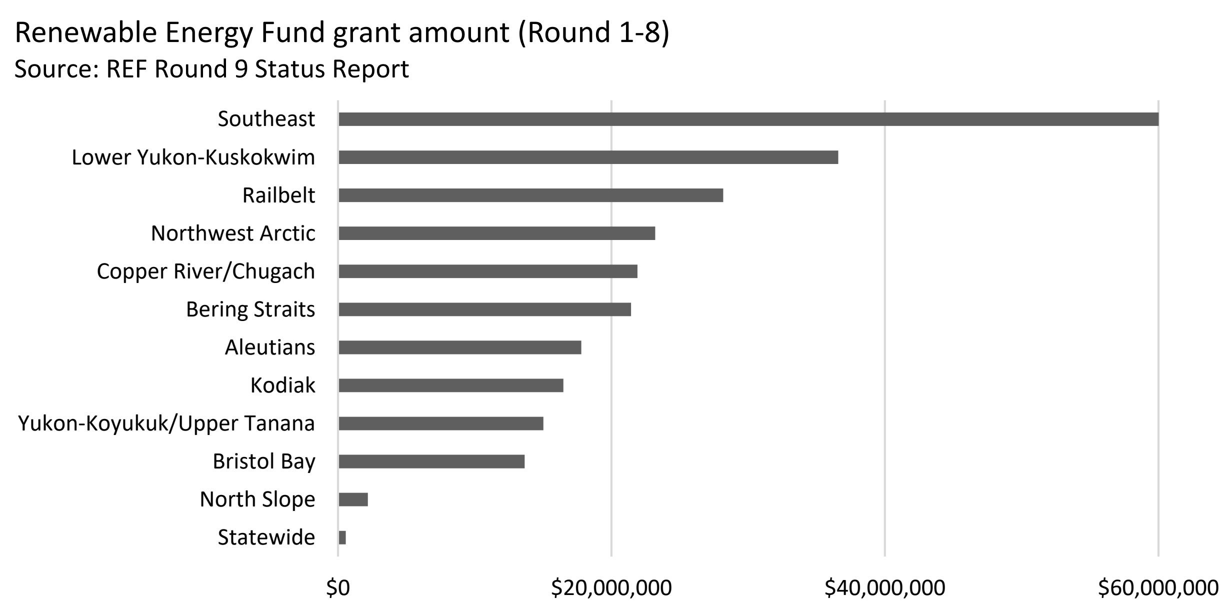


Figure 68: Renewable Energy Fund grants by AEA energy region

[231] Alaska Energy Authority. "Renewable Energy Fund Round Status Report and Round IX Recommendations." May 2016. http://www.akenergyauthority.org/Portals/0/Programs/RenewableEnergyFund/Documents/REFRound9StatusRptPrintSpreads.pdf

The REF program has been successful in increasing renewable energy use in Alaska and decreasing the amount of fossil fuels used for heat and electricity. This is best seen in Kodiak, where two large REF projects (a third turbine for the Terror Lake hydro project and the 9-MW Pillar Mountain wind project) have allowed the local utility to generate almost solely with renewable energy.

The primary contribution of the REF program to energy affordability comes from replacing imported diesel and heating oil with cheaper alternative fuels and resources. This is usually expressed as the number of gallons of diesel equivalent displaced by a project and the project's cost savings represents the value of that displaced fuel at current prices.

In 2015, over 27.8 million gallons of diesel equivalent were displaced, for an annual savings of $73.7 million.[232] Wind projects—particularly the large multi-MW installations in Kodiak and Fairbanks—have been the major source of fuel savings for the REF program to date, although hydro surpassed wind in 2015. The Anchorage Landfill Waste to Energy project has also contributed a significant portion to fuel displacement; this appears in the chart as biofuel. The fact that prior investments in wind feasibility studies had led to "shovel-read" construction projects was the likely reason for the early primacy of wind.[233] The absolute and relative contributions to fuel displacement from REF hydro projects is expected to increase as several more hydro projects are brought on-line.

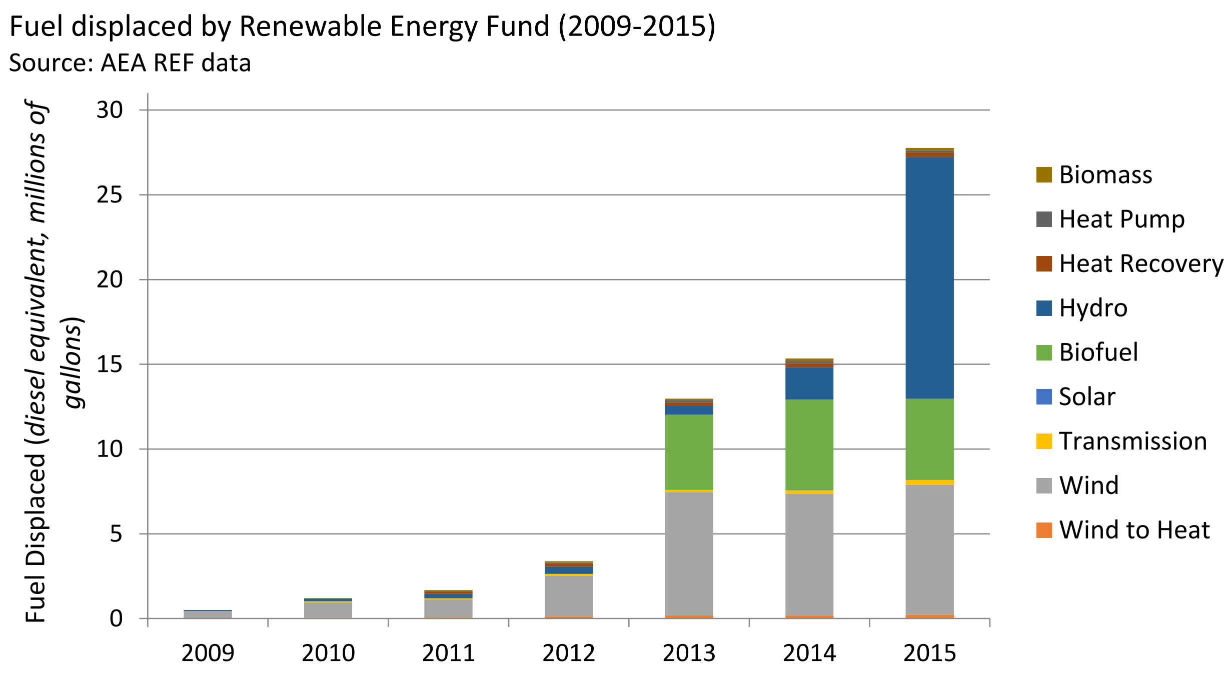


Figure 69: Fuel displaced by REF projects (2009-2015)[234]

---

232 Alaska Energy Authority, 2016.

233 Vermont Energy Investment Corporation. Renewable Energy Grant Recommendation Program Impact Evaluation. 2012. https://www.veic.org/documents/default-source/resources/reports/veic-alaska-energy-authority-rgrp-impact-and-process-evaluation-report.pdf?sfvrsn=2

234 Alaska Energy Authority. "Renewable Energy Fund Round Status Report and Round IX Recommendations." May 2016. http://www.akenergyauthority.org/Portals/0/Programs/RenewableEnergyFund/Documents/REFRound9StatusRptPrintSpreads.pdf

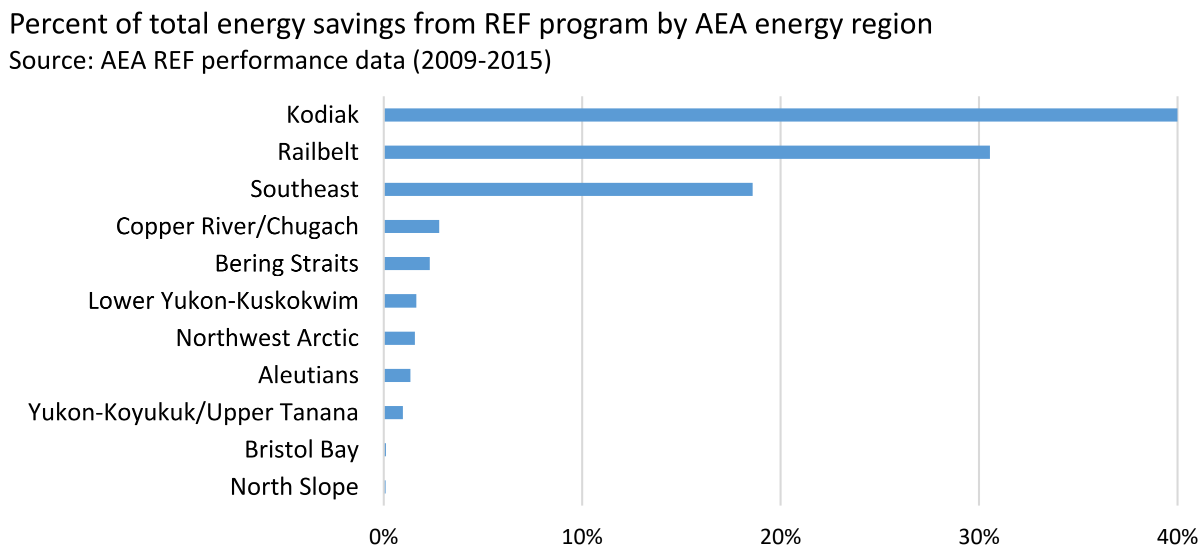


Figure 70: Percent of total energy savings from REF program by AEA energy region[235]

The majority of REF project savings are in regions and communities that are not eligible for PCE, as shown in Figure 70. The three most heavily populated regions (Kodiak, Railbelt, Southeast), which collectively comprise almost 90% of the state's population, have captured nearly 90% of REF savings. Because of the larger size of these energy markets, projects are on a larger scale than the more remote regions of the AkAES study area.

In 2012, a third party conducted a process and impact evaluation of the REF program. The process evaluation provides valuable insights into how any energy program in Alaska could be administered more efficiently and effectively for participants and the State:

1. Provide for more project differentiation in the selection process by creating separate tracks to lessen competition between large and small communities.
2. Provide for more coordinated and directed development of renewable energy projects, and rely less on the open market to service communities with less capacity.
3. Provide for differentiation of financial and technical support to meet market needs and more effectively leverage State resources. Larger communities and utilities may not need grants and technical assistance. These communities may be better served through direct loans and/or loan guarantees. Other smaller may need greater technical, managerial, and financial assistance.[236]

Emerging Energy Technology Fund

The Emerging Energy Technology Fund (EETF) was created by the Alaska State Legislature in 2010 through AS 42.45.375 to promote the expansion of energy sources available to Alaskans. Administered by AEA, the EETF funds projects that test emerging energy technologies or methods of conserving energy, improve an

[235] AEA analysis of REF performance data
[236] Vermont Energy Investment Corporation. Renewable Energy Grant Recommendation Program Process Evaluation. 2012. https://www.veic.org/documents/default-source/resources/reports/veic-alaska-energy-authority-rgrp-impact-and-process-evaluation-report.pdf?sfvrsn=2

existing technology, or deploy an existing technology that has not previously been demonstrated in the state. EETF grants must be used to demonstrate technologies that have a reasonable expectation of becoming commercially viable within five years. Eligible types of energy technologies include improvements to renewables, conservation of energy, and technologies enabling the efficient and effective use of hydrocarbons.[237]

Since 2012, a combination of legislative appropriations and contributions from the Denali Commission have resulted in grant awards totaling $11.3 million, which leveraged an additional $4.8 million in committed match, as shown in Table 14.

Table 14: Emerging Energy Technology Fund appropriations by year and source[238]

	State	Federal (Denali Commission or Dept. of Energy)
2012	$4,800,000	$4,800,000
2014	$2,000,000	
2017		$250,000

The EETF has tested and advanced several technologies to date to determine their economic and technical feasibility in Alaska. The grants are intended to test technologies that are expected to be commercially viable within five years. It may be some time before we know which technologies will prove out in Alaska, and under what conditions, in order to increase the range of economical energy solutions. This is true even for technologies receiving funding in Round 1 of the EETF, which should be nearing commercialization.

No formal program evaluation of the EETF has been commissioned. Since its inception in 2010, the EETF has tested and, in some cases, advanced technologies in several areas: hydrokinetic devices, energy storage devices, the use of exhaust thimbles (sleeves that increase the energy efficiency of a furnace/boiler at its ceiling penetration), and biomass reforestation techniques to improve the sustainability of wood energy systems in Alaska.[239]

Round 3 of the EETF, in 2016, focused on microgrid and microgrid-enabling technologies based on the input of Alaska energy stakeholders about where the program could have the greatest impact. Round 3 funding came from Round 1 and 2 funds, that were returned to the EETF, and an additional $250,000 from the Department of Energy was granted to AEA.[240]

[237] 3 AAC 107.700-799
[238] AEA Emerging Energy Technology Fund Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[239] Alaska Energy Authority. "Emerging Energy Technology Fund Project Status Updates. February 2016." http://www.akenergyauthority.org/Portals/0/Programs/EETF/Documents/EETFProjectUpdatesFeb2016.pdf?ver=2016-03-23-095100-640
[240] AEA Emerging Energy Technology Fund Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications

Weatherization Assistance program

Weatherization Assistance program (Wx) is a long-standing federal program of the Department of Energy to assist low-income households (both homeowners and renters) in reducing their energy costs. State and federal programs also require that Wx address imminent health and safety issues.[241] In 2008, the Alaska Legislature increased funding for the program sharply and expanded income eligibility to include households earning up to 100 percent of Area Median Income (AMI).[242]

Since 2008, Wx has been primarily funded through the State of Alaska's capital budget. Prior to 2008, Wx funding was steady and split nearly equally between State and federal sources. In 2008, the State funding level increased by nearly one hundredfold, from approximately $3 million to $200 million. The significant increase challenged existing organizational structures and capacity to deploy weatherization services, so it took the program time to ramp up activity. In 2012, the Legislature appropriated an additional $62.5 million for the program, and funding has declined in each year since 2012. Between the 2008 and September 2015, a total of $323.4 million in State funding was spent on Wx services.

Weatherization Assistance program funding by source (2000-2016)
Source: AHFC

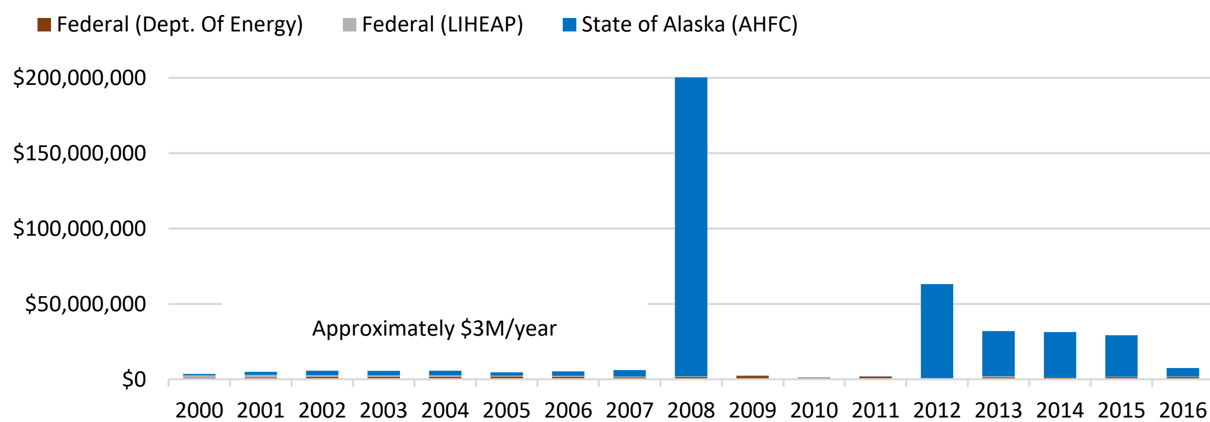


Figure 71: Weatherization funding by source (2000-2016)[243]

Since 2008, more than 20,000 housing units statewide have been made more energy efficient through the Weatherization program, primarily through State funds, saving participating households 20 to 45% annuallly on their energy costs. Approximately 47% of the retrofits were in the AkAES study area. The number of units weatherized per energy region and the total costs savings by region are shown in Figures 72 and 73 respectively. Since eligibility is based on income, some of the regional differences may reflect the percentage of households that meet the income guidelines.

The funding available per household is determined by community and region. Homes in the Railbelt or along the Marine Highway system receive an average of up to $11,000 per home in energy, health, and

[241] Cold Climate Housing Research Center. "Weatherization Assistance Program Outcomes." August 6, 2012. http://www.cchrc.org/sites/default/files/docs/WX_final.pdf

[242] FY 2016 Income Limits for Alaska. April 2016. https://www.ahfc.us/files/1114/7198/9173/Alaska_Income_Limits_-_FY_2016_with_Median_Incomes-FINAL.pdf

[243] AHFC data on Weatherization Assistance Program funding (Updated 10/5/16)

safety measures, while homes in remote rural areas of the state may receive up to an average $30,000 per home of Enhanced Weatherization services.[244]

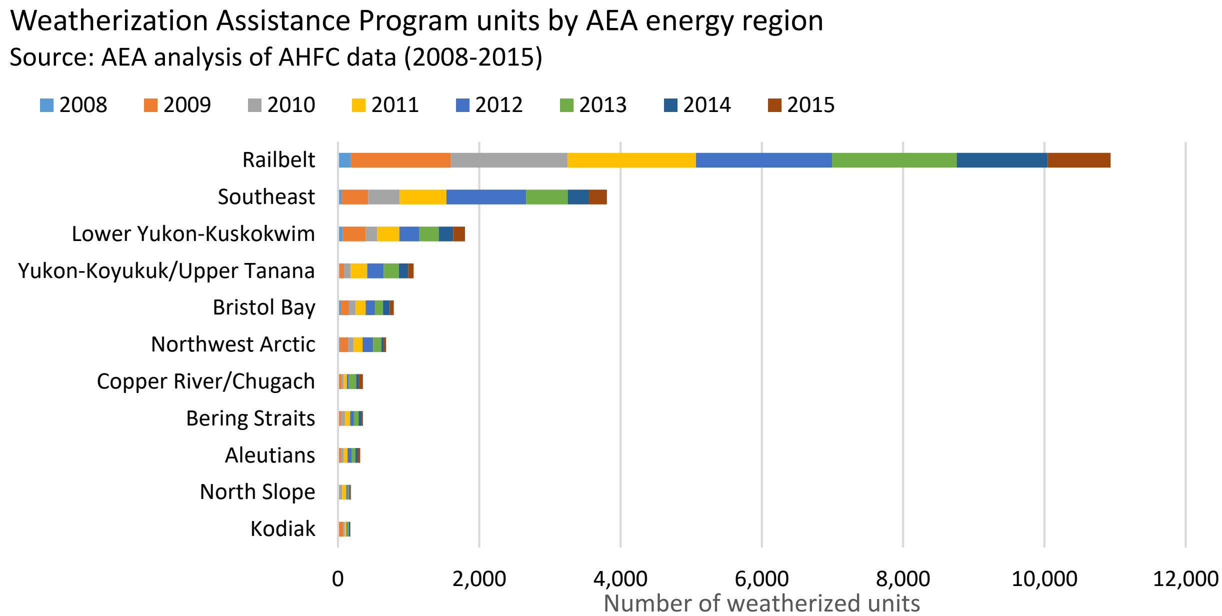


Figure 72: Weatherization Program units by AEA energy region[245]

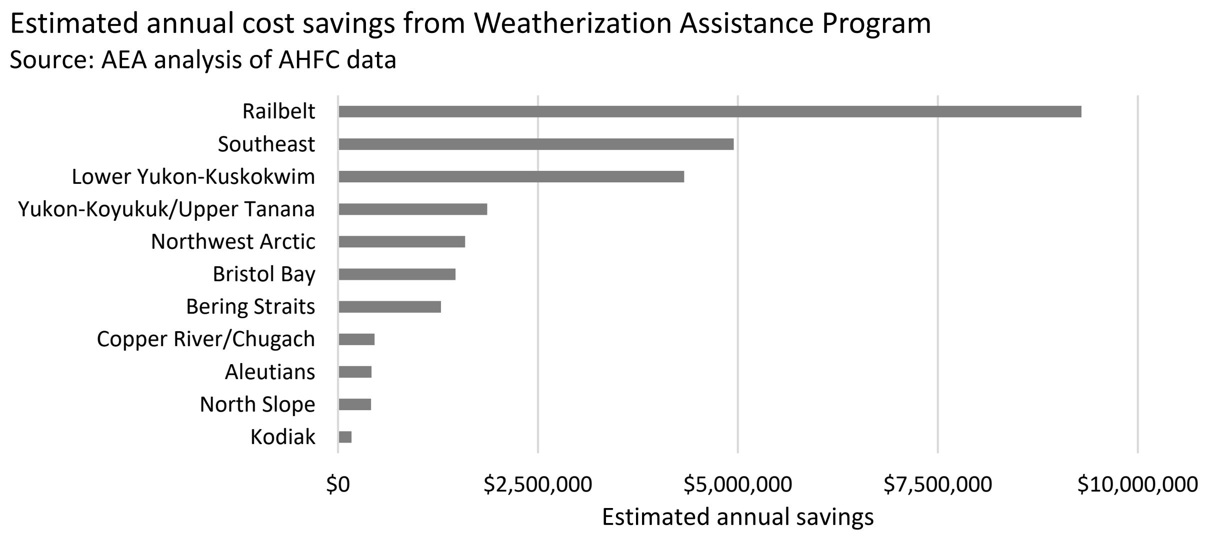


Figure 73: Weatherization program total estimated annual energy cost savings by AEA energy region[246]

While most of the savings have occurred in Railbelt communities due to the greater number of weatherized units, the higher energy costs in other regions increased their per-unit savings.

---

[244] Vermont Energy Investment Corporation. “Energy Efficiency Program Evaluation and Financing Needs Assessment.” July 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

[245] AEA analysis of AHFC Weatherization Assistance Program data (accessed December 2016).

[246] AEA extrapolations of 2012 AHFC Wx energy savings data based on 2016 Wx completions.

The percentage of household savings in heating fuels show some regional differences as well, with modeled savings ranging from 20% to 45%. Kodiak had the lowest average savings and the rural Interior (Yukon-Koyukuk/Upper Tanana) had the highest. In general, regions with higher heating oil costs and colder climates realize more savings. Although there are a number of determinants for how much savings a Wx project produces, the initial condition of the housing is a huge factor: lower quality housing has much higher savings potential.

The success of Wx in rural Alaska is likely due to the activities of regional housing authorities, many of which would walk door to door in communities to sign up eligible applicants.[247] In some communities, this led to all residential buildings being served by Wx.

In 2012, AHFC commissioned the Cold Climate Housing Research Center (CCHRC) to do an impact evaluation of the Weatherization program. CCHRC found that the Weatherization program was generally performing as expected and did not note any significant gaps or barriers in program delivery.[248]

Home Energy Rebate program

In 2008, AHFC initiated the Home Energy Rebate (HER) program. The HER Program, funded through the State capital budget, provided homeowners a rebate of up to $10,000 in materials and contracted labor for making pre-approved energy efficiency improvements.[249] The State's investment in the program was intended to make homes more energy efficient while stimulating private investment in home retrofits and reducing energy costs.[250] Program participation was limited to year-round residents who occupied their home; there were no income limits and no match requirements. The program was suspended in 2016 for lack of funding.

Participants received an initial home energy audit including a ranked list of cost-effective measures for increasing the efficiency of the house. Health and safety improvements related to energy use, such as ensuring adequate ventilation, were also included, and generally reimbursable. The homeowner was responsible for choosing and implementing any or all the energy efficiency improvements listed in the energy audit. The time allowed after the initial energy rating to complete all improvements, receive a post-improvement rating, and submit final paperwork and receipts was 18 months.

The rebate amount was based on the improvement in the home's energy efficiency and the submittal of eligible receipts. In addition to the energy improvements, homeowners were reimbursed up to $500 for the initial and post energy rating.[251] Program participants were not required to submit all receipts for work completed, only receipts totaling up to the allowed reimbursement.

---

[247] Scott Waterman, personal communication. December 2016.
[248] Cold Climate Housing Research Center. "Weatherization Assistance Program Outcomes." August 6, 2012. http://www.cchrc.org/sites/default/files/docs/WX_final.pdf
[249] https://www.ahfc.us/efficiency/energy-programs/home-energy-rebate/
[250] Cold Climate Housing Research Center. Home Energy Rebate Program Outcomes. 6/26/2012. http://www.cchrc.org/docs/reports/HERP_final.pdf
[251] https://www.ahfc.us/files/6114/1295/9895/Consumer_Guidelines_100114.pdf

After high initial participation, when a long waitlist formed, the demand for new HER audits gradually slowed. AHFC did not advertise the program, but the program still averaged over $20 million in rebates per year.

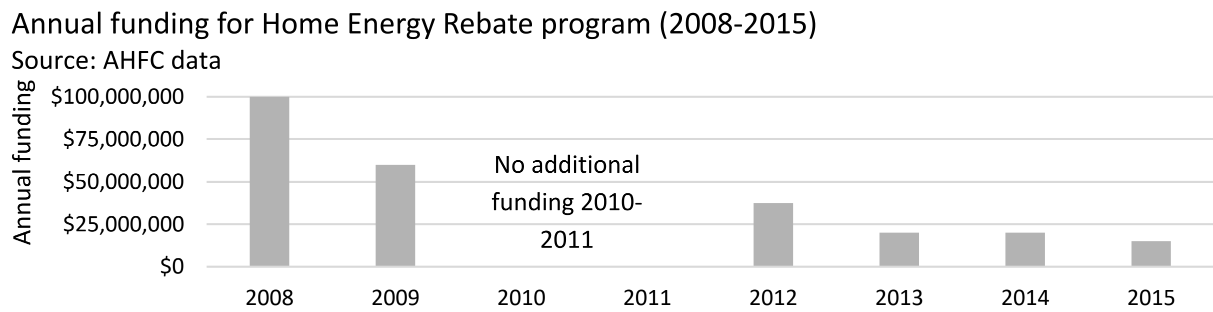


Figure 74: Annual funding for Home Energy Rebate program (2008-2015)[252]

From the program's inception through October 2015, the state invested a total of $204.6 million, resulting in 23,980 completed retrofits and leveraging over $120 million in homeowner investments.[253]

The overwhelming majority of HER rebates went to homeowners in the Railbelt, only 14% of HER funding was within the AkAES study area, primarily in the four largest cities in the Southeast.[254] Figure 75 breaks out estimated HER rebates by energy region. Since regional rebate data was not available, AEA approximated regional spending by dividing total State funding by the number of rebates per region.

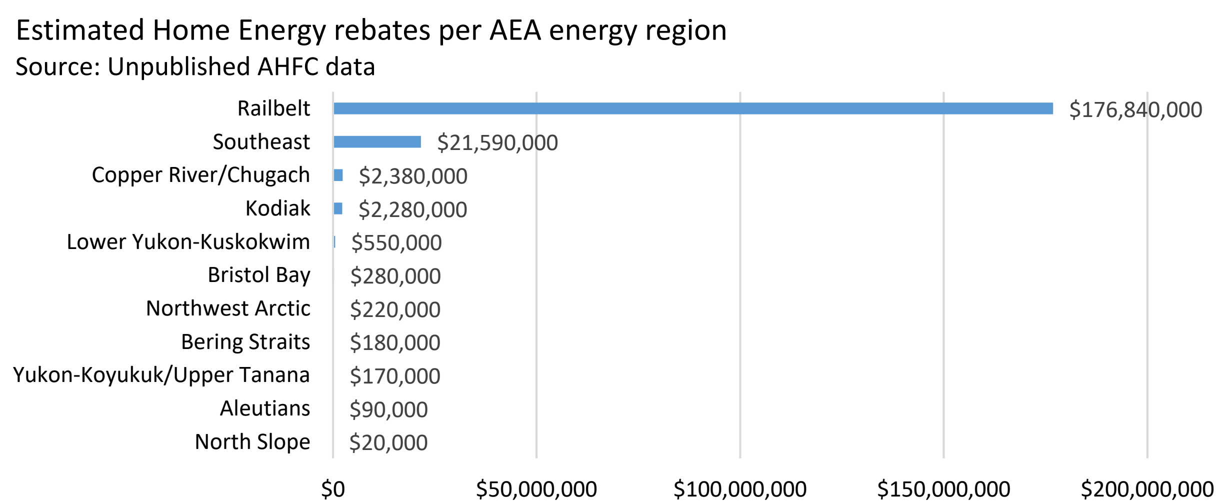


Figure 75: Estimated Home Energy Rebates disbursed per AEA energy region[255]

---

[252] AHFC data on Home Energy Rebate Program funding (Updated 10/5/16).
[253] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107
[254] AEA analysis of Home Energy Rebate data provided by AHFC (December 2016).
[255] AEA extrapolations of 2012 AHFC per household savings based on unpublished 2016 AHFC data on rebates.

Rural residents in the AkAES study area had lower participation and completion rates than urban Alaskans. Approximately two-thirds of all HER applicants completed their post-rating and paperwork to receive a rebate, but in rural areas of the state, the completion rate was between 32% and 54%.[256]

A 2013 online survey of 574 program participants found that the demographics of participants were not representative of Alaska as a whole; HER participants had higher average incomes and significantly higher education levels than statewide averages.[257] A number of barriers likely led to the lower number of households in the AkAES study area participating in the program:

- The rate of home ownership is lower in rural than urban Alaska making fewer rural residents eligible for the program.[258]
- Since the program is based on rebates, it required homeowners to have sufficient cash or credit to pay for upfront costs and wait for reimbursement, which lower income households are less able to do. 46% of respondents to the survey stated that lack of money was the reason they had not completed the program.[259]
- Outside urban centers, poor access to materials and labor, including qualified energy raters, made it more difficult for homeowners to make needed improvements to their houses.
- The amount of funding allotted for Enhanced Weatherization services in rural Alaska (three times as much as for communities on the road system) indicates a significantly higher cost to make home improvements in rural locations. The HER program did not adjust maximum reimbursement amounts for remote locations—reimbursement amounts seemed more appropriate for expenses incurred in urban areas of the state. Therefore, it would appear that the HER program offered an insufficient amount for rural participants to cover the higher costs for improving the efficiency of their houses.

AEA estimated the annual savings per region shown in Figure 76 based on the number of homes retrofitted in each region and the average savings per household of 34%, as calculated by AHFC in 2012. Since most of the rebates were disbursed to the Railbelt region, which has 78% of the state's population, it is not surprising that most of the annual savings were also captured by that region. AEA estimates that HER retrofits are saving residents of the AkAES study area nearly $7.3 million per year, less than $1.1 million of that is in more rural parts of the region (outside the city of Kodiak and the larger Southeast cities).

---

[256] Cold Climate Housing Research Center. Home Energy Rebate Program Outcomes. 6/26/2012. http://www.cchrc.org/docs/reports/HERP_final.pdf

[257] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

[258] Jack Cannon. "Housing Trends." Alaska Department of Labor and Workforce Development. 2004. http://laborstats.alaska.gov/trends/jun04art2.pdf

[259] Cold Climate Housing Research Center. Home Energy Rebate Program Outcomes. 6/26/2012. http://www.cchrc.org/docs/reports/HERP_final.pdf

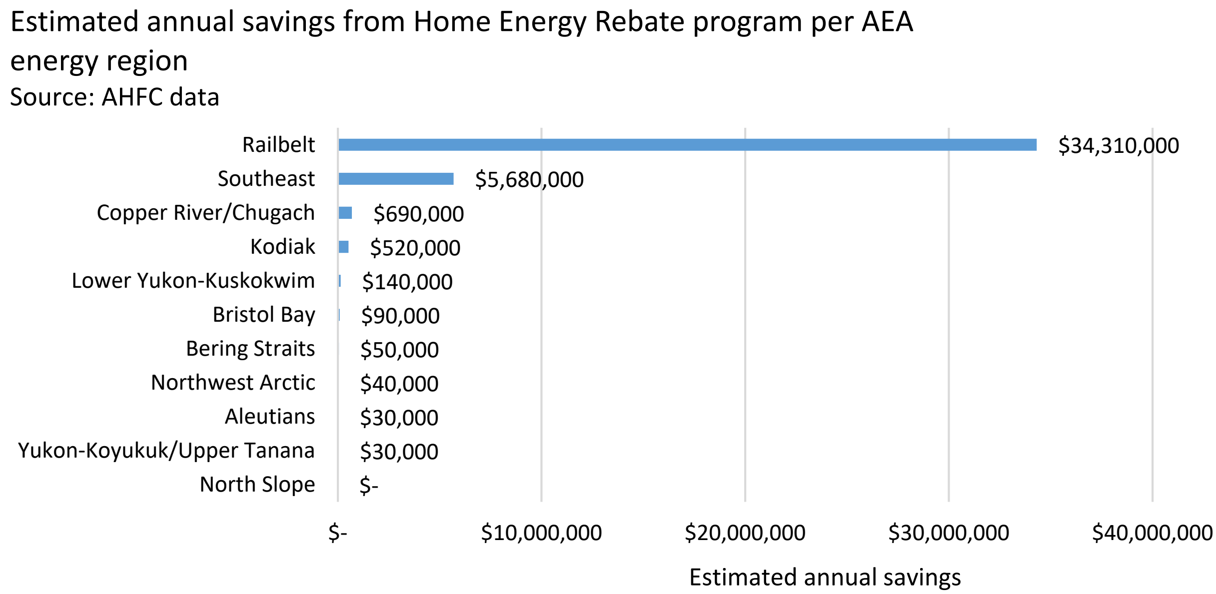


Figure 76: Annual energy cost savings for Home Energy Rebate program[260]

Participation in the HER program does not mean all cost-effective efficiency measures were performed, since the number of measures completed was limited by the time, money, and effort the homeowner could afford. AHFC does not know what the average homeowner investment was in the HER program, because participants were not required to submit all receipts, only those up to the maximum allowable reimbursement based on the home's improved energy rating. Table 15 summarizes the estimated average costs and returns of the HER program. The average homeowner costs are based on submitted receipts. AHFC costs only include the reimbursement, and do not include program administration. The simple payback and return on investment are calculated based on the modeled energy savings and current costs at the time of the rating.

Table 15: Home Energy Rebate program cost-effectiveness[261]

	Average costs (2012 $)	Simple payback (years)	Return on investment
AHFC	$6,516	5.0	20%
Homeowner	$4,447	3.4	29%
Total	$10,963	8.5	12%

Other research indicates that additional savings may be unaccounted for through this analysis. As a result of the Home Energy Rebate program, Chugach Electric found a 2% reduction in electricity consumption,

[260] AEA analysis of AHFC data
[261] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

which is surprising since the HER program does not directly address measures to reduce electricity consumption.[262]

While the average total cost (homeowner plus State) of approximately $11,000 per housing unit is about half as much as what was reported for the Weatherization program, this does not mean that Weatherization is less cost-efficient than the HER. Since Weatherization assisted many more rural areas where logistics make it more expensive to work, it is expected to cost more to retrofit a house than through the HER program, which primarily served Alaska's major urban areas where labor and materials are both more available and much less expensive. Additionally, costs for the Weatherization program are actual totals, while for the HER program costs are those reported by participants and may underestimate total investment.

New Home Rebate program

The New Home Rebate program, administered by AHFC, provided an incentive for reaching a high standard of residential efficiency. Funded initially in conjunction with the Home Energy Rebate program, the New Home Rebate program began in 2008 and paid out $7,500 rebates for new homes that received an energy rating of 5 Star Plus using the AkWarm modeling software. When the Building Energy Efficiency Standard (BEES) was updated in 2013, the New Home Rebate incentive was modified so that buyers of a Five Star Plus home could qualify for a rebate of $7,000, and buyers of the newly added stretch goal of Six Star could qualify for a $10,000 rebate. The amount of the Six Star home rebate was informed by an economic analysis of the additional costs required to increase the energy efficiency of a home from the minimum BEES standard, Five Star, to a Six Star rating. The New Home Rebate is paid directly to the buyer; builders have suggested that more homes would be built to these standards if the rebate was made available to them as well.[263]

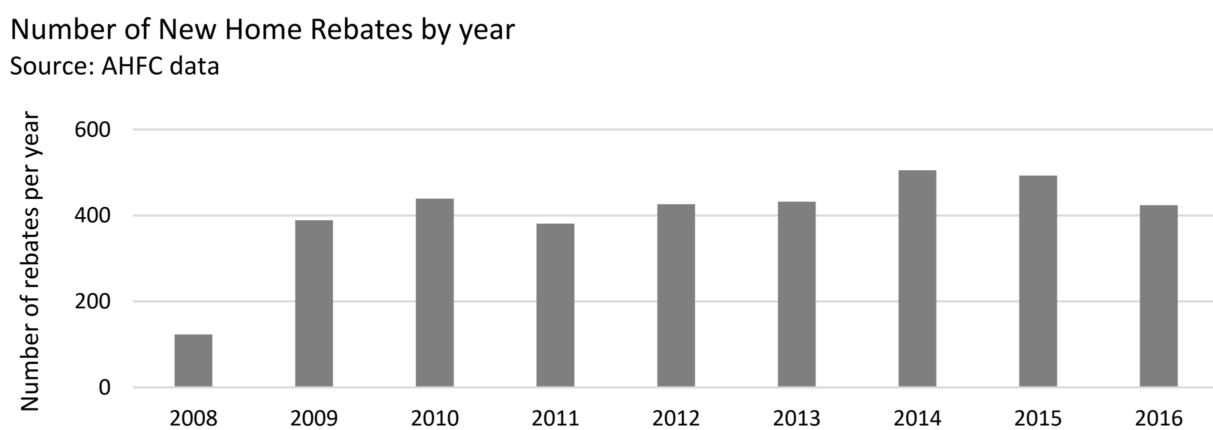


Figure 77: Houses accessing New Home Rebate program 2008-2016[264]

[262] Northern Economics. "The AHFC Home Energy Rebate Program and Electric Consumption by Chugach's Residential Customers." May 2013.
[263] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107
[264] AHFC data on New Home Energy Rebate Program funding (Updated 10/5/16)

Between the inception of the New Home Rebate program in 2008 and November 2015, AHFC paid out over 3,000 Five Star Plus rebates and 139 Six Star rebates, for a total estimated State cost of $22 million.[265] Figure 76 shows the demand for New Home Rebates has been fairly consistent since 2009 with approximately 400 rebates disbursed each year.

Figure 77 shows that there have been few New Home Rebate participants in the AkAES study area. Nearly all rebates have gone to home buyers in the Railbelt. Outside of urban centers, most housing is built through regional housing authorities, which do not receive the rebate, although they are eligible for the Supplemental Housing Development grant. The distribution of rebates also mirrors the concentration of new construction, which has been focused in the Mat-Su area in the period the program has been active.[266]

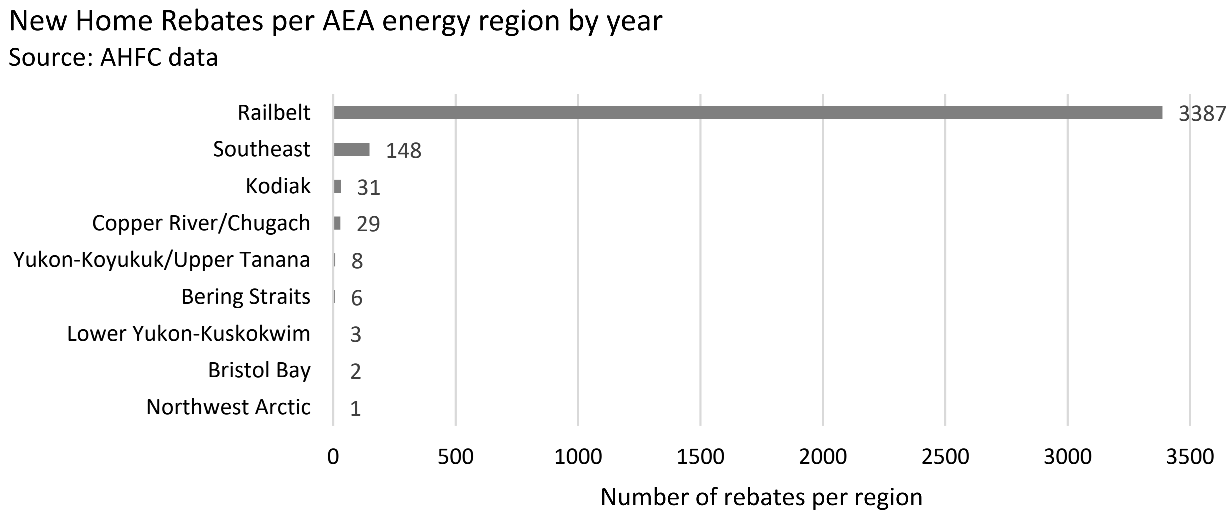


Figure 78: New Home Rebates per AEA energy region[267]

Calculating the benefits of the New Home Rebate program is complicated. A primary difficulty is accounting for so-called free riders, homes that would have been built to the Five Star Plus or Six Star standard even if the homeowner/builder had not been offered a rebate. Since Alaska does not have a statewide residential building energy code, it is difficult to know what to use as a baseline.

Village Energy Efficiency Program

The goal of the Village Energy Efficiency Program (VEEP), managed by AEA, is to implement energy- and cost-saving efficiency measures in community buildings and other facilities in small Alaska communities. Contractors work with individual communities and school districts to determine the best energy-saving measures within the budgeted grant to the community.

[265] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

[266] Karinne Wiebold. "Alaska's Housing Market: Characteristics, affordability, and what makes us unique." Alaska Department of Labor and Workforce Development. 2014. http://laborstats.alaska.gov/trends/apr14art1.pdf

[267] AHFC data on New Home Energy Rebate Program funding (Updated 10/5/16)

The VEEP program began as the Village End Use Efficiency Measures (VEUEM) Program in 2005 with funding from the Denali Commission. Measures implemented under this program were primarily lighting upgrades and some weatherization. Between 2005 and 2009, 51 communities benefited from the program. Between 2010 and 2012, the federal American Recovery and Reinvestment Act (ARRA) funded energy efficiency improvement projects in an additional 110 communities and small boroughs through both the Small Cities Energy Efficiency Community Block Grants (EECBG) and VEEP programs. VEEP in particular used the VEUEM model but increased the funding per community to accomplish a greater number of, and deeper, building efficiency improvements.[268]

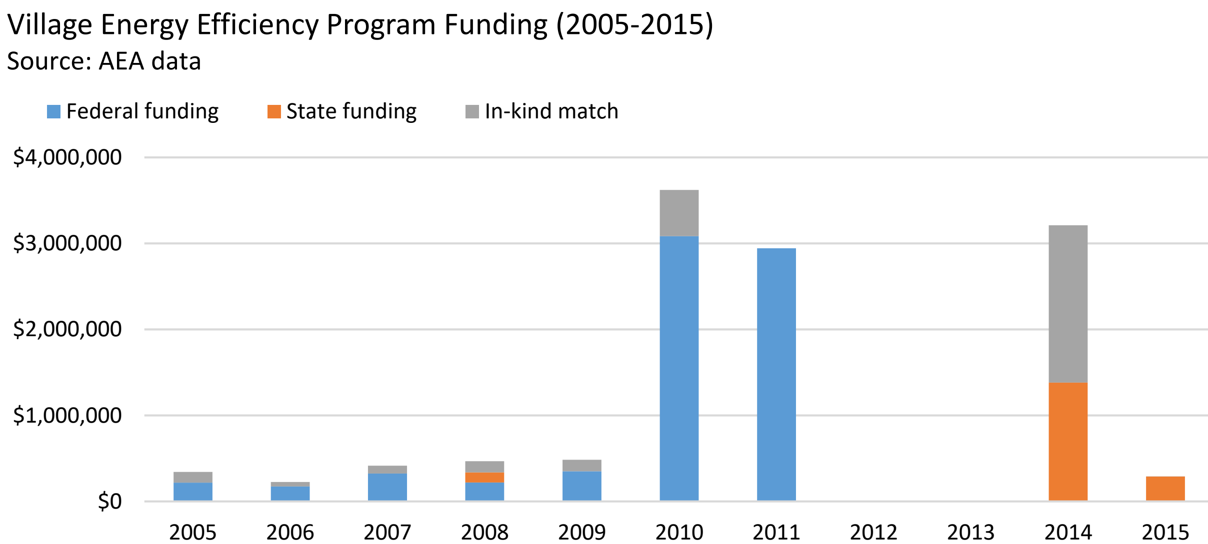


Figure 79: Village Energy Efficiency Program Funding (2005-2015)[269]

Communities with a population of less than 8,000 residents are eligible for VEEP funding, which is awarded competitively after each open application period. The FY14, state-funded VEEP program awarded a total of approximately $1.4 million to seven communities for energy- and cost-saving efficiency projects.[270] Despite the program's demonstrated success and strong support from communities and regions, no legislative appropriations have been made since FY14.

268 http://www.akenergyauthority.org/Efficiency/veep
269 AEA analysis of data from Village Energy Efficiency Program (compiled 2015)
270 http://www.akenergyauthority.org/Efficiency/veep

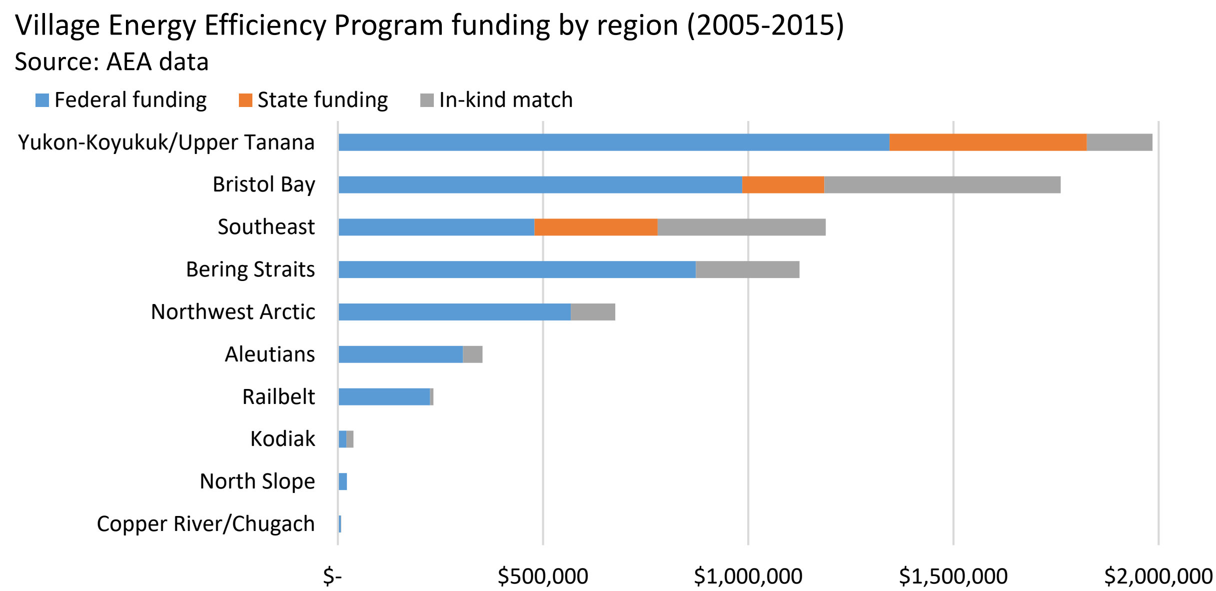


Figure 80: VEEP funding by region (2005-2015)[271]

Primarily funded through federal sources through 2011 and State appropriation in 2014-15, VEEP has also been successful in leveraging cash and in-kind matches. The program has generally benefitted the regions with the highest energy costs and the AkAES study area in general, as seen in Figure 79.

Outcomes for the VEEP program were reported at the community level between 2005 and 2010. The program has aggregate data for ARRA-funded retrofits performed by the Alaska Building Science Network (ABSN) between 2010 and 2012 (roughly half of all retrofits done over that period). The aggregate data show that, on average, ABSN retrofits achieved a simple payback period of 5.4 years, taking into consideration local in-kind contributions of labor and materials.[272] These outcomes are summarized by energy region in Figure 80 with modeled electricity savings converted to gallons of diesel equivalent saved, based on an assumed generation efficiency of 13 kWh/gallon. The VEEP projects saved approximately 178,000 gallons of heating oil and 88,000 gallons of diesel for electric generation.

[271] AEA analysis of data from Village Energy Efficiency Program (compiled 2015)

[272] Vermont Energy Investment Corporation. “Energy Efficiency Program Evaluation and Financing Needs Assessment.” July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

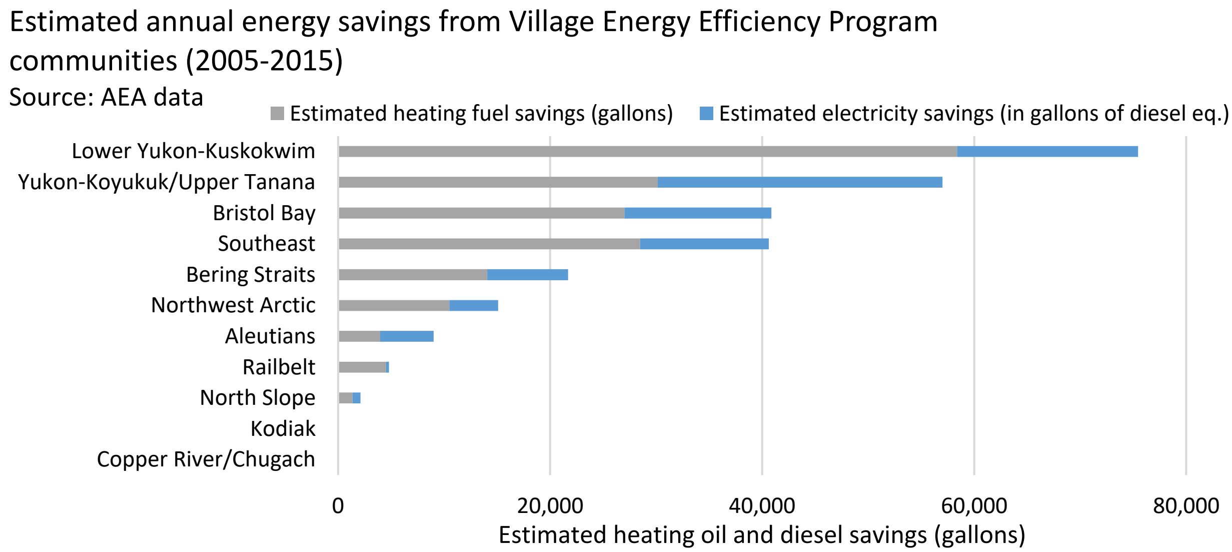


Figure 81: Estimated annual savings from VEEP communities (2005-2015)[273]

An analysis of 40 VEEP energy audits that used AkWarm modeling software from several different phases of the program shows that, on average, energy used for space heating was reduced by 28%. While reported data in Figure 80 show that the savings in heating fuel is significantly greater than for electricity, electrical savings may be significantly underrepresented in the data due to recording errors in the early years of the program, particularly for Kodiak and Copper River/Chugach. The ABSN report found that electricity savings were approximately 44% of total savings from the buildings retrofitted in their projects.[274]

VEEP illustrates one of the main difficulties in evaluating the effectiveness of State and federal energy programs: energy data collection is not a priority for many program participants, and significant barriers exist to gaining access to consumption records, particularly heating fuel data. AEA sent a team to Nightmute in 2014 to follow-up on the city's 2009 VEEP project. A number of buildings were re-audited and the community's heating oil records were located and copied, however there was still not enough data of sufficient quality to quantify the benefits of the retrofits with a high degree of certainty. This does not mean that benefits didn't exist, but rather that there were not good baseline and post-retrofit records to demonstrate the change in consumption. The team also looked at PCE data to determine changes in electricity consumption following the project, but there was too much year-to-year volatility in the data to isolate a direct effect.[275] The Denali Commission commissioned a study to evaluate a VEEP project in Shishmaref which reported similar issues with the availability of data.[276]

---

[273] AEA analysis of data from Village Energy Efficiency Program (compiled 2015)
[274] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107
[275] Katie Conway. "Nightmute Whole Village Retrofit—then and now." Alaska Energy Authority. January 15, 2015.
http://www.akenergyauthority.org/Content/Efficiency/Veep/Documents/NightmuteWVR20082014FINAL11515.docx
[276] Armstrong, Richard." Measurement and Verification Review of 2010/2011 VEEP & EECBG Energy Efficiency Retrofits" December 17, 2013.

State energy subsidy programs

The two primary state energy subsidy programs are the Power Cost Equalization program and the Alaska Heating Assistance Program (AKHAP), which supplements the federal Low Income Heating Assistance Program (LIHEAP).

The structure, requirements, and outcomes of PCE and AKHAP are very different. AKHAP is a focused subsidy for low-income households in all Alaska communities, while PCE subsidizes electricity consumption for community facilities and residential customers irrespective of income in eligible communities.

Power Cost Equalization

The Power Cost Equalization program was created to even out the large disparities in power costs statewide by subsidizing power costs in rural areas to bring them close or equal to the population-weighted average of the per kWh cost in Anchorage, Fairbanks, and Juneau.[277] The FY17 PCE rate is $0.1667/kWh. Communities that receive power from the state-funded Four Dam Pool hydroelectric projects (Tyee Lake, Swan Lake, Solomon Gulch, and Terror Lake) or are connected to the Railbelt grid are not eligible for PCE.[278]

It is a common misconception that PCE only subsidizes a utility's diesel fuel consumption.

According to Alaska Statutes 42.45.100-170, the Regulatory Commission of Alaska (RCA) determines if a utility is eligible to participate in the program and calculates the amount of PCE per kWh payable to the utility. The per kWh PCE payment is based on the RCA's determination of the eligible expenses submitted by the utility. Eligible expenses include costs for fuel, generation, personnel, interest, bad debt, administration, depreciation, and other direct costs of producing electricity. Some expenses, such as unpaid fuel bills, are not eligible. It is a common misconception that PCE only subsidizes a utility's diesel fuel consumption. In some years, diesel costs are the largest component of reported expenses, but all generation expenses, including renewable generation costs, are allowed under the program.

Common PCE terms

PCE base rate	The population-weighted average of the per kWh cost in Anchorage, Fairbanks, and Juneau
PCE level	Amount payable per kWh, expressed in cents. Calculated by subtracting the PCE base rate from the lesser of the reported, eligible costs (expressed in $/kWh) or the Utility rate
Utility rate	Rate charged to customers prior to PCE reimbursement
Effective rate	Subsidized rate calculated by subtracting the PCE level from the Utility rate.

The PCE program is funded by the earnings of the PCE Endowment Fund. AS 42.45.085 provides that 5% of the PCE Endowment Fund's three-year monthly average market value may be appropriated to the PCE

[277] Power Cost Equalization Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[278] AS 42.45.115

program. The PCE Endowment Fund's market value of total invested assets was $949.9 million as of Aug. 31, 2016.[279] The most recent deposit to the PCE Endowment was $400 million in 2012.

Year-to-year subsidy levels are not constant since PCE reimbursements are based on utilities' reported, eligible expenses and on actual electricity consumption by utility customers. Figure 81 summarizes annual PCE subsidy for fiscal years 2001 to 2016.

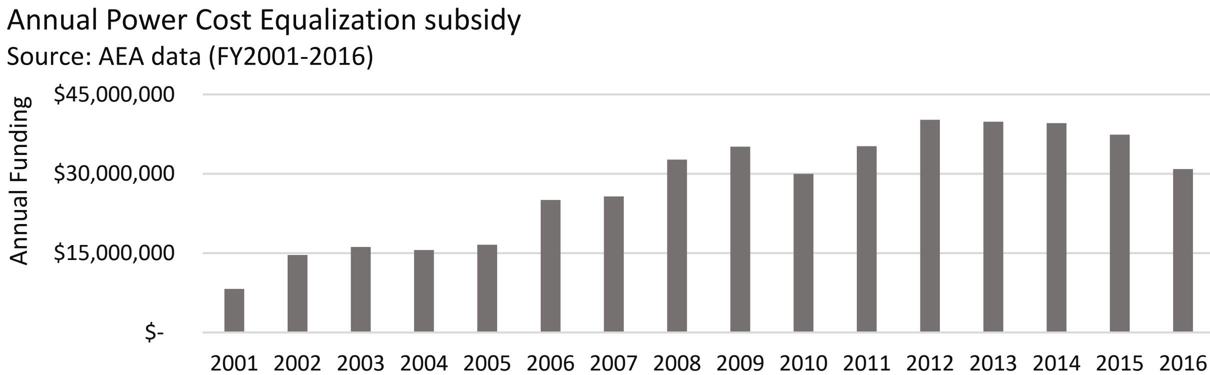


Figure 82: Annual Power Cost Equalization subsidy (FY2001-2016)[280]

PCE subsidy levels grew steadily through 2012. Between 2012 and 2016 there has been a decline of just under $10 million, even though more communities now receive PCE. This has largely been due to the decrease in the price of fuel. The sharp drop in crude oil prices that has created deep fiscal problems for the State has resulted in a 17% savings to the PCE program between 2015 and 2016. A secondary factor behind the gradual decline in annual PCE subsidies since 2012 is the growing amount of diesel displaced by REF-funded renewable energy projects that have come online.[281]

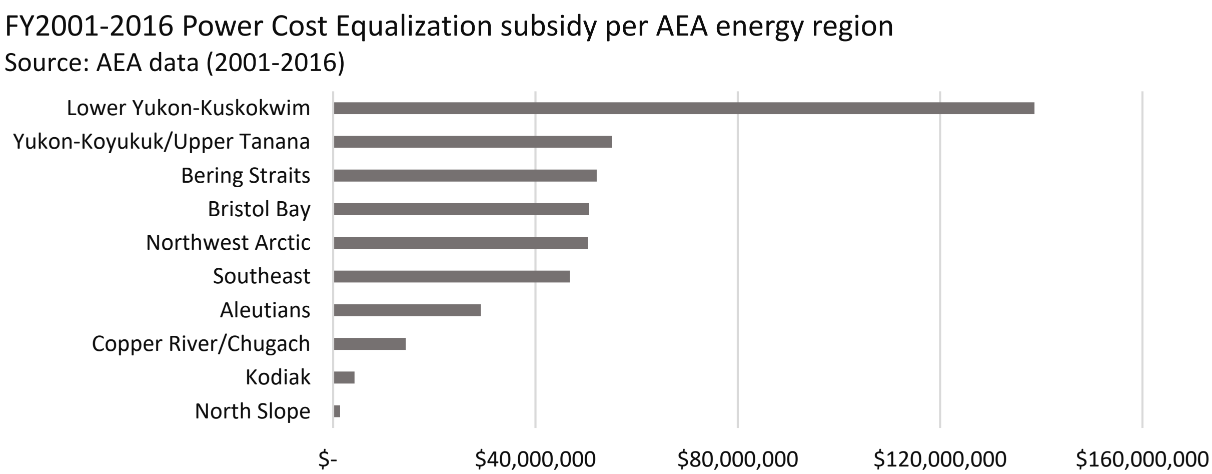


Figure 83: FY2001-2016 Power Cost Equalization subsidy per AEA energy region[282]

[279] Power Cost Equalization Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[280] AEA financial data
[281] David Hill, Chris Badger, Leslie Badger, Nikki Clace, and Molly Taylor. "Alaska Energy Authority: Renewable Energy Grant Recommendation Program Impact Evaluation Report." 2012. https://www.veic.org/resource-library/alaska-energy-authority-renewable-energy-grant-recommendation-program-process-and-impact-evaluation-reports
[282] AEA financial data

The Lower Yukon-Kuskokwim has the largest population and the largest total subsidy. The cumulative PCE subsidy has been remarkably similar for five of AEA's energy regions, which have each received $45 to $55 million over the past 16 fiscal years, as shown in Figure 82. Communities in most of the remaining regions (including Juneau, Ketchikan, Petersburg, Wrangell, Sitka, Kodiak, and all of the service area of Copper Valley Electrical Cooperative) do not receive PCE either because their rates are not high enough to qualify or they are statutorily excluded. The North Slope Borough subsidizes residential rates to a low enough level that North Slope communities are eligible for little reimbursement.

Generation efficiency and line loss standards for PCE-eligible utilities are set in regulations. The standards are a maximum 12%-line loss and a generation efficiency ranging from 8.5 to 13.5 kWh/gallon, as shown in Table 16.

Table 16: PCE generation efficiency and line loss standards[283]

Minimum kWh generated	Maximum kWh generated	Efficiency standard (kWh/gallon) >80% diesel	Efficiency standard (kWh/gallon) <80% diesel
-	99,999	9.5	8.5
100,000	499,999	10.5	10
500,000	999,999	11.5	11
1,000,000	9,999,999	12.5	12
10,000,000		13.5	13

For communities that fail to meet the standard, their PCE reimbursement is reduced to the amount that would have been necessary if the performance standards were met.[284]

The RCA determines the PCE level for each community, and AEA determines the eligibility of residential customers and community facilities, and it authorizes reimbursement to the electric utility for the PCE credits extended to customers.[285] AEA and RCA spend approximately $600,000 per year to administer and provide regulatory oversight for the approximately $30 million annual program.

PCE brings the effective residential rate to less than $0.22/kWh in 71% of eligible communities. To reach this level, 61% of PCE communities received a subsidy between $0.30 and $0.50 per kWh. [286]

Figure 84 illustrates how PCE brings down the effective residential rate. Without PCE, electric rates for rural residents would be at the top of each bar (each bar represents one community). PCE reimbursement brings the effective residential rate (the rate the resident will pay for the first 500 kWh of electricity used each month) down to the light gray line. If the unsubsidized residential rate in every community were

[283] 3 AAC 52.620. Generation efficiency and line loss standards
[284] "Power Cost Equalization Program Guide." http://www.akenergyauthority.org/Content/Programs/PCE/Documents/PCEProgramGuideJuly292014EDITS.pdf
[285] "Power Cost Equalization Program Guide." http://www.akenergyauthority.org/Content/Programs/PCE/Documents/PCEProgramGuideJuly292014EDITS.pdf
[286] AEA analysis of Alaska Energy Statistics (2013) http://www.akenergyauthority.org/Portals/0/Publications/2013DetailedSumTbl.xlsx

exactly equal to the utility's eligible expenses, then all the gray bars would be about the same height—at about $0.15/kWh. A community with an effective rate above that indicates that the utility is charging residents more than what is needed to cover its reported, eligible expenses as determined by the RCA. These charges are not reimbursed by the State.

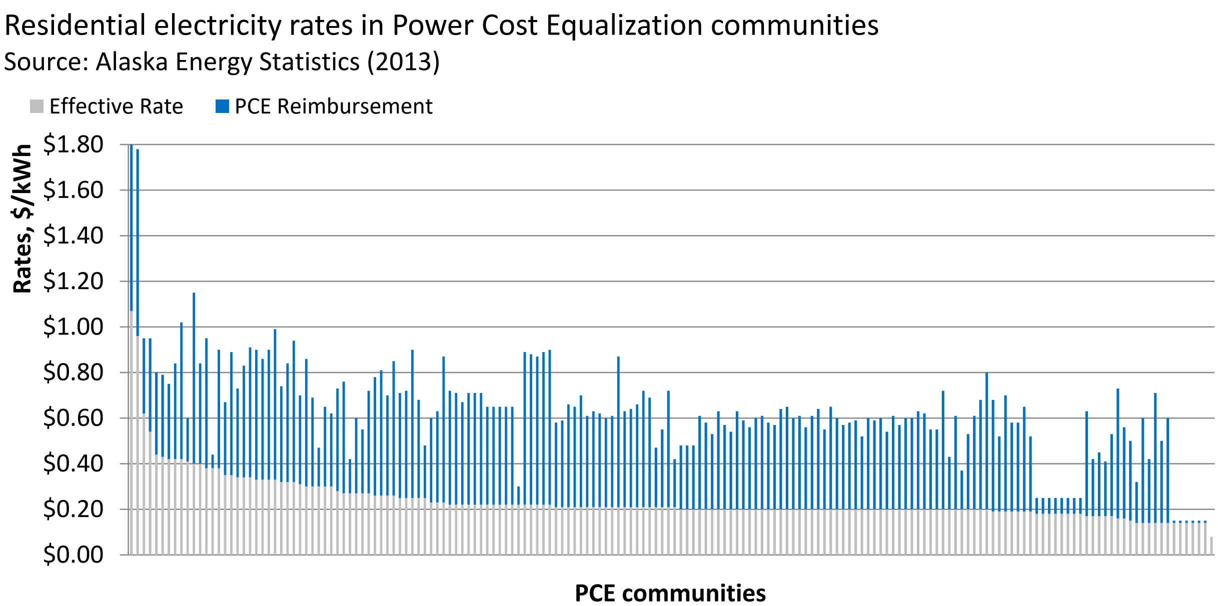


Figure 84: Residential electricity rates in Power Cost Equalization communities[287]

The energy data collected through the PCE program, even though it contains reporting errors, is an invaluable resource for policy analysts, researchers, and potential investors, as well as the communities themselves. It represents an important non-monetary benefit of the PCE program. Without it, there would be very scant information available about electric generation, use and sales for nearly 200 of Alaska's communities. Energy use and cost data, such as that collected by the PCE program, provides the most basic information needed for comparing the cost-effectiveness of potential energy projects. Without it, this report would not have been impossible to produce.

PCE and other energy data provides the most basic information needed for comparing the cost-effectiveness of potential energy projects. Without it, this report would not have been impossible.

Alaska Heating Assistance Program

The Alaska Heating Assistance Program (AKHAP), administered by the Department of Health and Social Services, supplements the federal Low Income Heating Assistance Program (LIHEAP). LIHEAP/AKHAP assists households with incomes at or below 150% of federal poverty guidelines, who have a minimum of $200 in out-of-pocket heating costs per year and meet all other eligibility criteria. The program is open to homeowners and renters.[288] Benefits are calculated using a point system based on: the area of the state

[287] Alaska Energy Statistics (2013) http://www.akenergyauthority.org/Portals/0/Publications/2013DetailedSumTbl.xlsx
[288] http://dhss.alaska.gov/dpa/Pages/hap/default.aspx

where the home is located, heat type, dwelling type, as well as household size and income.[289] The benefit is a one-time annual payment sent directly to the household's heating fuel vendor and credited to the customer's account.

Since 2009, total LIHEAP/AKHAP subsidies have been similar in scale to PCE reimbursements—$25 million to $45 million per year, with the overwhelming majority coming from federal funds, as seen in Figure 84. AKHAP was cut at the end of FY16 due to the reduced State budget, and approximately 10,000 Alaskans in both urban and rural areas are expected to receive reduced or no heating assistance because of the cuts. The federal LIHEAP program is still in place, but it only serves the lowest-income Alaskans.[290]

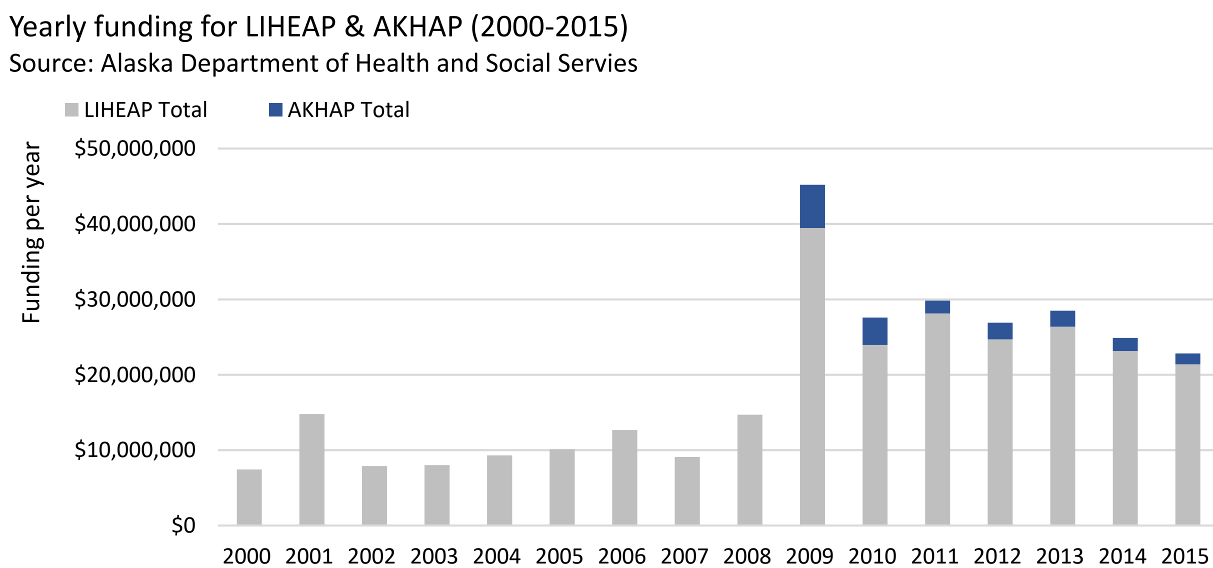


Figure 85: Yearly funding for LIHEAP & AKHAP (2000-2015)[291]

Unlike the PCE program, there are no limitations on which communities can participate in LIHEAP/AKHAP. With no geographic restrictions and 78% of Alaskans living in the Railbelt, the majority of LIHEAP/AKHAP households have also been in the Railbelt, as seen in Figure 86. The amount of heating assistance per household does factor in geography and costs, with larger benefits going to households in colder and higher cost areas of the state.

[289] http://dhss.alaska.gov/dpa/Documents/dpa/programs/hap/FY17-HAP-Application.pdf
[290] McChesney, Rashah. KTOO Public Media. "In rural Alaska, loss of heating assistance hits hard." 11/11/2016, http://www.ktoo.org/2016/11/11/rural-alaska-loss-heating-assistance-hits-hard/
[291] AEA analysis of LIHEAP and AKHAP data from Department of Health and Social Services, November 2016

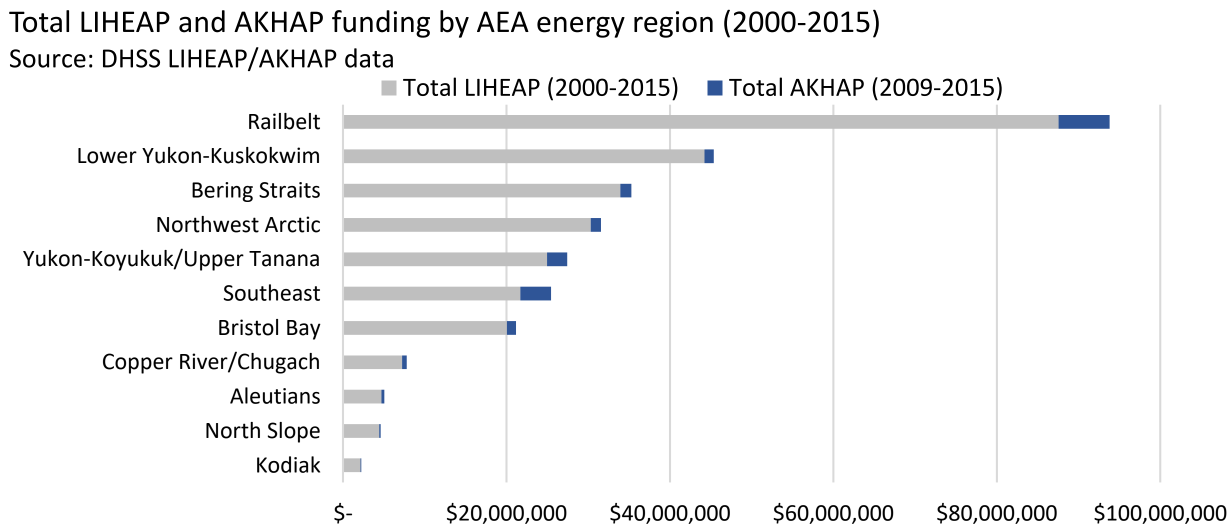


Figure 86: Total LIHEAP and AKHAP funding by AEA energy region (2000-2015)[292]

On a per-capita basis, the Railbelt and Southeast are underrepresented in their share of LIHEAP/AKHAP funding, while some other regions, especially the Lower Yukon-Kuskokwim, are overrepresented. This is consistent with the lower household incomes and higher heating fuel costs outside of the Railbelt and Southeast. It is not known what proportion of eligible households access benefits in each region.

The average subsidy provided per household varies considerably by region due to differences in median income, climate, heating fuel costs, and other factors where there could also be regional variation (household size, housing type, and fuel type). The regions with the highest average household subsidy (Northwest Arctic and Bering Straits) received nearly $3,000 or almost five times more than the region with the lowest average household subsidy (Kodiak) at just over $600 per year, as shown in Figure 87.

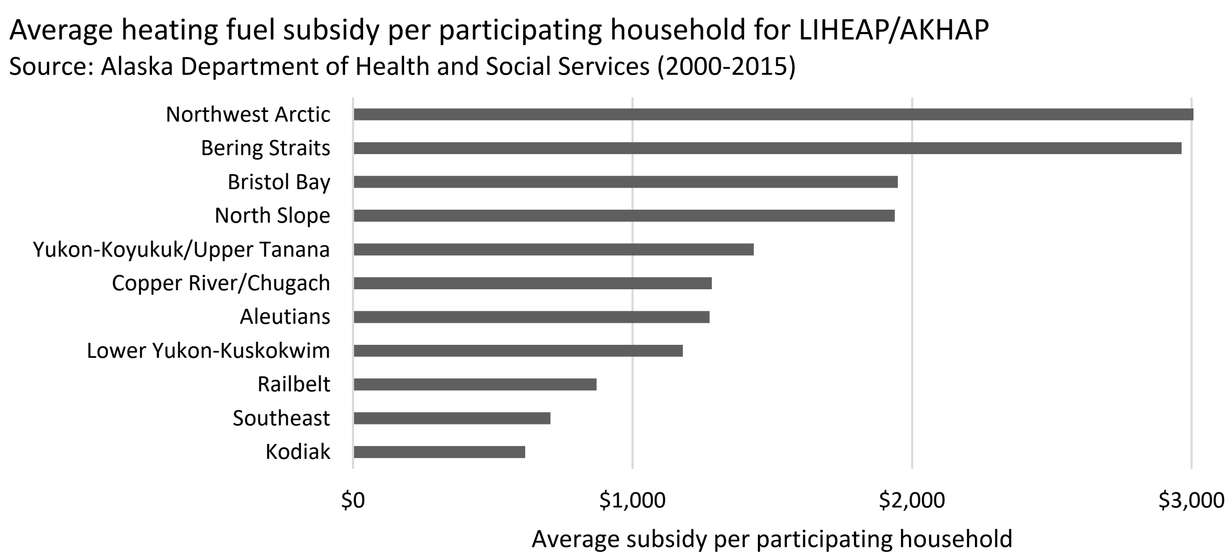


Figure 87: Average heating fuel subsidy per participating household for LIHEAP/AKHAP (2000-2015)[293]

[292] AEA analysis of LIHEAP and AKHAP data from Department of Health and Social Services, November 2016

[293] AEA analysis of LIHEAP and AKHAP data from Department of Health and Social Services, November 2016

The LIHEAP/AKHAP data make it clear that even with other local, State, and federal programs in place aimed at making energy more affordable, many Alaska households still qualify for heating assistance using objective measures of income, family size, and heating cost established by the LIHEAP/AKHAP programs. This is true even in areas of the state with the lowest average energy prices, the Railbelt and Southeast, and on the North Slope where borough subsidies greatly reduce heating fuel prices. This suggests that existing programs are not sufficient to make energy truly affordable for all Alaskans, at least not without programs like LIHEAP/AKHAP.

Municipal Energy Assistance Program

The Municipal Energy Assistance Program, created under Governor Murkowski in FY06[294], provided grants to communities with populations less than 2,500 before it was discontinued in FY08. The grants could be used:

1. To repay any indebtedness of the city or borough to the Bulk Fuel Revolving Loan Fund;
2. To repay any indebtedness of the city or borough to a fuel company or fuel vendor; or
3. For the purchase of fuel by the city or borough.

The three years of funding is shown in Table 17.

Table 17: Municipal Energy Assistance Program 2006-2008[295]

Year	Amount
2006	$6.5 million
2007	$48.0 million
2008	$48.7 million

State energy loan programs

Although State energy programs have historically focused on grants, it is likely that future loans—either from State or other sources—will provide a greater share of the money needed to build energy infrastructure projects.

Although State energy programs have historically focused on grant funds, it is likely that future loans—either from the State or other sources—will provide a greater share of the money needed to build energy infrastructure projects.

Given the availability of grant funds, it is not surprising that communities have not availed themselves of the State's energy loan products or loans products from other sources, including private and federal financing. Based on data from state and federal loan programs, it appears that many communities have made the rational choice of waiting for grant opportunities instead of taking out loans.

[294] Administrative Order No. 230. http://www.gov.state.ak.us/admin-orders/230.html
[295] Meghan Wilson, Ben Saylor, Nick Szymoniak, Steve Colt, and Ginny Fay. "Components of Delivered Fuel Prices in Alaska." June 2008. http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf

Five State loan programs are discussed in this section: four are loans for capital expenses and one for short-term credit.

Power Project Loan Fund (PPF)

AEA administers the Power Project Loan Fund (PPF), which is a revolving loan fund that provides low-cost loans to local utilities, local governments, or independent power producers for the development, expansion, or upgrade of electric power facilities, including distribution, transmission, efficiency and conservation, bulk fuel storage, and waste energy.[296] PPF loans often assist higher-risk communities that would be unable to get traditional financing from banks and other government sources, or to fund energy projects seeking lower-than-market rates. Loan repayments remain with the program and are available for new loans.

Per 2010 State energy policy, the PPF was to become the primary funding source for energy projects.[297] Yet even for communities within the AkAES region, which accounts for the greatest share of PPF loans, this has not been the case as REF, RPSU, BFU, direct legislative appropriations and other grants funds have remained available.

Since 1980, 119 loans have been requested by 70 applicants, with 87 loans actually disbursed.[298] Of the approximately $29 million currently disbursed or committed in the PPF, nine loans are currently being repaid, three are still being disbursed, and two have been committed but not yet disbursed. No loans are currently in default; however, a few loans have been forgiven by the State in the past. As of Aug. 31, 2016, the outstanding balance of AEA's Power Project loans was approximately $6.2 million. The regional distribution of PPF applications is shown in Figure 88.

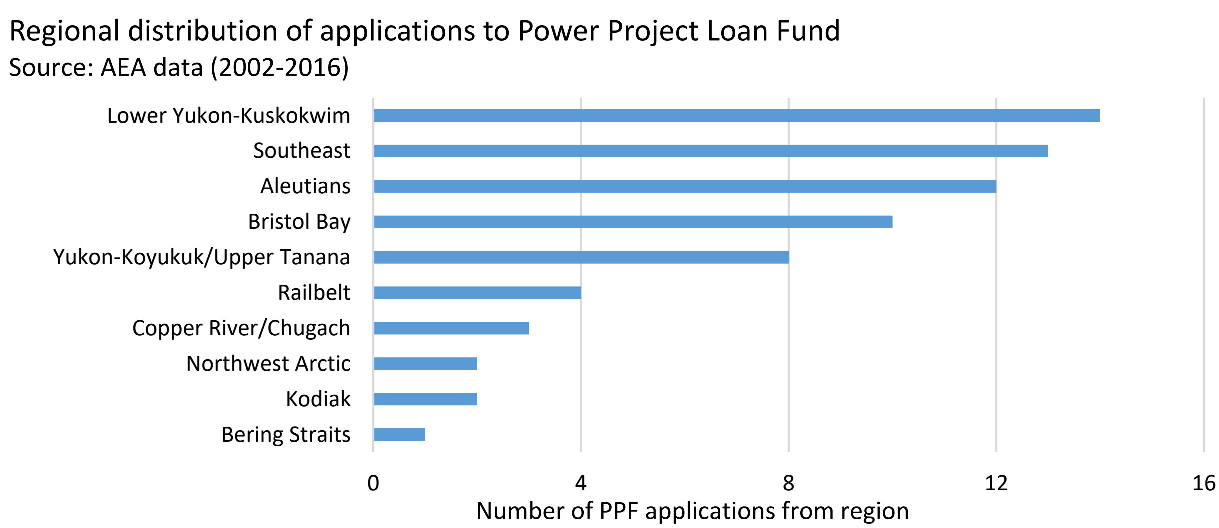


Figure 88: PPF applications by AEA energy region[299]

---

[296] Power Project Loan Fund Fact Sheet. October 2016. http://www.akenergyauthority.org/Publications
[297] AK Stat § 44.99.115 (through 27th Leg Sess 2012)
[298] Power Project fund application data (1980-2016)
[299] Power Project fund application data (1980-2016)

Since 2002, the PPF has serviced between one and five communities per year. The total value of loans has ranged between $60,000 and nearly $3 million per year. In the last few years, there has been a trend toward smaller communities with lower loan amounts, primarily for generator repairs and replacements.

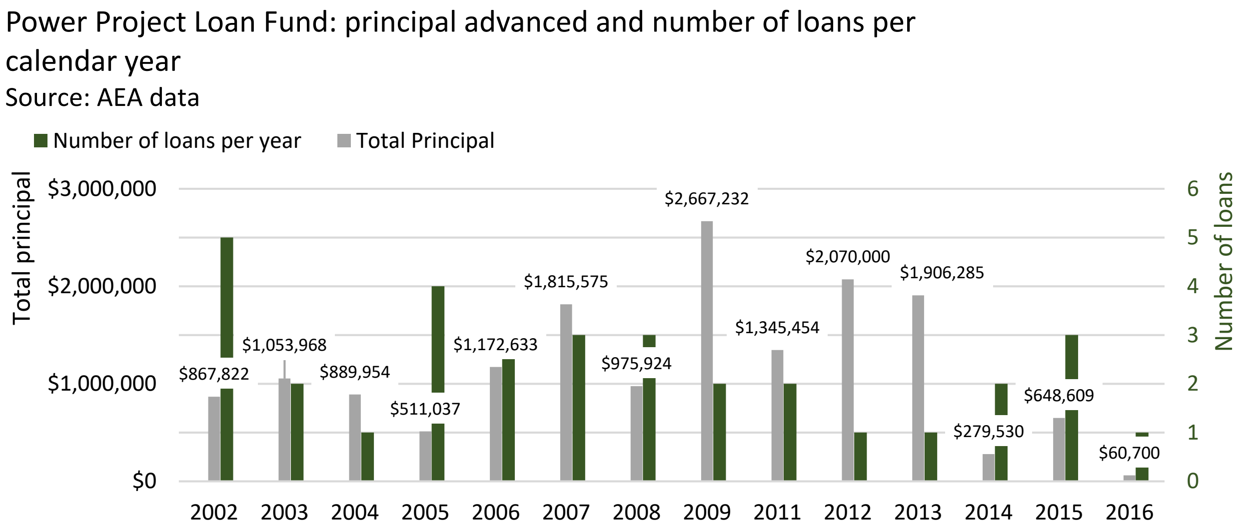


Figure 89: Power Project Loan Fund: principal advanced per year[300]

Loan terms are related to the productive life of the project and are not allowed to exceed 50 years. Interest rates vary between zero, at the low end, and tax-exempt rates at the high end. As of Sept. 12, 2016, the upper rate was 3.64%. The interest rate can be adjusted downward in certain circumstances to improve financial feasibility.

Security for PPF loans is flexible and written to accommodate the ability of the applicant while maximizing security for the State loan funds. Traditional types of security include: taking a security interest in equipment, land, and other assets; cash reserve requirements; debt-service ratio requirements; requirement to pledge revenue streams from business activities; and in the case of local governments from other revenue sources as well (e.g. community assistance program revenue). The PPF loan program also mitigates risk in less traditional ways including: requiring utilities that struggle with financial management to maintain a relationship with a third party professional bookkeeping service; requiring utilities that have a history of failure to maintain equipment to provide regular operations; and maintenance reporting and communication with AEA technical staff.

Bulk Fuel Loan program

AEA administered the Bulk Fuel Loan program from the late 1990s until 2013, when the Division of Community and Regional Affairs (DCRA) took over management of the program. Loans from the Bulk Fuel Revolving Loan Fund, currently capped at $750,000 per year are now made either as bulk fuel loans or bulk fuel bridge loans as provided in AS 42.45.250-42.45.299. Bulk fuel bridge loans are specifically for applicants that were rejected for a bulk fuel loan, and have zero percent interest rate for the first loan. Loans may assist communities in purchasing bulk fuel, which can include diesel, heating oil, avgas, low

[300] Power Project fund application data (1980-2016)

sulfur diesel, and gasoline. Loans are limited to communities with populations under 2,000 and can be made to a municipality, unincorporated village, private individual, or private company (including village corporations) retailing fuel or electricity in a community.[301]

Borrowers must agree to secure bulk fuel revolving loans with revenues from fuel sales and other legally available monies. They may be required to assign payments from the State of Alaska for funds they expect to receive from Community Revenue Sharing, Payment in Lieu of Taxes (PILT), Power Cost Equalization or other programs.[302]

While the DCRA and AEA Bulk Fuel loan programs were identical, DCRA made the Bridge loan available for those communities that could not qualify for a Bulk Fuel loan. Since 2009, the Bridge loan has comprised up to 25% of all fuel loans from the State. Chapter 4 includes an analysis of the reasons for this.

Figure 90 shows the amount of lending under AEA's Bulk Fuel loan, the DCRA Bulk Fuel loan, and the DCRA Bridge loan. The annual total of all Bulk Fuel Loans increased steadily through 2009, when it held relatively stable for a few years before decreasing over the past couple of years. The increase and decrease broadly follow the cost of oil.

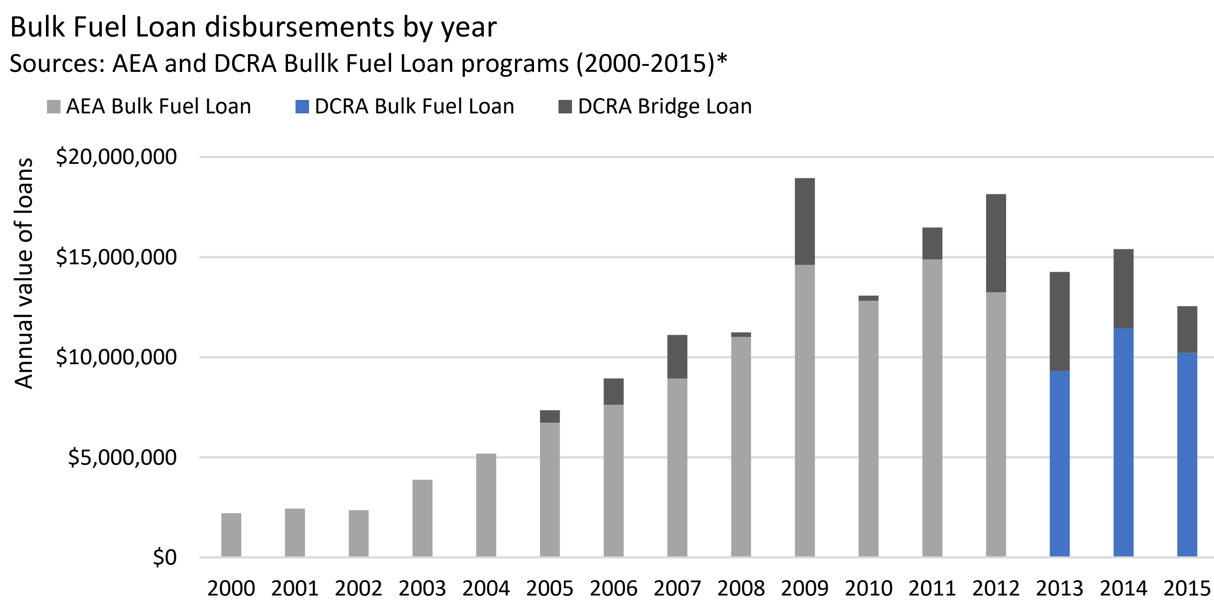


Figure 90: Bulk Fuel Loan program disbursements[303]
*Note: Bulk Fuel Bridge Loan data unavailable pre-2005.

Although most regions are served by the Bulk Fuel Loan program (the exceptions are the North Slope and Copper River/Chugach regions), the primary beneficiaries are communities in the AkAES study area, as shown in Figure 90. The Lower Yukon-Kuskokwim region was the recipient of nearly half of the loan value

301 https://www.commerce.alaska.gov/web/Portals/4/pub/Bulk%20Fuel%20Revolving%20Loan%20Fund%20Statutes.pdf
302 https://www.commerce.alaska.gov/web/dcra/BulkFuelLoanProgram.aspx
303 Unpublished data from AEA bulk fuel loan, unpublished data from DCRA bulk fuel loan and bulk fuel bridge loan, 2014 and 2015 DCRA annual reports.

between 2000 and 2013, followed by Bristol Bay, Northwest Arctic, and Yukon-Koyukuk/Upper Tanana regions, each of which received approximately 15% of the total value.

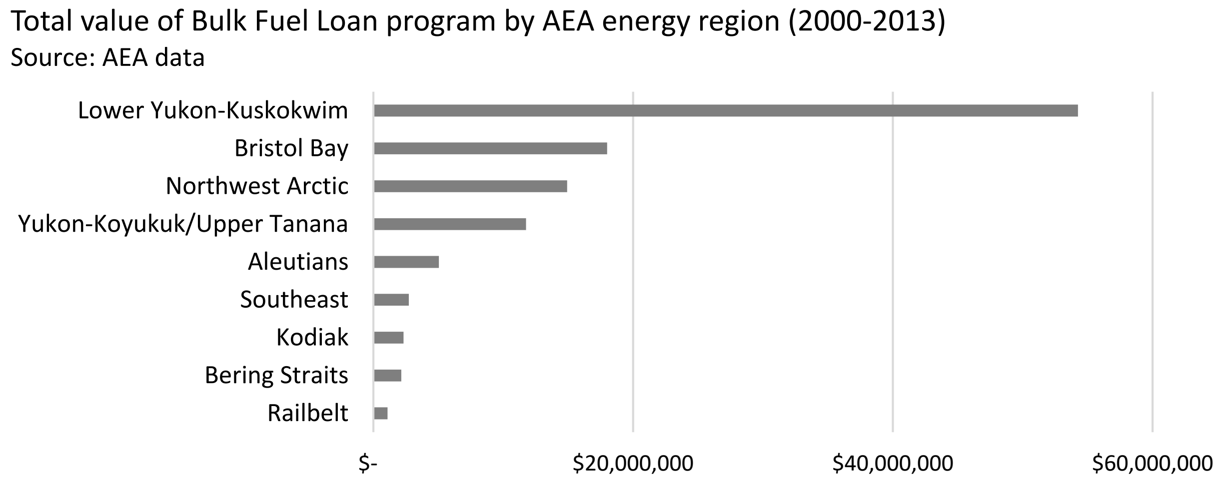


Figure 91: Total value of Bulk Fuel Loan program by AEA energy region (2000-2013)[304]

The Bulk Fuel Loan program has served an important niche by transferring higher risk loans from the private sector to the government. In discussions with at least one fuel deliverer, removing the uncertainty of getting repaid for fuel deliveries allowed them to continue delivering fuel to communities with a history of poor repayment.[305] A similar risk transfer is provided by regional fuel consolidators, such as the Norton Sound Economic Development Corporation's Consolidated Bulk Fuel program, which helped group and negotiate the delivery of $4.1 million in fuel in 2014.[306, 307]

Even though loan recipients are required to provide security for repayment of the loans, the delinquency rates were approximately 15% in 2014 and 14% in 2015.[308, 309] See Chapter 4 for further analysis of risks associated with the Bulk Fuel Loan program.

Sustainable Energy Transmission and Supply

The Sustainable Energy Transmission and Supply (SETS) program is a loan program managed by AIDEA. The SETS loan fund was capitalized in 2013 and 2014 with $67.5 million and $125 million, respectively. AIDEA has a number of loan products that can be accessed through SETS, including loan participation, direct loans, and loan guarantees.[310] No loans have been serviced in the AkAES study area. To date, the SETS has been used solely for the Interior Energy Project, a project to bring LNG to Fairbanks.

---

304 Unpublished data from AEA bulk fuel loan
305 Trevor Crowder, Everts Fuel, personal communication 4/25/2016.
306 http://www.nsedc.com/programs/community-benefits/consolidated-bulk-fuel/
307 http://www.nsedc.com/wp-content/uploads/267304-NSEDC-AR-proof.pdf
308 DCRA, "Bulk Fuel Revolving Loan Program Annual Report 2014"
309 DCRA, "Bulk Fuel Revolving Loan Program Annual Report 2015"
https://www.commerce.alaska.gov/web/Portals/4/pub/BulkFuelAnnualReport.pdf
310 http://www.aidea.org/Programs/EnergyDevelopment.aspx

Alaska Energy Efficiency Revolving Loan Program

The Alaska Energy Efficiency Revolving Loan Program (AEERLP), administered by AHFC since the loan's creation in 2010, provides financing for permanent energy efficiency improvements to buildings owned by regional educational attendance areas, the University of Alaska and the State of Alaska municipalities. The loan can be repaid through guaranteed savings from energy efficiency improvements identified in an Investment Grade Audit.[311] The ability to use expected savings from efficiency improvements as security is a unique feature of AEERLP; almost all other loans require collateral, adequate cash flow, and other measures to guarantee that the loan can be repaid. For many lenders, the future is too uncertain—from energy price fluctuations, changes in building use, or ownership, etc.—to base the repayment of a loan on future energy savings.

Although the enabling legislation allowed for AHFC to bond for up to $250 million to support AEERLP, it is not clear that there is a need for the program or if the requirements to access program funds are too restrictive. In an attempt to develop customers for AEERLP, auditors conducted 327 energy audits throughout the state, including approximately 58 percent in the AkAES study area. Although building owners and operators welcomed the audits, no loans have resulted through the program as of November 2016.[312]

AHFC contacted building owners or their representatives for 76% of the audited buildings. Of these, 84% said they had implemented some of the recommended energy efficiency measures. Of these, 29% were funded with bonds, 22% with grants, and 33% with cash on hand. The remainder did not report how they funded their projects.[313]

Energy Efficiency Interest Rate Reduction

The Energy Efficiency Interest Rate Reduction (EEIRR) program is a program to promote energy efficiency in existing and newly constructed homes. As the name implies, the EIRR provides a reduced interest on mortgages financed through AHFC. The interest rate reduction is available either for new or existing energy-efficient properties that meet specific criteria or existing properties that perform efficiency upgrades.[314]

---

311 https://www.ahfc.us/efficiency/non-residential-buildings/energy-efficiency-revolving-loan-fund-aeerlp/

312 Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

313 VEIC 2016

314 https://www.ahfc.us/efficiency/energy-programs/energy-efficiency-rate-reduction/

Table 18: Energy Efficiency Interest Rate Reduction based on efficiency improvement[315]

	Access to natural gas	**No access to natural gas**
1 Step:	-0.125%	-0.250%
2 Steps:	-0.250%	-0.375%
3 Steps:	-0.500%	-0.625%
4 Steps:	-0.625%	-0.750%

Although the EEIRR program does not provide an upfront grant for efficiency improvements, it can provide significant financial incentives for efficiency improvements in existing structures. For instance, if a property with a $200,000 mortgage achieves the 0.625% reduction, the interest payments would be reduced over $900 per year.

Only 571 EEIRR loans were closed between 2012 and 2014. Eighty-seven percent of the loans were in Railbelt communities, and no EEIRR loans were financed in small, rural communities in the AkAES study area.[316]

Existing and new energy-efficient properties that meet either the Five Star Plus or Six Star energy rating can receive interest rate reductions as well.[317] Without new funding for the Home Energy Rebate program the EEIRR remains the best option for improving the energy efficiency of residences not eligible for the low-income Weatherization Assistance Program.

Alternative Energy and Conservation Loan

The Alaska Department of Commerce, Community and Economic Development (DCCED) offers the Alternative Energy and Conservation Loan Fund for small businesses to construct and install alternative energy systems or make energy efficiency improvements in commercial buildings. The legislature amended the Alternative Energy Loan program in 2010 and made it effective in 2012, with a capital outlay of $2.5 million. The maximum loan amount from the fund is $50,000 and the maximum loan term is 20 years. At the end of 2015, no loans had yet closed.[318] Some of the reasons why no loans have been closed include: lighting retrofits are not allowed, the applicant must have been denied by two financial institutions, and the maximum loan amount is insufficient for retrofitting many commercial facilities.

Other State Energy Programs

In addition to grant, subsidy and loan programs, Alaska has a number of programs that provide technical assistance and other energy-related services. The three programs addressed in this section are administered by DOT&PF and AEA, and does not cover all technical assistance provided by State energy

---

[315] https://www.ahfc.us/efficiency/energy-programs/energy-efficiency-rate-reduction/
[316] AEA analysis of AHFC EEIRR data
[317] https://www.ahfc.us/efficiency/energy-programs/energy-efficiency-rate-reduction/
[318] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

program staff. Other technical assistance activities provide benefits to communities but are not codified in statute or regulations.

Public Facilities Energy Efficiency Improvement Program

Passed in 2010, the Alaska Sustainable Energy Act (SB220 Chapter 83 SLA10) required that DOT&PF retrofit 25% of all state-owned facilities of at least 10,000 square feet by 2020. DOT&PF achieved this requirement in 2014. To accomplish this, DOT&PF used a combination of commercial financing, American Recovery and Reinvestment Act (ARRA) funds as well as agency deferred maintenance funds. The energy efficiency work completed to date is saving the State over $2.8 million each year in energy costs, based on estimated costs and savings.[319] The net savings is less, as some of the energy savings are being used to pay off the loans.[320]

The DOT&PF program is an excellent example of how a clearly defined energy efficiency goal can lead to benefits for the State and individual communities. By reducing energy costs in State buildings, money is available for more productive programs and core agency services, providing indirect benefits to communities. One likely reason for this program's success is the close, clear alignment between the policy requirement and the authority of the organization tasked to fulfill it. As the owner and operator of the buildings, the State clearly has the authority to effect the necessary upgrades. The legislation also included meaningful metrics to track program success. Given the number and size of state buildings, an economy of scale is created throughout the program.

DOT&PF has also provided technical assistance to other government entities including the City of Sitka and, in 2015, the Anchorage School District.[321] An opportunity exists for the expertise and resources developed through this program to be expanded beyond State buildings. As discussed in Chapter 6, there is a significant cost-effective energy efficiency potential throughout the AkAES study area for both public and privately-owned non-residential buildings.

Circuit Rider & Technical Assistance

Under 3 AAC 108.200 – 240, the Alaska Energy Authority's Circuit Rider program provides utilities in communities with populations of less than 2,000 with technical assistance to improve the efficiency, safety and reliability of their power systems, and to reduce the risk and severity of emergency conditions.[322] AEA is required by statute Sec. 42.45.900 to provide this service to communities.[323]

Through the Circuit Rider & Technical Assistance program, AEA instructs rural utility operators and managers in the proper operations and maintenance of their generation and distribution infrastructure. Technical staff can help diagnose and troubleshoot issues through remote monitoring, or can provide onsite training, technical consultation, assistance and minor repairs. The program does not provide

---

[319] Department of Transportation and Public Faculties. "Alaska Sustainable Energy Act: Annual Report. 2015 Progress Report." January 2016

[320] Rebecca Smith. Personal correspondence. 11/8/2016.

[321] Department of Transportation and Public Faculties. "Alaska Sustainable Energy Act: Annual Report. 2015 Progress Report." January 2016

[322] Circuit Rider Program Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications

[323] http://www.legis.state.ak.us/basis/folioproxy.asp?url=http://wwwjnu01.legis.state.ak.us/cgi-bin/folioisa.dll/stattx15/query=[JUMP:%27AS4245900%27]/doc/{@1}?firsthit

funding for major repairs or reconstruction of utility systems, nor does it replace the need for rural utilities' maintain an operations and maintenance budgets.[324]

The Circuit Rider & Technical Assistance program, in concert with other AEA programs, has reduced the number of catastrophic events, according to AEA program staff.[325] Quantitative data on the communities assisted by the Circuit Rider program is only available from 2015 through the third quarter of 2016. In less than two years, 61 utilities, all located in the AkAES study area, received assistance from the Circuit Rider program, including some who received services up to four times.

As a share of the total operations and maintenance costs for all utilities and energy infrastructure in the AkAES study area, the Circuit Rider program represents well under one-tenth of one percent. Although the relative cost is very low, the program, at least anecdotally, has had positive impacts on energy safety, reliability and affordability by preventing catastrophic events and helping to protect investment in rural energy infrastructure.

Electrical emergency assistance

Under 3 AAC 108.200 – 240, the Alaska Energy Authority provides on-call emergency response to reduce imminent threat to life or property during extended power outages. If an eligible utility suffers an electrical emergency, AEA, subject to the availability of appropriations, assists the utility in re-establishing power to the utility's customers in a manner that does not constitute a significant threat to life or property. Assistance may include financial or technical assistance, including emergency repairs.[326]

Since emergencies cannot be planned for, the amount of annual program funding shown in Figure 92 is based on the actual costs incurred in responding to calls each year. There is no clear trend in annual costs from 2005 to 2015.

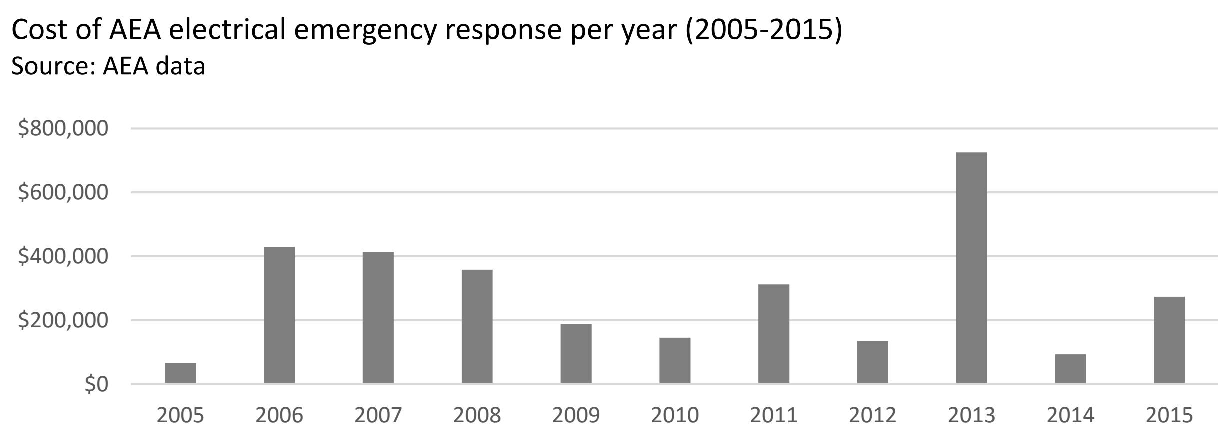


Figure 92: Cost of AEA electrical emergency response per year[327]

---

[324] Circuit Rider Program Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications
[325] Kris Noonan, personal communication, December 2016.
[326] Circuit Rider Program Fact Sheet, October 2016.
[327] AEA analysis of unpublished Electrical Emergency Response program data

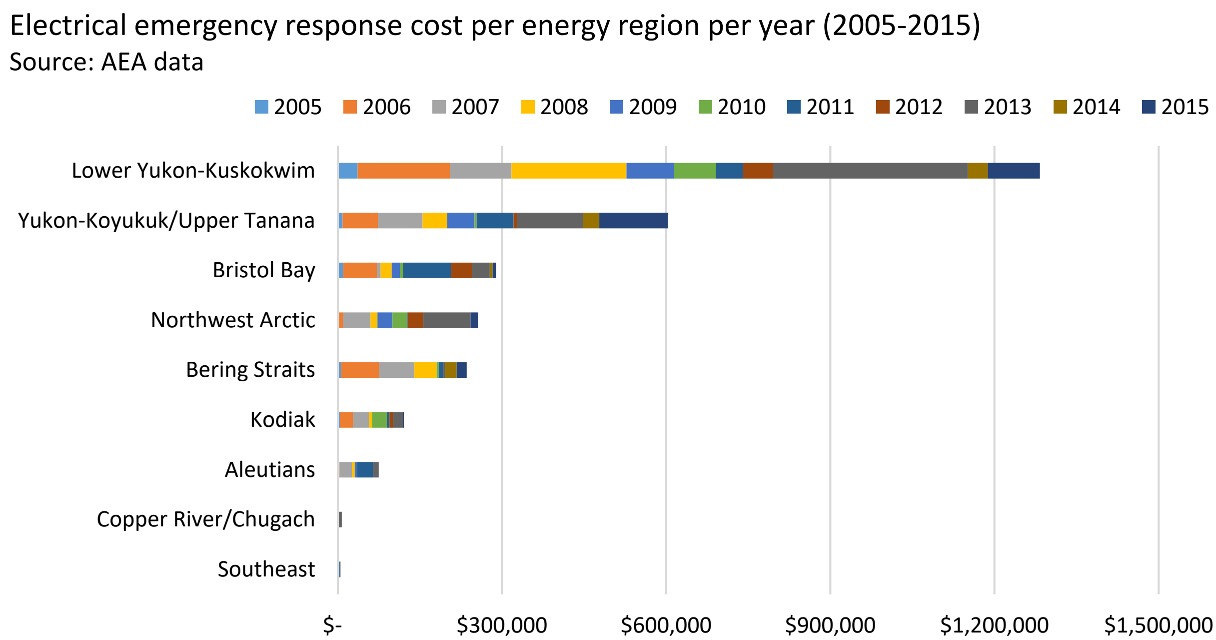


Figure 93: Electrical Emergency Response cost per AEA energy region per year[328]

The highest costs for responding to electrical emergencies are in the Lower-Yukon-Kuskokwim and Yukon-Koyukuk/Upper Tanana regions, as shown in Figure 93.

Slightly more than half (41 out of 70) of all communities accessing Electrical Emergency Response services between 2005 and 2015 had incidents requiring assistance in more than one year, as is shown in Figure 93. For example, the figure shows that 10 communities accessed emergency response in six to seven years between 2005 and 2015.

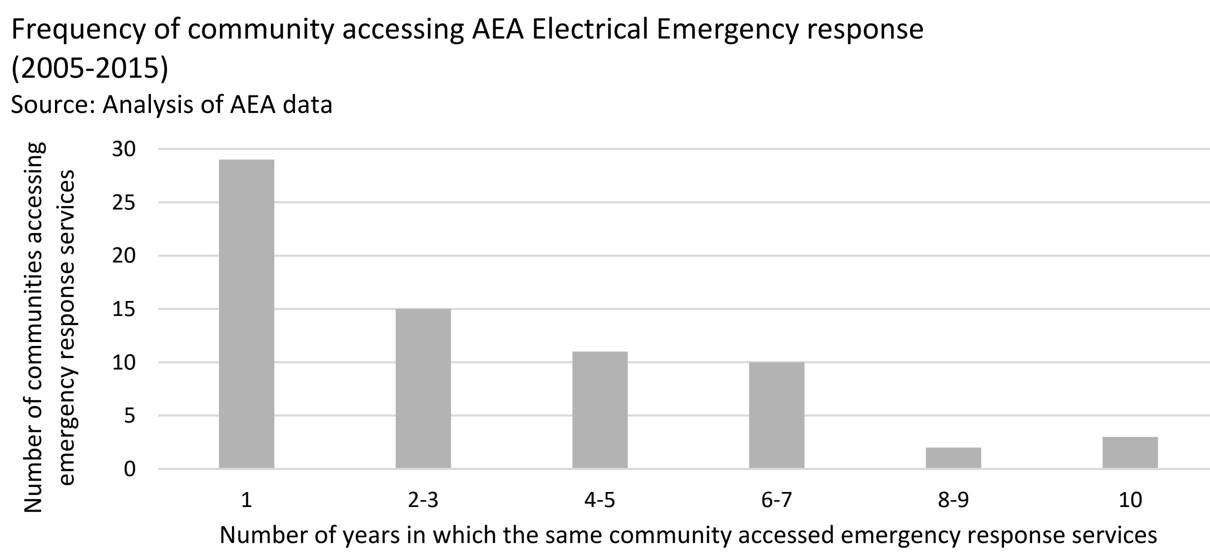


Figure 94: Frequency of communities accessing AEA Electrical Emergency Response (2005-2015)[329]

[328] AEA analysis of unpublished Electrical Emergency Response program data

[329] AEA analysis of unpublished Electrical Emergency Response program data

The electrical emergency response program directly benefits communities by assisting utilities in re-establishing power in a manner that does not constitute a significant threat to life or property, and it protects investments in rural infrastructure by addressing problems before a catastrophic emergency occurs.[330]

The average community size for Electrical Emergency Response is 229 and the median is 151, both of which are smaller than the median community size in the AkAES study area. About 93% of Electrical Emergency Response expenditures were for standalone village- and city-owned utilities. Regional co-ops and regional investor-owned utilities (IOUs) accounted for 1% of all expenditures.[331] The data appears to confirm the benefits of larger utility structures in assisting smaller communities, either in reducing the number of emergency episodes or by being able to respond to the emergency without State assistance.

AEA training programs

AEA provides training opportunities for local residents to learn how to operate and maintain their energy infrastructure and keep facilities code-compliant and sustainable. Proper maintenance and operation of energy infrastructure are essential components of delivering safe, stable, reliable, and affordable power to a community. Currently, there are no administrative or regulatory requirements for utilities to prove the maintenance and operational capacity to deliver the services required of them as a utility.

> *Proper maintenance and operation of energy infrastructure are essential components of delivering safe, stable, reliable, and affordable power to a community.*

AEA contracts with Alaska Vocational Technical Center (AVTEC) in Seward to deliver training courses that include: Power Plant Operator, Advanced Power Plant Operator, Bulk Fuel Operator, and Hydroelectric training.

AEA also provides training on an as-available basis for utility clerks in PCE reporting, RCA reporting, and general accounting practices.[332]

[330] Kris Noonan, personal communication, December 2016.
[331] AEA analysis of unpublished Electrical Emergency Response program data
[332] Training Programs Fact Sheet, October 2016. http://www.akenergyauthority.org/Publications

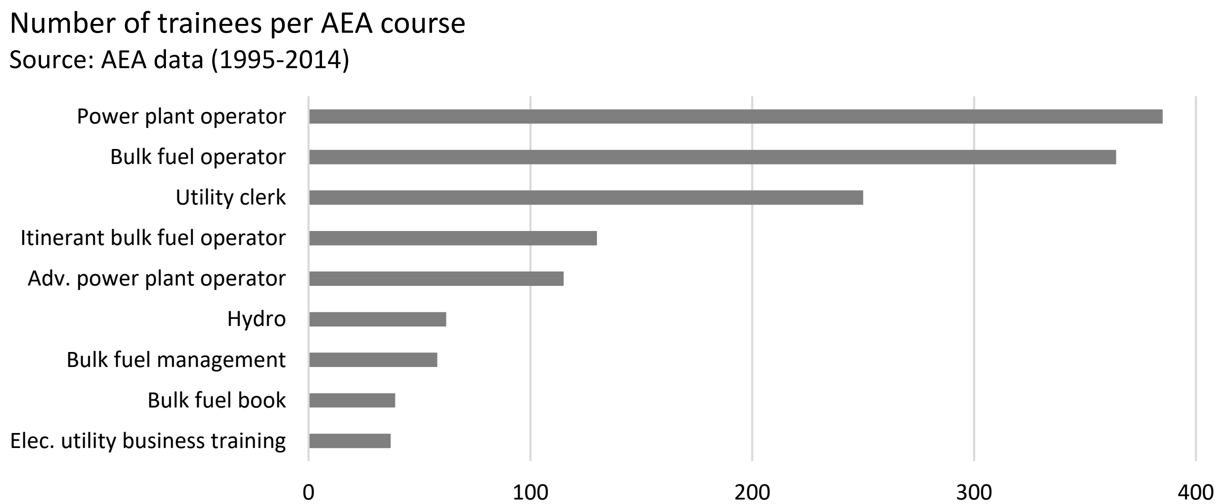


Figure 95: Number of trainees per AEA course[333]

Power plant and bulk fuel operator courses each account for one-third of all trainees, as shown in Figure 95. Utility clerk training accounts for approximately 17%, with the balance made up by other financial and management and hydro trainees.

From 1995 to 2015, more than 1,400 individual trainings were started and approximately 87% completed by about 1,000 different participants from 160 communities. Individual training participants took between one and six courses. The breakdown of participation by region is in Table 19.

Table 19: AEA training program participation by region (1995-2014)[334]

AEA energy region	Communities	Trainings completed	Average participants per community
Lower Yukon-Kuskokwim	41	491	14
Yukon-Koyukuk/Upper Tanana	27	169	8
Bristol Bay	24	165	7
Bering Straits	15	115	10
Aleutians	10	89	9
Kodiak	6	60	11
Northwest Arctic	10	59	7
Southeast	15	48	3
Copper River/Chugach	4	28	8
Railbelt	4	18	5
North Slope	3	5	3

Good utility operations and maintenance relies on qualified, well-trained staff; high staff turnover makes this challenging. AEA's training program has helped to train new hires and allow for continued professional

333 AEA analysis of unpublished AEA training data (1995-2014)
334 AEA analysis of unpublished AEA training data (1995-2014)

development for experienced personnel. Quantifying the benefits of any training program is difficult, and AEA was unable to find sufficient data to support quantitative analysis.

In particular, it is not clear how to interpret the participants-per-community data in Table 19. The high number of trainees from some small communities is either an indication of high staff turnover or that the community has found benefit in having multiple people trained, or a combination of factors. There is a common perception that personnel turnover at rural utilities is high, and the list of training participants kept by AEA suggests that is true with some exceptions. A few participants in AEA's training program have remained at the same utility since the 1990s; these employees have taken multiple AEA courses over that time. AEA's 2015 bulk fuel assessment provided another source of information about rural utilities that showed a staff experience, but not tenure. That evaluation of 56 communities, pre-identified as being most in need, showed that the 130 bulk fuel operators in those communities had an average of 10 years of experience.[335]

NON-PROGRAMMATIC DIRECT LEGISLATIVE APPROPRIATIONS

Outside of the State energy programs, the Legislature has also funded energy projects through direct appropriations. Direct appropriations ranged in size from $25,000 for a biomass pilot project in the Southeast to $180.9 million for planning the Susitna Hydroelectric project. The amount of annual appropriations by AEA energy region is shown in Figure 96.

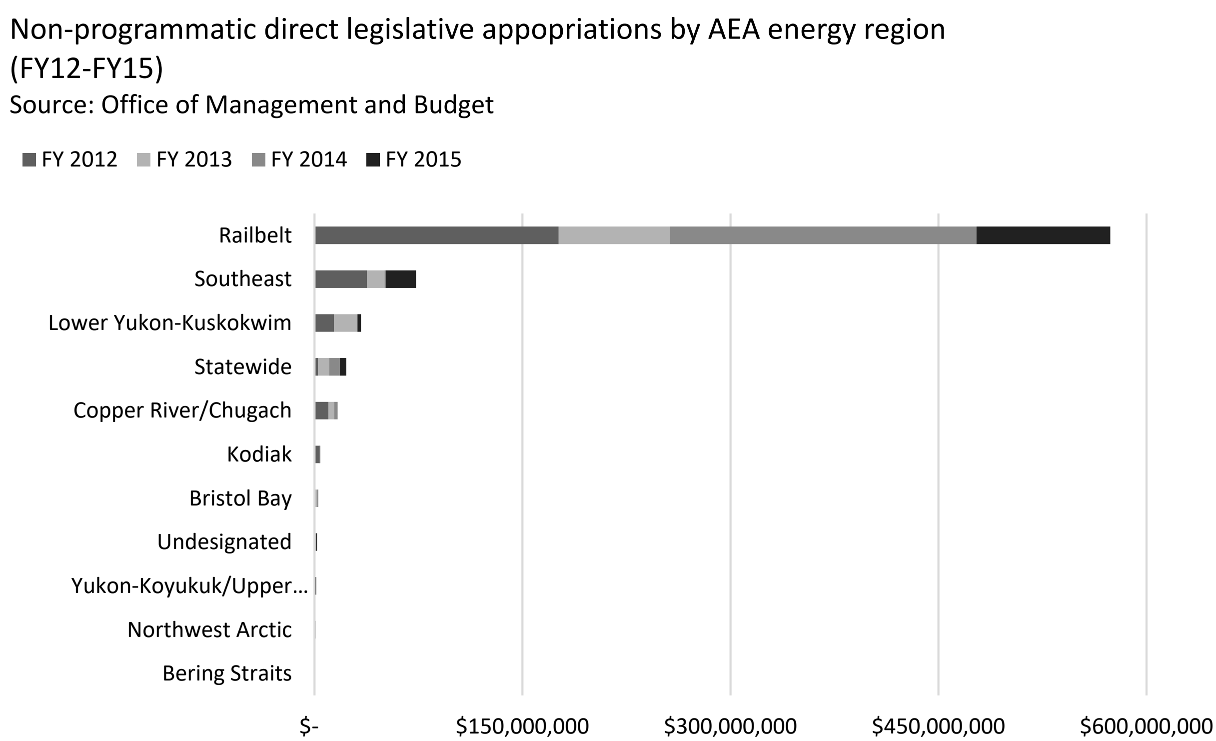


Figure 96: Non-programmatic state direct legislative energy appropriations by AEA energy region[336]

[335] AEA analysis of data from Alaska Energy Authority. "Bulk Fuel Inventory Assessment Report." 2016.
[336] Data from Office of Management and Budget, 2015.

For the four fiscal years from 2012 to 2015, the Railbelt received nearly 80% of all direct legislative appropriations. Appropriations for Railbelt projects included funding for the Susitna-Watana Dam, the Interior Energy Project, and an additional $200 million for other projects. About 79% of appropriations for Southeast went to Sitka. The figure does not include $379.2 million for the In-State Gas Pipeline Fund, otherwise known as the Alaska Stand Alone Pipeline (ASAP) project.

Table 20 shows direct legislative appropriations by energy region on a per capita basis for FY12 through FY15. The average per capita funding amount across the state is nearly $1,000. Four regions received more than the average, while two regions received no direct appropriations for energy projects. The regional distribution shows that non-programmatic legislative appropriations have not generally targeted areas with the highest energy costs. With the exception of the Lower Yukon-Kuskokwim, the largest recipients of direct legislative appropriations, both on a total and per capita basis, were regions with lower energy costs.

Table 20: Per capita direct legislative appropriations by AEA energy region[337]

AEA energy region	Funding per capita
Copper River/Chugach	$1,830
Lower Yukon-Kuskokwim	$1,230
Southeast	$1,090
Railbelt	$1,000
Kodiak	$440
Bristol Bay	$350
Yukon-Koyukuk/Upper Tanana	$190
Northwest Arctic	$130
Bering Straits	$30
Aleutians	$0
North Slope	$0

FUNDING LEVELS FOR STATE AND FEDERAL ENERGY PROGRAMS

This section outlines how State and federal funding for various energy programs has changed over time. While this is not an exhaustive index of funding sources, Figure 97 captures the largest and most consistent State and federal funding sources. The chart shows how funding levels and sources have changed over time as the availability of funds and priorities have changed.

Funds not represented in the chart include: State and federal loans; some large, technology-specific grants to Alaska communities from the U.S. Department of Energy; some funding for the Railbelt (some Railbelt spending is included, but Railbelt data was not systematically researched or collected since the region is not in the AkAES study area); and tax credits and other incentives for natural gas exploration and

[337] AEA analysis of Office of Management and Budget data

development in the Cook Inlet region. A number of State and federal programs were also left out because their funding levels were too low to be reflected on the chart. These include training, electrical emergency response, Circuit Rider & Technical Assistance, Emerging Energy Technology Fund, and Village Energy Efficiency Program.

Two large appropriations are omitted from Figure 97. A $400 million deposit into the PCE Endowment Fund, which was excluded from the direct appropriation totals since deposits into the endowment fund are not spent, but serve as a source of long-term investment income. The $379.2 million allocated to the ASAP gasline project funding is also not included in the chart.

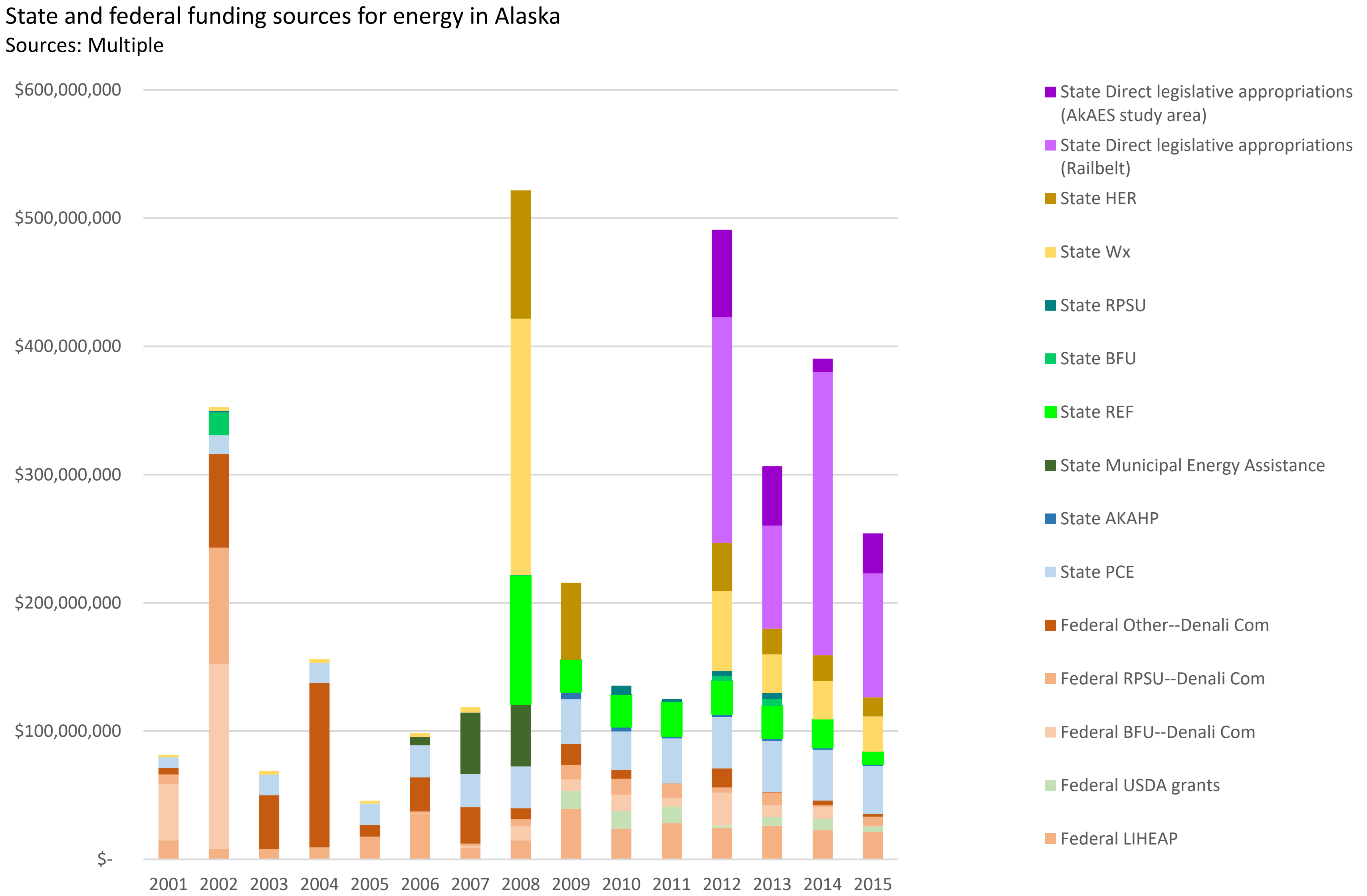


Figure 97: Historical State and federal energy funding

Federal funding has generally declined from a high of more than $300 million in 2002. Denali Commission funding spiked in 2002 with $230 million allocated for RPSU and BFU projects. Not all of the funds allocated in 2002 were spent in that year as the funding was spread over the next several years. Total federal funding was less than $50 million in 2015, most of which was for LIHEAP. The federal funding levels before 2009 are underreported, since AEA does not have pre-2009 data for USDA. LIHEAP has been a consistent and sizeable source of energy subsidy over the past 15 years.

Identified State energy funding peaked in 2008, with more than $400 million in allocations not including direct appropriations. This included $100 million for REF, $200 million for the Weatherization Assistance Program, and $100 million for the Home Energy Rebate program. Not all 2008 allocations were spent that year. Direct legislative appropriations, which were sizeable from 2012 to 2015, also existed in previous years, but the data was not systematically captured for earlier years. In 2014, direct legislative appropriations for Railbelt projects were more than half of all government energy funding. Overall, PCE has been the State's most consistent, though not the largest, source of energy funding.

HOW STATE ENERGY PROGRAMS HELP TO ACHIEVE STATE ENERGY POLICIES

In 2010, the State Legislature declared a State energy policy under AS 44.99.115. As part of that energy policy, five key intentions were outlined:

1. The state [should] achieve a 15% increase in energy efficiency on a per-capita basis between 2010 and 2020;
2. The state [should] receive 50% of its electric generation from renewable and alternative energy sources by 2025;
3. The state [should] work to ensure a reliable in-state gas supply for residents of the state;
4. The Power Project Fund (AS 42.45.010) [should] serve as the main source of state assistance for energy projects; and
5. The state [should] remain a leader in petroleum and natural gas production and become a leader in renewable and alternative energy development.

The first two policies will be explored in more depth in this section. The fourth policy, concerning the PPF, has already been reviewed. The third policy will be partially addressed in the next section and the fifth is outside of the purview of this report.

Understanding how current State energy programs have helped to achieve these energy policies sheds light on how well current programs are aligned with State policy, as well as how the AkAES can most effectively achieve its policy goals. Four questions will aid in developing this understanding: Which entities are ultimately responsible for achieving the goal? What requirements are placed on those entities? How can State energy programs help to achieve the goal? How is progress towards the goal tracked?

THE STATE WILL ACHIEVE A 15% INCREASE IN ENERGY EFFICIENCY ON A PER-CAPITA BASIS BETWEEN 2010 AND 2020.

Who is ultimately responsible?

- Residential and non-residential building owners and occupants

What requirements exist for the entities responsible for achieving the goal?

- Legislation from 2010 suggests the building energy codes should be encouraged[338], but no building energy codes have been enacted statewide.
- The Alaska Sustainable Energy Act (SB220 Chapter 83 SLA10), passed in 2010, required that the DOT&PF retrofit 25% of all state-owned facilities that are at least 10,000 square feet by 2020. DOT&PF met the requirement by 2014.
- AS 42.45.130 requires that each "eligible electric utility shall cooperate with appropriate State agencies to implement cost-effective energy conservation measures…"[339]
- No other requirements exist for reducing either thermal or electric energy consumption in the state.

Which State of Alaska energy programs help to achieve the goal?

- A number of State energy programs can help to achieve the energy efficiency goal. State energy efficiency grant programs include: Weatherization, Home Energy Rebate/New Home Rebate, and the Village Energy Efficiency Program.
- State loan programs that can be used for energy efficiency include: The Power Project Loan fund, the Alaska Energy Efficiency Revolving Loan fund, the Alternative Energy and Conservation Loan, and the Sustainable Energy Transmission and Supply Development fund. The DOT&PF's Public Facilities Energy Efficiency Improvement program also helps to achieve the statewide efficiency goal.
- In addition to the DOT&PF energy program, technical assistance for energy efficiency is provided through AEA and AHFC energy efficiency programs. Aside from supporting specific funded projects and programs, AEA and AHFC efficiency programs are not codified in law or regulation.

What reporting requirements are there for tracking progress towards the goal?

- The Alaska Office of Management and Budget is directed to work with State agencies to develop a standardized methodology to collect and store energy consumption and expense data.[340]
- There are no reporting requirements for any sector. Electricity consumption is tracked through PCE and Energy Information Authority (EIA) for other purposes. No heating or transportation fuels consumption data is systematically collected or stored. Some fuel price data is tracked but not required.

THE STATE WILL RECEIVE FIFTY PERCENT OF ITS ELECTRIC GENERATION FROM RENEWABLE AND ALTERNATIVE ENERGY SOURCES BY 2025

Who is ultimately responsible for achieving the goal?

- Electric utilities, distributed generation owners, and independent power producers

What requirements exist for the entities responsible for achieving the goal?

[338] AS 44.99.115
[339] AS 42.45.130
[340] AS 37.07.040(12)

- No requirements exist for utilities to install renewable or alternative energy systems or reduce consumption of diesel, natural gas, or naphtha.
- AS 42.45.130 requires that each "eligible electric utility shall cooperate with appropriate state agencies to … plan for and implement feasible alternatives to diesel generation."[341]

What State of Alaska energy programs help to achieve the goal?

- A number of State energy programs can help to achieve the renewable and alternative energy goal. Aside from direct legislative appropriations and the Susitna-Watana Dam project, which is outside the scope of this study, the Renewable Energy Fund is the primary grant program that helps to achieve this goal. AEA's RPSU program has assisted communities to integrate hydro and wind projects in a number of communities. The Emerging Energy Technology Fund aims to aid in the development of alternate energy sources for communities, though grants are unlikely to result in additional renewable generation before 2025 due to the pre-commercial status of the technologies funded.
- A number of loan programs can be used to fund renewable and alternative energy infrastructure, including AIDEA's SETS program, AEA's PPF, and the DCCED Alternative Energy and Conservation Loan fund.
- AEA's Alternative Energy and Energy Efficiency and Rural Energy Groups provide technical assistance for alternative and renewable energy development and implementation. Aside from providing technical assistance for REF and other legislatively funded capital projects, the program is not codified in law or regulation.

What reporting requirements are there for tracking progress towards the goal?

- No specific reporting requirements exist to track renewable and alternative electric generation, although electric generation by source is collected by AEA through the PCE program and by the federal EIA for other purposes. This data is published by AEA as the Alaska Energy Statistics.

LESSONS LEARNED

1. Voluntary participation in programs requires targeted, predictable incentives. Many of the State's energy programs respond to community applications and requests, which requires that participants have the capacity needed to comply with requirements of the program. Programs such as the Home Energy Rebate program and Renewable Energy Fund have been very effective with sectors that exhibit sufficient capacity but less successful with other groups.
2. Proactive grant programs, such as the Weatherization program that search to find eligible applicants, can be very successful in developing projects in underserved markets.
3. Loan and other debt financing programs are not, by themselves, effective in incentivizing development of new renewable energy or energy efficiency projects. Technical, communication, and financial barriers to participation must be addressed before non-grant financing can be effective.

[341] AS 42.45.130

4. As seen by the DOT&PF program, requiring energy efficiency improvements for public building owners can be effective and cost-efficient, assuming the owner has the authority and means to make the improvements. By extension, other requirements could provide cost-effective savings.
5. A number of programs exist outside the scope of the 2010 State energy policy goals articulated in AS 44.99.115, including:
    a. Rural Power System Upgrade program
    b. Bulk Fuel Upgrade program
    c. Circuit Rider & Technical Assistance program
    d. Electrical Emergency Response,
    e. Power Cost Equalization
    f. Alaska Heating Assistance Program

CHAPTER 6: INFRASTRUCTURE AND NON-INFRASTRUCTURE OPPORTUNITIES TO REDUCE COMMUNITY ENERGY COSTS

Key Takeaways

1. Almost all communities have at least one cost-effective opportunity for more affordable energy.
2. Energy efficiency—for both residential and non-residential buildings and facilities—is the most common, has the highest expected savings, and is consistently the most cost-effective opportunity across the AkAES study area.
3. In order to perform thorough evaluations of potential opportunities in a community, a significant amount of detailed data is required and much of that data is not readily available.
4. Many of the best bets for more affordable energy, such as non-residential efficiency, are not currently being pursued very often.
5. Non-infrastructure opportunities such as improved business management may also hold significant potential for reducing community energy costs.

This chapter will explore various infrastructure and non-infrastructure strategies and opportunities for reducing the cost of energy in communities within the study area. Although there are opportunities available in all communities, no single solution or suite of solutions will quickly reduce energy costs for all consumers in all communities. The purpose of this chapter is to evaluate and compare the potential opportunities that will represent the best return. It should be noted that although much of this chapter addresses infrastructure projects, for those communities that do not have cost-effective infrastructure projects, AEA has identified other cost savings measures. The end of Chapter 6 includes a comparison of the cost-effectiveness of the various project types.

….no single solution or suite of solutions will quickly reduce energy costs for all consumers in all communities

This chapter draws heavily from existing research done over the past decade, as well as research and analysis performed as a part of the AkAES project. The work covers existing and new that investigate resource and technology feasibility and pull from the Alaska Center for Energy and Power (ACEP), Alaska Housing Finance Corporation (AHFC), Cold Climate Housing Research Center (CCHRC), Northern Economics, U.S. Army Corps of Engineers (USACE), Vermont Energy Investment Corporation (VEIC), Institute of Social and Economic Research (ISER), Denali Commission, National Renewable Energy Laboratory (NREL), and previous AEA studies, among others.

In particular, the Alaska Affordable Energy Model (AAEM), an AEA-designed model programmed by the University of Alaska Fairbanks' (UAF) Geographic Information Network of Alaska (GINA), is used extensively to evaluate energy infrastructure opportunities in study-area communities. The AAEM uses the best data available for each community, including resource assessments, residential and non-residential building audits, energy consumption information, and generation infrastructure details.

The AAEM uses historical and status quo data on energy costs, consumption, generation, and infrastructure to create a snapshot of energy use and costs in a community. The AAEM provides a high-level assessment of opportunities based on numerous data sources, including the Alaska Energy Data Gateway, the Alaska Retrofit Information System, the Alaska Energy Data Inventory, AEA's Renewable Energy Fund program, work performed by the ACEP, ISER, the Department of Energy, national laboratories, and numerous other sources.

Forecasts were developed for the factors that will lead to changes in the consumption, generation and costs of energy in a community. These factors include the prices of diesel, heating oil and electricity, community population, and trends in consumption. Consumption trends are calculated by the model for each community and/or intertie.

The most recent and best data on resource availability (including wind, hydro, solar, residential and non-residential efficiency, diesel efficiency, and heat pumps) are captured from multiple sources. If a study has estimated the costs and generation for a proposed project, those values are incorporated into the model, otherwise regional or statewide average values are used.

A community-level economic analysis is performed by integrating the status quo, forecasted and resource data for all potential resources in a community. A reconnaissance-level analysis is provided for each potential resource, which allows a community or potential investor to compare opportunities available to the community and identify the best, most cost-effective opportunities to pursue.

For a comprehensive description of the model, please see Appendix B and the model documentation.[342] Community-specific model outputs, which will be available via AEA's website (www.akenergyauthority.org), are intended to help guide communities toward infrastructure opportunities most likely to be cost-effective. In this chapter, the community-level results are aggregated by AEA energy regions.

OPPORTUNITIES INVESTIGATED FOR MORE AFFORDABLE ENERGY IN COMMUNITIES

Figure 98 is a reprint Figure 25, first used in Chapter 3 to provide a framework for understanding the components of bringing more affordable energy to communities. Each of the boxes in the figure represents both potential opportunities and impediments to reducing the cost of energy in study area communities. There are a limited number of ways to reduce consumers' energy costs.

[342] http://www.akenergyinventory.org/energymodel

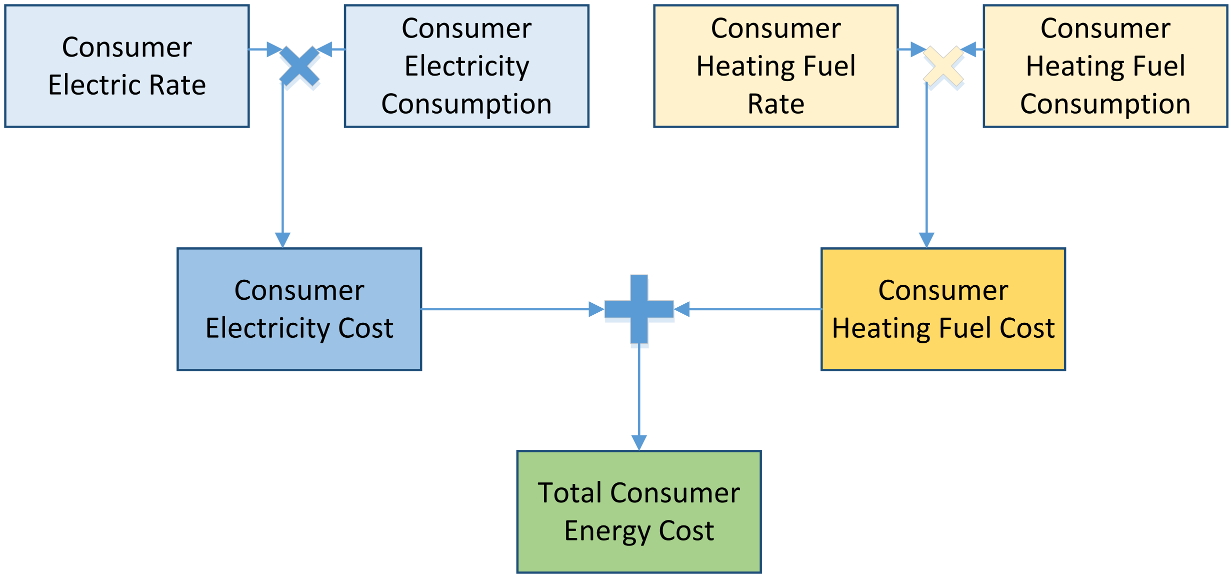


Figure 98: Components of consumer energy costs

The following sections of this chapter include the options investigated. Not all of the investigations and studies were able to identify a viable opportunity. In these cases, changes or improvements in technology and/or better data may result in viable projects.

For the analysis in this chapter, it is important to remember that all of the options are compared against the status quo, which in most cases is grant-funded infrastructure. A key assumption for this analysis is that all new infrastructure will be debt financed with a 5% interest rate.

CROSS-CUTTING OPPORTUNITIES FOR ELECTRICITY AND HEATING COST REDUCTION

Some options could potentially reduce the cost of both heat and electricity and will be explored in this "cross-cutting" section.

CHANGE FUELS

A common hope expressed by many Alaskans is that there might be a lower cost alternative fuel to diesel and heating oil. As part of the AkAES, two potential fuel switching options were investigated: liquefied natural gas (LNG) and propane.

AEA commissioned a study to investigate the feasibility of LNG as an alternate fuel in the AkAES study area. The results of that study, performed by Anchorage-based Northern Economics with engineering consultation from Michael Baker International, did not indicate that LNG was likely to be economically feasible as an alternate fuel for electricity generation, thermal loads, or a combination of uses.[343] There

[343] Northern Economics, Inc. "LNG Feasibility for Alaska Affordable Energy Strategy Communities." Prepared for Alaska Energy Authority. July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/LNGFeasibilityStudy2016.pdf?ver=2016-07-29-145517-400

are indications that communities and utilities may be interested in LNG for reasons aside from reduced cost, particularly for meeting air quality requirements, as has recently been the case in Tok.[344]

While the commodity cost of LNG can be significantly cheaper than diesel and heating oil—as little as 20% of the cost per unit of energy at the export terminal—the complex logistical, safety, storage, and infrastructure requirements to use the LNG increase the retail cost in the community. Even though LNG is cooled to -260 degrees Fahrenheit, LNG is less energy dense than diesel, necessitating 1.7 gallons of LNG to replace each gallon of diesel. Since LNG must remain very cold or it will expand and gasify, a very heavy, specially insulated container is required. For most uses, the weight of the container is greater than the weight of the LNG delivered, increasing the cost of delivery. Even with a specially insulated container, LNG has a limited shelf life (approximately 90 days before off gassing becomes problematic) that would prevent LNG from being used as the sole fuel in communities without year-round access to barge service.[345]

Similarly, in a 2010 study commissioned as part of the "Pathways" report, AEA determined that propane was not a viable alternative to heating oil in study area communities.[346] Propane could be a viable electricity replacement in certain applications—particularly cooking appliances and water heaters—but due to many of the same the logistical challenges as LNG (lower energy density, heavy container), it does not appear to be a viable solution for community heating needs.[347] In many study area communities, propane appears to be priced competitively with electricity.[348]

AEA did not investigate the viability of local gas resources. In 2016, both Ahtna and Doyon investigated potential resources in the Copper Valley and Minto Flats areas, respectively. The Doyon investigation in 2016 did not find commercially-viable deposits of oil and gas.[349] The results of the Ahtna drilling program were not made public before the completion of this report. State investment in these two projects will likely be approximately $9 million for the Copper Valley project and $60 million for the Minto Flats exploration. To put this in perspective, the $9 million on the Copper Valley project could weatherize 28% of the existing residential buildings still to be weatherized in the Copper Valley/Chugach region.

Fuel transportation improvements

Increasing the efficiency of delivering fuel into communities has been proposed by a number of previous studies as a possible way of reducing the cost of fuel in communities.

---

[344] Tim Ellis. "Utility officials: Test project shows LNG could help reduce cost of generating electricity in Tok." 11/4/2016. http://fm.kuac.org/post/utility-officials-test-project-shows-lng-could-help-reduce-cost-generating-electricity-tok
[345] Northern Economics, 2016.
[346] Western Alaska Propane Conversion. Discussion Paper. 2010. ftp://ftp.aidea.org/2010AlaskaEnergyPlan/2010%20Alaska%20Energy%20Plan/Propane%20Study/AEA_Plan_Propane.pdf
[347] Alaska Gasline Development Corp. In-State Propane Utilization Study for the Alaska Gasline Development Corporation. July 1, 2011. http://www.arlis.org/thepipefiles/Record/1465394
[348] AEA analysis of data from Alaska Energy Data Gateway.
[349] Alex DeMarban. "Native Wildcatters push ahead with exploration at oil and gas projects." Alaska Dispatch News. November 17, 2016. https://www.adn.com/business-economy/energy/2016/11/17/native-wildcatters-pushing-ahead-with-exploration-at-oil-and-gas-prospects/

AEA commissioned a study by the U.S. Army Corps of Engineers (USACE) to investigate potential improvements to infrastructure for fuel delivery, including solutions such as the establishment of regional fuel depots. The study concluded that enough cost savings potential exists in the construction and operation of new regional fuel depots along the Yukon and Kuskokwim Rivers to warrant further analysis, and that most other regional storage options are not cost-effective.

The creation of two new regional fuel depots and a new fuel facility at the Dalton Highway bridge over the Yukon River, as well as increased capacity in Aniak (on the Kuskokwim River), were found to merit additional analysis. Including the approximately $4 million capital cost to construct a new fuel depot, the USACE estimated an average annual net benefit of approximately $200,000 could be accrued by using a new fuel depot constructed at the Dalton Highway bridge. The estimated average annual net benefits from the increased capacity in Aniak is approximately $540,000/year for an initial capital cost of nearly $5.6 million. The main benefits of the Aniak depot would be realized by a barge being able to travel upriver from Aniak more fully laden to serve communities upriver on the Kuskokwim during the high-water time prior to the lower reaches of the Kuskokwim being open.[350]

Approximately a dozen other communities had a combination of local moorings and increased tankage that showed the possibility of having cost-effective benefits. While the analysis on increased tankage is suspect due to the methodology and data used, it does identify some communities that could merit further investigation to determine if increased tankage could be beneficial. The recommended moorings, a continuation of work the USACE performed for the Denali Commission[351], showed annual net benefits that were generally less than 1% of the estimated cost of delivered fuel.[352]

The community-specific recommendations are accessible through the Alaska Energy Data Inventory [http://www.akenergyinventory.org/].

FUEL COOPERATIVES

In 2012, the Alaska Village Electric Cooperative (AVEC) entered into the fuel delivery business to supply its communities with fuel. AVEC reports that it has saved its communities approximately $1 million by operating its own barge service in 2012[353] and $500,000 in 2014.[354] These values would translate in a $0.10 to $0.20 per gallon decrease in delivered costs to communities. As there are numerous factors that lead to delivered cost of fuel in communities, it is difficult to verify reported cost reductions.

The experiences and research of others indicate that it may be difficult to replicate AVEC's reported successes. The Norton Sound Economic Development Corporation (NSEDC) has had success with the Consolidated Bulk Fuel program, where NSEDC has assisted communities and shouldered some of the risk

---

[350] US Corps of Engineers, Alaska District. "Fuel Transportation Improvement Report." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AEAfueltransportationreport101416.pdf

[351] US Corps of Engineers, Alaska District. "Alaska Barge Landing System Design Statewide Phase 1, Various Locations Final Report." January 2009. http://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf

[352] US Corps of Engineers, Alaska District. 2016.

[353] Laurel Andrews. "New fuel barges deliver energy savings to rural Alaska." Alaska Dispatch News. 5/6/2013. https://www.adn.com/rural-alaska/article/new-barges-brought-energy-savings-rural-alaska-electric-co-op-says/2013/05/07/

[354] http://avec.org/wp-content/uploads/2016/03/2014-Annual-Report.pdf

of bulk fuel transactions.[355] Results from other co-ops have been less clear-cut.[356, 357] Others have noted the difficulties that come from trying to coordinate purchases within a community. Additional challenges exist where business models and/or financial strengths vary too significantly among communities considering shared fuel purchasing via a co-op.[358]

Fuel co-ops and coordinating purchases within a community could in theory reduce the cost of fuel through several mechanisms. First, it is possible that larger purchases could allow for a better price at the wholesale level through a volume discount. Researchers have noted that this would require the existence of undue profits, which a 2010 attorney general investigation did not find at the distribution level.[359] Second, there is research indicating discounts to some communities in co-ops would result in a zero-sum game from a statewide perspective, in which costs are shifted to communities outside the co-op.[360]

Third, the most likely way in which a co-op would reduce costs in a community is by maximizing the efficiency of delivering the fuel to a community. By limiting the number of trips to a community and the fixed costs of preparing to offload fuel, operational savings could be realized. This conclusion parallels the method chosen by USACE for evaluating benefits of different options for increasing the efficiency of transporting fuel.

CONSUMER ELECTRICITY COST

The State mechanism to directly reduce the cost of electricity for residential consumer is the Power Cost Equalization program (PCE).

Since PCE only covers a portion of the electricity sold in communities (between 8% and 70% depending on the community[361]), the program could further reduce costs through extending the subsidy to other customers and/or the rest of electricity sold in the communities. Extrapolating from the 2014 reimbursement rates in communities, extending PCE to cover all sales would cost an additional $82 million per year. Since there is insufficient revenue from the PCE Endowment to cover this additional subsidy, the funds would either drain the endowment or need to be found elsewhere.

Approximately 30 communities within the AkAES study area are excluded from receiving PCE reimbursement. Extending PCE to currently excluded communities, primarily the Copper Valley Electric Association service area, would cost an additional $7 million per year.

---

[355] http://www.nsedc.com/programs/community-benefits/consolidated-bulk-fuel/
[356] Steve Colt, Ginny Fay, Matt Berman, Sohrab Pathan. "Energy Policy Recommendations Draft Final Report." January 25, 2013. http://www.iser.uaa.alaska.edu/Publications/2013_01_25-EnergyPolicyRecommendations.pdf
[357] Rural Energy Action Council. "Rural Energy Action Council. Findings and Action Recommendations for Governor Frank Murkowski." April 15, 2005. http://www.arlis.org/docs/vol1/60412439.pdf
[358] Dave Pelunis-Messier, personal communication, January 2016.
[359] Alaska Attorney General. "Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General's gasoline pricing investigation", 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf
[360] Colt et al, 2013.
[361] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

CONSUMER ELECTRIC RATE—FUEL COSTS

Only a few ways exist to potentially reduce fuel costs for generating electricity: 1) generate and distribute power more efficiently; 2) interconnect communities to develop a greater economy of scale; or 3) switch to a renewable source. The option of switching to an alternate fuel, such as LNG or propane, was addressed in the previous section and was not found to be a cost effective option for any communities.

1. Historically, the State has improved generation efficiency in communities by building a new powerhouse. In most of the communities in the AkAES study area, a diesel powerhouse is basic infrastructure, just as the airport and roads are basic infrastructure. While this section focuses on the cost-effectiveness of replacing a powerhouse for the efficiency that could be gained, efficiency is rarely the driving force behind upgrading the powerhouse. Rather, maintaining the safety, stability, and reliability of the community's energy system will determine when a powerhouse needs to be upgraded or replaced.

   The AAEM uses the average efficiency gains found in the RPSU program (approximately 10%) and a cost model to estimate the cost of a new powerhouse based on the expected load in each community. The AAEM combines these factors and the community-specific forecasts to evaluate the economic feasibility of replacing the powerhouse based on a 30-year expected life.

   Based on the assumptions made by the Alaska Affordable Energy Model for this analysis, improving generation efficiency through a powerhouse replacement was cost-effective in only one community. Other ways to increase generation efficiency include replacing individual generators instead of the entire powerhouse.[362]

Table 21: Savings from increasing generation efficiency in PCE-eligible communities[363]

AEA energy region	Annual fuel cost savings (2017 estimate)	Gallons of diesel saved per year
Lower Yukon-Kuskokwim	$1,908,000	827,000
Yukon-Koyukuk/Upper Tanana	$583,000	248,000
Bristol Bay	$581,000	225,000
Northwest Arctic	$444,000	194,000
Copper River/Chugach	$255,000	158,000
Bering Straits	$226,000	116,000
Southeast	$176,000	107,000
Aleutians	$224,000	103,000
North Slope	$240,000	96,000
Kodiak	$19,000	10,000
Total of AkAES study area	**$4,661,000**	**2,085,000**

[362] "Diesel Efficiency" "Alaska Rural Energy Plan." 2004

[363] AEA analysis of PCE data. Note: due to the rounding, the total may sum properly

Table 21 estimates the diesel savings potential by region based on PCE data from 2013. The savings estimated in Table 21 assume that communities larger than 500 people can achieve a diesel efficiency of 15.5 kwh/gallon and communities smaller than 500 can achieve 14 kWh/gallon. These efficiencies are technically possible but likely challenging, since only a few communities in these size ranges are able to maintain this level of efficiency.

Federal emissions standards are making it more difficult to find operational savings with newer diesel generation units. Replacing older generators with newer, higher-efficiency units that are compliant with EPA Tier 4 emission standards could actually increase operational costs. In many cases, the newer models are more complex, and the added complexity of newer units can increase the amount and cost of maintenance, particularly if the local operator does not have requisite skills to maintain the gensets.[364]

System efficiency can also be improved by reducing losses that occur when distributing electricity, what is generally referred to as line loss**.** Line loss, calculated as the difference between the kWhs generated and those sold, can be caused by myriad reasons, such as improperly sized or faulty transformers, unseen grounds, malfunctioning meters, and uncharged customers. Because of all these possible sources of loss, there is no reliable way to determine the costs of reducing line losses.[365] The potential benefits are sizeable in some communities.

Table 22: Potential savings from reducing line loss to 10% in PCE-eligible utilities[366]

AEA energy region	Annual fuel cost savings (2017 estimate)	Gallons of diesel saved per year
Lower Yukon-Kuskokwim	$644,000	329,000
Yukon-Koyukuk/Upper Tanana	$404,000	171,000
Aleutians	$321,000	124,000
Southeast	$210,000	133,000
North Slope	$189,000	88,000
Northwest Arctic	$161,000	46,000
Copper River/Chugach	$124,000	75,000
Bristol Bay	$91,000	34,000
Bering Straits	$3,000	1,000
Railbelt	$2,000	1,000
Kodiak	$0	-
Total of AkAES study area	**$2,151,000**	**1,004,000**

Lower Yukon-Kuskokwim appears to have the largest opportunity for reducing energy costs through improving line losses. As mentioned before, there is not a clear way to evaluate the costs, along with these benefits, to be able to compare these estimated benefits with the other opportunities within

364 Kris Noonan, personal communication, December 2016.
365 Kris Noonan, personal communication, December 2015.
366 AEA analysis of 2013 PCE data, Note: due to the rounding, the total may sum properly

this chapter. Generally, distribution upgrades are relatively minor costs, and it is likely that the line loss reductions will more than pay for the capital costs.

Line losses also have a direct impact on the amount of PCE that communities receive. Since the amount of PCE reimbursement is based on a maximum line loss of 12%, PCE reimbursement is lower than would be expected in communities that exceed this cap.

2. **Interties** are low voltage transmission lines between communities. Interties have been proposed by a number of studies as a potential way of reducing energy costs in communities. The most likely savings from an intertie would come from the avoided capital expenditure associated with the replacement of a powerhouse. Operational benefits from interconnections could come from lower operational costs if a power house was eliminated in the process of connecting, greater efficiency and/or incorporation of renewables by being able through economy of scale or lower operational and management costs by combining utilities. Physically larger utilities are not necessarily more cost-efficient or more efficient than smaller utilities, and most of these economic benefits could be gained without interties through close coordination between communities. Larger utilities were shown to be more cost-efficient administratively, but this economy of scale does not require physical interconnections.[367]

   Based on work performed by ACEP for the AkAES project, the AAEM uses per-mile cost assumptions of $500,000/mile off of the road system and $200,000/mile on the road system for the construction of new transmission lines.[368] As a best-case scenario assumption, to estimate costs of new transmission lines in the AkAES study area, a straight-line distance between communities was used. For comparison, the model was run against the nearest community with lower priced power or the regional hub. The costs and benefits are based on an assumed economic life of 30 years.

   Regional distribution systems do not appear to be a cost-effective solution for most of rural Alaska and do not appear to create sufficient economies of scale to merit the investment. Only one project in Southeast was identified as potentially cost effective. The distances traversed are too large, and the loads connected and the savings are too small to cost-effectively reduce the cost of energy in communities. Specific cases may exist that could utilize a low-cost renewable energy or significantly more efficient generation capacity, but based on current conditions these instances are rare. Insufficient data was available to test when an intertie could be used to offset the capital cost of a new powerhouse, but this is likely the situation which would provide the best benefit to communities.

3. **Renewable energy** reduced and/or stabilized the cost of energy in many Alaska communities. In particular, hydro, wind, biomass, and solar power have been touted as solutions for energy costs in

---

[367]Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017.
http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

[368] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

study area communities. In general, however, it can be technically and economically challenging to integrate renewables into the local grid, particularly in small, isolated communities. While it can be difficult, there are a number of potential, site-specific renewable energy resources across the state that could reduce the cost of energy based on today's technology.

The following does not include analysis of all possible renewable energy resources. In particular, it does not include geothermal, tidal, in-river, wave, or biomass for electricity. Geothermal is not included because of the inability to assess a resource without significant, expensive drilling, and no community resource to date have been found to be economically viable. Tidal, in-river hydrokinetics, wave energy, and small-scale biomass for electricity are not mature technologies, and there is insufficient data on which to base the economic analysis of potential projects.

Hydropower can be an especially cost-effective and stable energy source for communities. Although limited by the seasonality of flow and size of resource, both run-of-river (which does not require a sizeable dam) and storage-type projects can displace some or all non-renewable electricity generation in a community.

The data for the evaluation of potential hydro projects comes from more than 400 resource evaluations compiled by the USACE[369] and the REF. Currently, there is no way to effectively model the cost of hydropower due to the multitude of factors that can skew the cost, although this capacity may be available in the future.[370] Some recently identified projects have not been added to the dataset.[371]

If there were multiple potential projects in a community or on an intertie, the highest-performing option was used so that there would not be double counting of the opportunity. The results in Table 23 are based on an assumed 50-year economic life.

As can be seen in Table 23, many of the potential projects are in regions, particularly Southeast, where hydropower already supplies the majority of electricity. The analysis does include some potential projects that have been deemed infeasible for non-economic reasons. For example, one of the two projects in the Lower Yukon-Kuskokwim region was the Chikuminuk Lake Hydroelectric project, which the region was not able to pursue because the resource is in protected lands and permitting was not probable. Copper River/Chugach region will likely have less need for power with the Allison Creek hydroelectric project now online.[372] It is possible that, once data is available from the project, one of the projects within that region will no longer be viable.

---

[369] US Army Corps of Engineers, Alaska District. "Alaska Hydropower Evaluation." May 2014.

[370] Alex DeMarban. "Department of Energy eyes hydropower to help Alaska." Alaska Dispatch News. October 16, 2016. http://www.adn.com/business-economy/energy/2016/10/16/department-of-energy-eyes-hydropower-to-help-alaska/

[371] Elizabeth Jenkins, "Is hydropower renewable? One village in SE Alaska needs it to be." January 6, 2017. KTOO public media. http://www.ktoo.org/2017/01/06/hydropower-renewable-energy-one-village-se-alaska-needs/

[372] Alex DeMarban. "Valdez hydropower project makes utility all-renewable in the summer." Alaska Dispatch News. October 14, 2016. http://www.adn.com/business-economy/energy/2016/10/14/valdez-hydropower-project-makes-utility-all-renewable-in-summer/

Table 23: Hydropower opportunity[373]

AEA energy region	Projects analyzed in region	Number of cost-effective projects identified	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Gallons of diesel offset per year
Aleutians	36	13	$99,935,000	$111,653,000	1,756,000
Lower Yukon-Kuskokwim	7	1	$224,462,000	$79,940,000	3,181,000
Southeast	182	4	$22,205,000	$42,877,000	446,000
Copper River/Chugach	48	7	$241,595,000	$30,293,000	3,622,000
Bristol Bay	29	2	$44,868,000	$13,414,000	872,000
Northwest Arctic	8	3	$35,167,000	$2,591,000	360,000
Yukon-Koyukuk/Upper Tanana	37	1	$15,610,000	$1,123,000	260,000
Bering Straits	16	0	$0	$0	-
Kodiak	34	0	$0	$0	-
Total of AkAES study area	**397**	**31**	**$683,847,000**	**$281,893,000**	**10,499,000**

Wind power uses turbines to extract energy from the wind. Using current technologies, wind power acts as a supplementary source of electricity with another source, such as diesel generators, which provide the majority of power, forming and stabilizing the grid.

The resources evaluated by the AAEM came from multiple sources—the NREL wind map[374], data from anemometers[375], REF projects, and AEA project manager input. Unless specific analysis had been done on a specific system, the assumed project capacity factors for each wind class—the primary means of estimating power production—borrows from the REF evaluation method.

For non-REF projects, the modeled wind nameplate capacity was based on 150% of the average community load, with a minimum average load of 100 kW. It is assumed that 20% of the electricity is diverted to a secondary load to heat a community facility.[376] The estimate for the capital cost was developed by ACEP through work commissioned for the AkAES based on installed projects in Alaska.[377] Insufficient data was available to differentiate the cost estimates by region. The costs and benefits presented in Table 24 are based on an assumed 20-year economic life.

[373] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0
[374] http://www.akenergyinventory.org/data
[375] http://www.akenergyauthority.org/Programs/AEEE/Wind
[376] Josh Craft, personal communication
[377] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

Table 24: Wind power opportunity[378]

AEA energy region	Projects analyzed in region	Number of identified cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Gallons of diesel offset per year
Lower Yukon-Kuskokwim	53	4	$64,695,000	$39,360,000	2,137,000
Bristol Bay	31	3	$36,594,000	$10,393,000	1,364,000
Aleutians	16	2	$31,950,000	$8,661,000	1,206,000
Copper River/Chugach	8	1	$18,307,000	$8,057,000	607,000
Bering Straits	20	1	$11,292,000	$1,872,000	454,000
North Slope	12	3	$8,369,000	$7,659,000	253,000
Kodiak Region	8	0	$0	$0	-
Northwest Arctic	12	0	$0	$0	-
Southeast	23	0	$0	$0	-
Yukon-Koyukuk/Upper Tanana	42	0	$0	$0	-
Grand Total	**225**	**14**	**$171,209,000**	**$76,003,000**	**6,024,000**

Given the site-specific nature of the wind resource, it is not surprising that many communities would not have an economically viable project. Another challenge for wind projects is that small projects cost significantly more per installed nameplate capacity than larger projects. For instance, a 2-MW (megawatt) wind project is estimated to cost one-quarter of the amount per installed capacity of a 100-kW project.

Solar power uses photovoltaic (PV) panels to convert light into electricity. Like wind, using current technologies, solar power acts as a supplementary source of electricity with another source, such as diesel generators, which provide the majority of power to form and stabilize the grid.

The resource estimate for each reference community was pulled from NREL's PVWatts web application[379], and AEA used a distance formula to find the nearest reference community for each AkAES community. Based on work performed by ACEP, commissioned for the AkAES, a price of $6,000/kW was chosen. Based on the data collected by ACEP, solar power in Alaska has had an installed cost between $6,000/kW- $11,000/kW.[380] The costs and benefits in Table 25 are based on the 20-year economic life of the projects and should be considered a best-case scenario.

[378] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

[379] National Renewable Energy Laboratory. PVWatts Calculator. http://pvwatts.nrel.gov/

[380] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

Table 25: Solar PV opportunity[381]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Diesel Offset
Bristol Bay	22	1	$71,000	$36,000	1,100
Yukon-Koyukuk/Upper Tanana	40	1	$56,000	$100	700
Aleutians	12	0	$0	$0	-
Bering Straits	16	0	$0	$0	-
Copper River/Chugach	8	0	$0	$0	-
Kodiak Region	8	0	$0	$0	-
Lower Yukon-Kuskokwim	39	0	$0	$0	-
North Slope	8	0	$0	$0	-
Northwest Arctic	10	0	$0	$0	-
Southeast	23	0	$0	$0	-
Total of AkAES study area	**160**	**2**	**$127,000**	**$36,100**	**1,800**

Solar does not currently appear to be an economically viable resource for utility-scale projects in Alaska. While the prices for solar panels have dropped significantly over the past decade, it is unknown if those hard costs will continue to drop and if the other "soft" costs, which constitute the majority of costs for Alaska projects[382], can be reduced sufficiently in the future to make utility-scale solar power economically viable.

This analysis only includes utility-scale solar projects and does not address building-scale projects. In some communities, it would be possible for a building-scale project to be less expensive than the retail rate for electricity. Utility-wide financial and technical difficulties can be caused by too much distributed generation so these building level projects can cause problems that increase costs if not managed properly.

CONSUMER ELECTRIC RATE—NON-FUEL COSTS

While controlling non-fuel costs has potential to offer energy cost savings, it is not as certain of reducing fuel costs. Infrastructure projects can be modeled relatively easily with physical and economic constraints; utility non-fuel costs are not as easily investigated. While most of Chapter 6 has tried to be as quantitative and data-driven as possible, this section is more qualitative and speculative due to insufficient data.

[381] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

[382] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

The six potential opportunities to reduce the rates that consumers pay for electricity, by reducing utility non-fuel costs include: 1) direct capital grants, 2) utility consolidation, 3) reducing bad debt, 4) reducing non-productive investments, 5) access to more training, and 6) operational and managerial efficiencies.

1. **Direct capital grants**—Most current and historical State energy programs (RPSU, BFU, REF, etc.) have focused on direct capital grants to reduce costs in communities. Anecdotally, capital grants based on the disrepair of the infrastructure instead of the financial need of the entity can create disincentives to properly maintain facilities.[383] There was insufficient data to test this hypothesis quantitatively.

2. **Consolidation of utilities to increase the scale of operations—**Since it was indicated above that interties were not likely to be cost-effective, except in cases where it would avoid the replacement of a powerhouse, the most realistic means of consolidating utilities in the AkAES region is through larger regional utilities—either investor-owned utilities (IOUs) or cooperatives. As seen in Chapter 3, larger utilities exhibited reduced non-generation costs.

   Figure 99 shows the amount of electricity produced at different cost points. The text provides the per kWh cost savings associated with joining a large regional co-op, e.g. AVEC or large regional IOU.

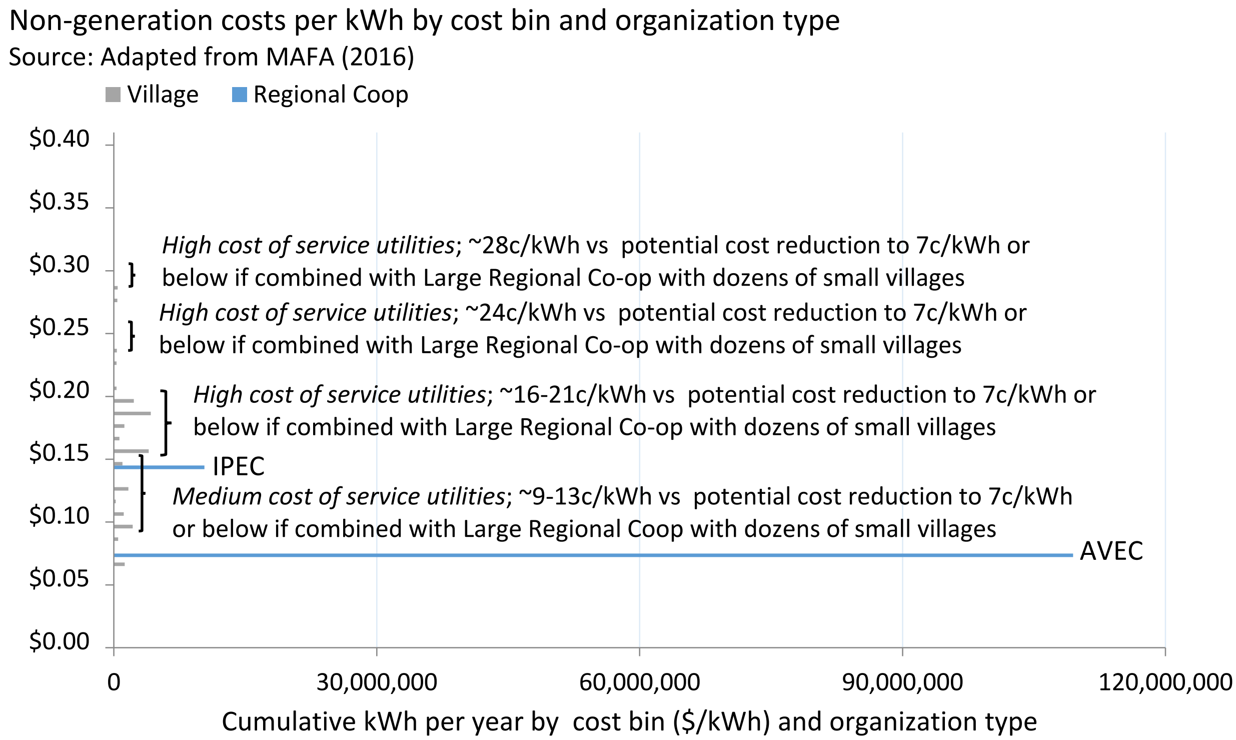


Figure 99: Non-generation costs per kWh by cost bin and organization type[384]

[383] Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm.

[384] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

Figure 99 indicates a potential savings of approximately $15 million per year across PCE communities.[385]

A number of communities have either joined or have expressed interest in joining larger utilities.[386] While savings may be available, not all communities will be in favor of losing control of their utility, especially if they have goals that are not directly about saving money. The example of Yakutat is particularly instructive. Although the incorporation of Yakutat's utility into AVEC would likely benefit Yakutat financially, the RCA received a petition with 277 names opposing the sale of the utility.[387]

The Alaska Rural Utility Collaborative (ARUC), a water and wastewater collaborative, provides assistance to 28 communities in Alaska to provide a greater economy of scale. Developed in 2004 by Alaska Native Tribal Health Consortium (ANTHC), ARUC has shown that a regional entity can successfully improve the operations and management of small, rural utilities and confer benefits to communities and the State. ARUC management assistance improved collection rates in member communities from 73% to 96-98%. By improving pay and benefits, operator turnover was reduced from over 50% to 7%.[388] The cost of energy in ARUC communities dropped by 27% from FY12 to FY14 through improved operations, efficiency, and renewable energy projects. The life of infrastructure built through State and federal grants are expected to last longer than in non-participating communities.[389] These benefits are gained through less direct control than electric cooperative.[390] In 2014, $1.1 million in federal and ANTHC grants helped to fund the financial, managerial, and technical assistance.[391]

In Chapter 5, it was shown that standalone village and city utilities were significantly more likely to need assistance from AEA's Electrical Emergency Assistance programs. Larger consolidated utilities have greater capacity to respond to emergencies without State assistance and/or ensure that emergencies do not happen.

Additionally, it is assumed that larger consolidated utilities are more capable of accessing non-State financing opportunities. Consolidation can also offer greater access to technical capacity and lead to greater generation efficiency and longer effective life of infrastructure and/or other similar benefits.

3. **Reduce the amount of bad debt**—Anecdotally, it has been noted that many utilities have difficulties in collecting customer payments, and this leads to significant bad debt. An analysis of the PCE filings to the RCA for almost 80 utilities did not find any systemic problem with bad debt. Across all

[385] Foster and Townsend, 2017.
[386] James Brooks. "Yakutat sells its power company to statewide cooperative." Juneau Empire. October 24, 2016. http://m.juneauempire.com/state/2016-10-24/yakutat-sells-its-power-company-statewide-cooperative#gsc.tab=0
[387] James Brooks. "Yakutat power sale draws ample opposition." Juneau Empire. November 18, 2016. http://juneauempire.com/state/2016-11-18/yakutat-power-sale-draws-ample-opposition
[388] John Nichols, personal communication, February 18, 2015.
[389] Alaska Rural Utility Collaborative. "2014 Report on Activities." https://anthc.org/wp-content/uploads/2015/12/2014-ARUC-Report-on-Activities-v2_02.09.15_email.pdf
[390] John Nichols, personal communication, February 18, 2015.
[391] ARUC 2014

communities, the savings from reducing bad debt appears to be minimal–at maximum a few hundred thousand dollars across the study area–but it could be important for specific utilities.

It is possible that some utilities do not report debt that has been written off or that it is more an issue of cash flow with payments being sporadic. It is not known what issues are created by sporadic cash flow, but at a minimum, it would require careful planning and an adequate cash reserve to ensure that a sufficient cushion is available to deal with commonly recurring operating payments.

4. **Reduce non- or under-productive investments**—Although utilities and their ratepayers in the AkAES study area do not generally bear the cost of non-productive investments, as most large capital investments have been made through State and federal programs, all non- and under-productive investments have an opportunity cost in terms of time and money spent.

   It is difficult to quantify the opportunity cost of non-productive infrastructure investments, but Chapter 4 showed that many risks and barriers existed that could lead to non- or under-productive investments.

   There are only a limited number of cases in which communities or utilities have had to pay for risky projects. However, in at least one case, this led to the bankruptcy of the utility.[392]

5. **Training and longevity—**Given the importance of having competent operators, training is vital for effective utility operations.[393] Improved operations and maintenance (O&M) will increase the usable life and performance of infrastructure. Adequate training is one of the factors that can improve O&M.

6. **Operational and managerial efficiencies—**Across the nation, it is common for rural and small utilities to have operational and managerial challenges.[394] Operating under the assumption that nearly all entities can be run more efficiently, a generic 5% reduction in the non-fuel costs was modeled against the communities that receive PCE. A reduction of this magnitude could return a total savings of over $5.3 million, with approximately $3.7 million going to consumers and $1.7 million saved in reduced PCE expenditure.

   Another way to address the operational and managerial costs would be to develop a maximum allowable non-generation cost. Figure 100 presents the range of non-generation operating costs.

---

[392] Wesley Loy. "Electric co-op seeks bankruptcy after well cost overruns." Alaska Dispatch News. October 16, 2010. https://www.adn.com/alaska-news/article/electric-co-op-seeks-bankruptcy-after-well-cost-overruns/2010/10/17/

[393] Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf

[394] USDA & EPA. "Rural and Small System Guidebook to Sustainable Utility Management." 2016. https://www.epa.gov/sustainable-water-infrastructure/rural-and-small-systems-guidebook-sustainable-utility-management

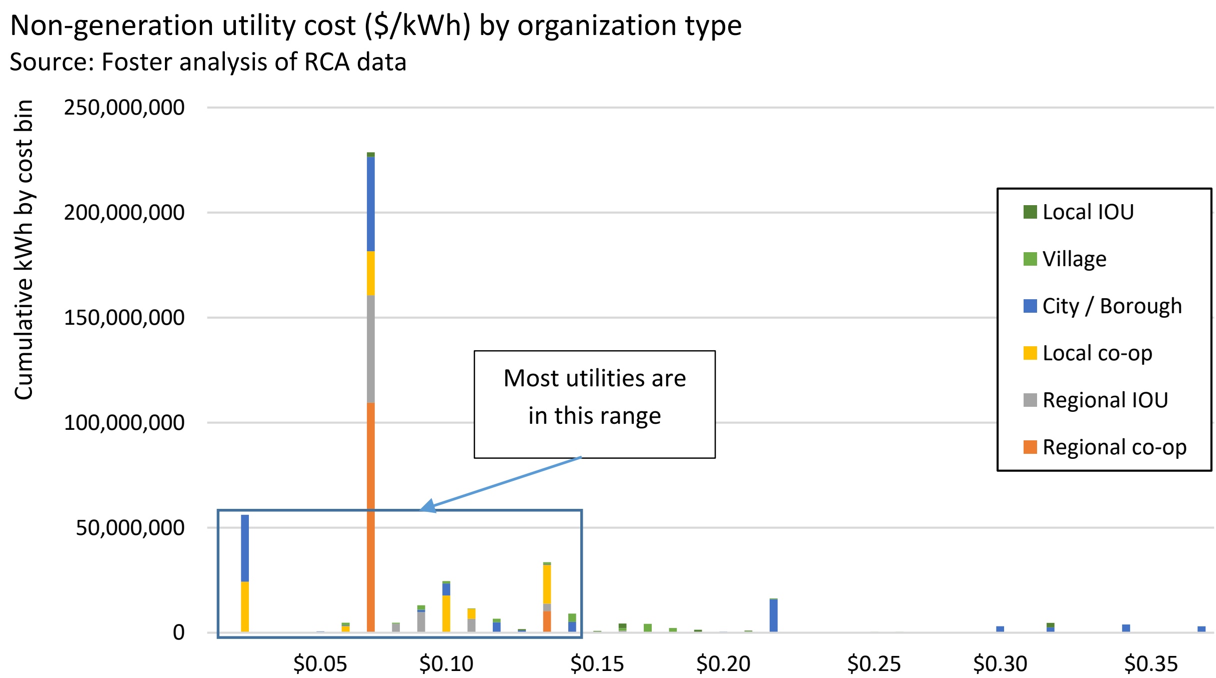


Figure 100: Range of non-generation operating costs by organization type[395]

Figure 100 includes all non-fuel costs that are not related to generation, essentially the overhead costs. A case could be made that the range of acceptable values could be somewhere within the boxed area. Further study would be needed to justify the exact boundaries, but this line of inquiry could provide a method for determining a reasonable cap on these types of expenses.

Ironically, improving utility management, particularly the reporting of expenses, could have the unintended side effect of increasing the reporting of non-fuel costs for some communities. Since it is difficult to know which utilities underreport their expenses, the increase is unknown.

CONSUMER ELECTRICITY CONSUMPTION

Reducing electricity consumption through efficiency and conservation can be, because of the distributed nature of the opportunity, more challenging than improving generation infrastructure. That being said, demand-side reductions have been successful in reducing consumer costs in Alaska.[396] The 2012 Southeast Integrated Resource Plan (SEIRP) identified energy efficiency and demand-side management as

[395] Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017.
http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf

[396] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016.
http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

top priorities for the region[397], and energy efficiency has been identified as the least-cost solution for most rural Alaska communities.[398]

1. **Residential efficiency—**Even without any direct intervention by the State, Alaska's residential electricity consumption is currently declining. Many utilities in the state have seen reductions in consumption per residential customer. Since there have not been any State requirements or programs that have targeted residential electricity consumption and the reduction has been maintained through the recent drop in oil prices, the most likely reason for this reduction is the greater saturation of energy efficient products—LED and CFL lighting, refrigerators, etc.—resulting from federal regulations and technology development.

   There have been limited programs in Alaska that have targeted electricity consumption. Because heating a residence is generally much more expensive than the electricity, and the PCE program lowers electricity costs for rural residents, focusing on electric energy efficiency and conservation savings has not been a high priority. The examples, including RurAL CAP's Energy Wise, Golden Valley Electric Association's Hom$ense program[399], and Sitka's Energy Star program did not yield sufficient data to adequately model the opportunity in the AkAES study area, although they appear to be successful at reducing electric and heating costs.[400, 401]

   Vermont Energy Investment Corporation's (VEIC) "Energy Efficiency Program Evaluation and Financing Needs Assessment" investigated Alaska's energy efficiency programs, primarily those focused on reducing thermal loads. The report provided some guidance on ways to reduce electricity consumption as well. Many states have requirements for their utilities to reduce consumption, an Energy Efficiency Resource Standard (EERS), for instance, and significant research has been done to evaluate the different methods of mandating energy consumption reduction. Another example provided by VEIC include requirements for consumer product efficiency, such as requiring Energy Star compliant products and/or providing incentives at the retail or distributor level to lower the additional cost of the energy efficient choice.[402] Residential building energy codes, covered later in this chapter, are another method to reduce electricity consumption in residential buildings.

   Non-residential—Non-residential buildings in the AkAES study area come in many shapes and sizes and have a variety of uses. Of the approximately 10,000 non-residential buildings in the study area,

---

397 Black & Veatch. "Southeast Alaska Integrated Resource Plan." July 2012. http://www.akenergyauthority.org/Content/Publications/SEIRP/SEIRP-Vol1-ExecSumm.pdf

398 Riley Allen, Donna Brutkoski, David Farnsworth, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska.' December 2015. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf

399 http://www.gvea.com/resources/energysense

400 Brian Saylor & Associates. "Energy Impacts of the RurAL CAP Energy Wise Program from Program Years 2009-201 and 2011-2012."

401 Juliet Agne. "Energy Star Rebate Program: Final Report". 5/20/2013. http://www.cityofsitka.com/government/departments/electric/documents/EnergyStarRebateProgramFinalReportwithAppendices.pdf

402 Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

AEA was able to find some information (the use, size, and/or energy consumption) for about 60% of them. Without energy consumption data for a higher percentage of buildings, there is uncertainty for the costs and benefits estimated in this section. When values for buildings were not available, AEA used known averages for the building size and the heating oil and electricity consumption per square foot (adjusted for climate).

Audits performed through state and federal programs have shown an average of 26% in cost-effective energy savings for heat and electricity at an average cost of approximately $7 per square foot.[403]

In addition to the modeling based on these audits, VEIC also recommended the same suite of programs (minimum product requirements, building energy codes, and incentive programs) as referenced in the residential section previously. The results included in Table 26 are based on a 15-year economic life.

Table 26: Non-residential efficiency opportunity[404]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Gallons of heating oil displaced yearly	kWh saved yearly
Copper River/Chugach	23	21	$42,977,000	$79,682,000	1,557,000	37,250,000
Bristol Bay	30	19	$36,034,000	$67,597,000	991,000	17,041,000
Lower Yukon-Kuskokwim	53	27	$82,329,000	$59,492,000	2,079,000	21,645,000
Kodiak Region	12	6	$47,136,000	$43,102,000	1,205,000	48,340,000
Southeast	43	25	$112,538,000	$42,719,000	2,728,000	98,949,000
Aleutians	12	8	$28,509,000	$39,542,000	644,000	12,724,000
Yukon-Koyukuk/Upper Tanana	55	26	$17,537,000	$12,355,000	502,000	4,043,000
Northwest Arctic	12	11	$22,888,000	$10,325,000	718,000	5,763,000
Bering Straits	16	8	$22,552,000	$8,785,000	659,000	7,292,000
North Slope	8	0	$0	$0	-	-
Total AkAES study area	**264**	**151**	**$412,503,000**	**$363,602,000**	**11,087,000**	**253,051,000**

Non-residential efficiency appears to be cost-effective in the majority of communities in the AkAES region. It would be difficult to capture all of the opportunity for non-residential efficiency, but it is clear there is the potential for significant reduction. Within each community there are likely cost-effective projects for individual buildings. The borough-wide energy subsidies in the North Slope are responsible for non-residential energy efficiency not being cost-effective.

[403] Richard Armstrong. "White Paper on Energy Use in Alaska's Public Facilities." For AHFC. October 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf

[404] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

Aside from new infrastructure, the 2012 "White Paper on Energy Use in Alaska's Public Facilities" identified that decisions on design, conservation, and operations dramatically affected energy use and costs in non-residential buildings.[405]

CONSUMER HEATING FUEL COST

Heating fuel costs are the primary energy expense for both residential and non-residential consumers.

LIHEAP/AKHAP directly addresses the idea of affordability for residential customers as an income-based, direct consumer subsidy program. As seen in Chapter 5, federal funding has been between $21 and $40 million and State funding from $1.4 to $5.7 million per year since AKHAP was instituted in 2009. A 2013 ISER study did not recommend any changes to the AKHAP program, particularly citing the dilution of benefits to the lowest income households if the income cap was raised.[406]

In the same 2013 report, ISER analyzed a potential "PCE-like" program for heating fuel. Using a limit of 500 gallons for the 62,000 eligible households and a $2/gallon reimbursement level, ISER estimated the program would cost $62 million per year.[407]

Other options, such as a system that follows more closely the logic of PCE, where the base rate is determined as a weighted average cost of Alaska's largest cities, would have even higher costs. Extending this logic to try to equalize the residential heating fuel rates equivalent to those in Anchorage on unit-of-energy cost basis would require a subsidy of more than $150 million per year, which is four times more than the current PCE program.

CONSUMER HEATING FUEL RATE

The earlier section outlining the cross-cutting opportunities for electricity and heating cost reduction are also applicable to this section. LNG and propane are unlikely to be economically viable for the AkAES study area and there might be regional fuel depots on the Upper Kuskokwim and at the Dalton Highway bridge over the Yukon that could provide benefits to some communities.

1. **Infrastructure capital subsidies**—The State and federal government have contributed significantly to subsidizing the cost of diesel and heating oil in communities through the Bulk Fuel Upgrade (BFU) program. A number of communities have been identified as needing to upgrade deteriorating facilities. The estimated average annual capital expenditures to replace bulk fuel facilities as they reach the end of their useful life is $17 million. The BFU has reduced retail cost by approximately $0.50/gallon by removing the need to repay the capital costs of the storage facilities.

2. In addition to heating oil, LNG, and propane, there are other heat sources. What follows are the analyses of the potential of biomass cordwood, biomass pellets, and air-source heat pumps (ASHP) for heat in residential and non-residential buildings.

[405] Richard Armstrong. "White Paper on Energy Use in Alaska's Public Facilities." For AHFC. October 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf
[406] Steve Colt, Ginny Fay, Matt Berman, Sohrab Pathan. "Energy Policy Recommendations Draft Final Report." January 25, 2013. http://www.iser.uaa.alaska.edu/Publications/2013_01_25-EnergyPolicyRecommendations.pdf
[407] Colt et al, 2013

Biomass, cordwood–Only non-residential buildings were accounted for in this analysis, as it is assumed that residential consumers would have converted to wood heat given the long-standing tradition of using firewood (the more commonly used term for cordwood) for heat in Alaska. A 2010 survey by the U.S. Forest Service found that a market price between $4.00 and $5.00 was needed for respondents to choose to convert to wood heating, a price point that was reached in much of the study area over the past decade.[408]

The cordwood potential for each community was estimated by analyzing the GIS data available through the Alaska Energy Data Inventory and assumed that 1% of the biomass available in a 5-mile radius could be harvested each year. The costs and benefits of cordwood use a conversion of 30% of the non-residential square footage to biomass heat. The results in Table 27 are over the expected 20-year economic life of the projects.

Table 27: Biomass (cordwood) opportunity[409]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Yearly heating oil displaced of cost-effective projects
Yukon-Koyukuk/Upper Tanana	50	19	$12,439,000	$5,427,000	417,000
Kodiak Region	11	4	$13,860,000	$3,955,000	564,000
Northwest Arctic	11	4	$2,843,000	$2,337,000	108,000
Bering Straits	16	2	$1,777,000	$1,034,000	62,000
Southeast	40	2	$533,000	$311,000	22,000
Lower Yukon-Kuskokwim	47	2	$710,000	$62,000	20,000
Copper River/Chugach	21	1	$177,000	$37,000	9,000
Aleutians	12	0	$0	$0	-
Bristol Bay	27	0	$0	$0	-
North Slope	8	0	$0	$0	-
Total of AkAES study area	**243**	**34**	**$32,341,000**	**$13,165,000**	**1,204,000**

Based on the assumptions of the model, more than 1.2 million gallons of heating oil could be displaced by cordwood annually in the AkAES study area, with more than two-thirds of this potential in the Southeast region. The opportunity is centered in Southeast because of the greater availability of biomass and the larger regional population.

Biomass, pellets–The method for evaluating the opportunity for biomass pellets was nearly the same as for cordwood, except that the availability of pellets was determined by access to roads or the State

[408] David Nicholls, Allen Brackley, and Valerie Barber. "Wood Energy for Residential Heating in Alaska: Current Conditions, Attitudes, and Expected Use." July 2010. https://www.fs.fed.us/pnw/pubs/pnw_gtr826.pdf
[409] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

ferry to allow for consistent delivery of pellets to the communities. The costs and benefits included in Table 28 are over the expected 20-year economic life of the projects.

Table 28: Biomass (pellet) opportunity[410]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Yearly heating oil displaced by cost-effective projects
Yukon-Koyukuk/Upper Tanana	50	11	$3,981,000	$1,972,000	277,000
Copper River/Chugach	21	2	$300,000	$155,000	20,000
Southeast	40	1	$90,000	$3,000	6,000
Aleutians	12	0	$0	$0	-
Bering Straits	16	0	$0	$0	-
Bristol Bay	27	0	$0	$0	-
Kodiak Region	11	0	$0	$0	-
Lower Yukon-Kuskokwim	47	0	$0	$0	-
North Slope	8	0	$0	$0	-
Northwest Arctic	11	0	$0	$0	-
Total of AkAES study area	**243**	**14**	**$4,372,000**	**$2,131,000**	**304,000**

Given the similarity in parameters between the cordwood and pellet modules, it is not surprising that the results are relatively similar. Once again, the Southeast region is the primary beneficiary of this potential opportunity, and it was identified as one of the top recommendation in the Southeast Integrated Resource Plan for reducing electric loads in Southeast communities with high electric heat penetration.[411]

Air-source heat pumps—More efficient than other types of thermal energy sources, air-source heat pumps can deliver up to four units of energy for every unit of electricity consumed. This ratio is generally referred to as the coefficient of performance (COP). While air-source heat pumps (ASHP) can be very efficient in delivering heat, their performance and costs are exceptionally sensitive to climate and electricity price.

The modeling that is used to develop Tables 31 and 32 is based on the fact that the COP and output of the ASHPs is temperature dependent. The COP and output both drop as the temperature drop. ASHPs require a backup heat source in most regions: ASHP do not work well below 0° Fahrenheit, requiring either a biomass or heating oil heating appliance.[412] It is assumed that the ASHP is replacing

[410] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0
[411] Black & Veatch. "Southeast Alaska Integrated Resource Plan." July 2012. http://www.akenergyauthority.org/Content/Publications/SEIRP/SEIRP-Vol1-ExecSumm.pdf
[412] Vanessa Stevens, Colin Craven, Robbin Garber-Slaght. "Air Source Heat Pumps in Southeast Alaska: A review of the literature, a market assessment, and preliminary modeling on residential air source heat pumps in Southeast Alaska." April 2013. http://www.cchrc.org/sites/default/files/docs/ASHP_final_0.pdf

an existing system, which could remain in place for the coldest times of the year, so this redundancy is not included as a cost in this analysis.

Although ASHPs can likely be effective in a number of communities, there is a huge obstacle for implementing them in many communities. As the last column in Table 29 and 30 show, there needs to be significant excess electricity generation capacity for the ASHPs to be viable. If there is insufficient excess capacity, there will not be enough power available in the community to run the heat pumps. Especially since the heating season corresponds with the lowest levels of hydropower availability in most communities[413], there are distinct limitations to the applicability of ASHPs in many regions. The cost of the increased generation capacity is not included as a cost in Table 29 or 30. In some circumstances if ASHPs replace existing electric resistance heating, it would free up generation capacity and potentially avoid or delay capital expenditures to increase capacity.

Non-residential ASHPs: Table 29 assumes that 30% of the non-residential square footage in a community can be converted to ASHPs. The costs and benefits of the projects are over the 15-year expected economic life of the projects.

Table 29: Non-residential ASHP opportunity[414]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Heating oil displaced yearly	Excess capacity needed (kW)
Southeast	40	12	$74,493,000	$66,645,000	4,281,000	7,400
Kodiak Region	11	7	$10,161,000	$18,120,000	684,000	950
Copper River/Chugach	21	1	$7,608,000	$1,156,000	457,000	800
Aleutians	12	3	$1,930,000	$579,000	111,000	150
Lower Yukon-Kuskokwim	47	1	$579,000	$281,000	19,000	50
Yukon-Koyukuk/Upper Tanana	50	1	$300,000	$17,000	7,000	30
Bering Straits	16	0	$0	$0	-	-
Bristol Bay	27	0	$0	$0	-	-
North Slope	8	0	$0	$0	-	-
Northwest Arctic	11	0	$0	$0	-	-
Total of AkAES study area	**243**	**25**	**$95,072,000**	**$86,801,000**	**5,562,000**	**9,000**

The results here are very similar to biomass, with most of the benefits seen in the Southeast region where there are communities with low cost power in a temperate climate. Other areas, with lower-

[413] Leila Kheiry, "KPU back on hydro after warm, wet weekend." KRBD. January 17, 2017. http://www.krbd.org/2017/01/17/kpu-back-on-hydro-after-warm-wet-weekend/

[414] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

cost power, including where cost reductions are available through local subsidies, and maritime climates, also see some significant benefits.

Residential ASHPs assume that all residential buildings are converted to ASHPs using the same logic and performance parameters as the non-residential ASHPs. The costs and benefits in Table 32 are over the expected economic life of 15 years.

Table 30: Residential ASHP opportunity[415]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Heating oil displaced yearly	Excess capacity needed (kW)
Southeast	40	7	$414,484,000	$173,736,000	15,204,000	26,000
Kodiak Region	11	7	$43,437,000	$65,715,000	2,491,000	3,400
Aleutians	12	3	$3,114,000	$830,000	173,000	240
Lower Yukon-Kuskokwim	47	1	$327,000	$134,000	10,000	20
Bering Straits	16	0	$0	$0	-	-
Bristol Bay	27	0	$0	$0	-	-
Copper River/Chugach	21	0	$0	$0	-	-
North Slope	8	0	$0	$0	-	-
Northwest Arctic	11	0	$0	$0	-	-
Yukon-Koyukuk/Upper Tanana	50	0	$0	$0	-	-
Total for AkAES study area	**243**	**18**	**$461,364,000**	**$240,417,000**	**17,879,000**	**30,000**

As with the non-residential ASHPs, the opportunity is clustered in Southeast, with its low cost electricity and maritime climate. Although ASHPs may decrease the consumption of heating oil in communities, it could increase the consumption of diesel to produce the electricity to power the ASHPs, if the electricity in not generated by a renewable source. Tables 29 and 30 assume that communities have the excess generation capacity needed to power the ASHPs.

Heat recovery, otherwise known as combined heat and power (CHP), is the concurrent production of electricity or mechanical power and useful thermal energy from a single source of energy. In diesel generating systems, approximately 30% of the fuel is transformed into electrical energy and 70% of the fuel is transformed into heat. Some of the heat energy normally wasted can be recovered and used directly for space heating, domestic hot water, or for tempering municipal water supplies to prevent freezing and facilitate treatment.

415 Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

There are currently more than 90 communities in rural Alaska that use recovered heat from the diesel generators for space heating needs. During the last 10 years, 41 heat recovery systems have been updated or newly installed in rural Alaska. Approximately 33 communities have completed studies that show a heat recovery system is technically feasible.[416] Table 31 shows the costs and benefits for the evaluated projects over their expected 20-year economic lives.

Table 31: Heat recovery opportunity, includes communities with an existing study[417]

AEA energy region	Number of communities in region	Number of cost-effective projects identified	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Heating oil displaced yearly
Yukon-Koyukuk/Upper Tanana	50	3	$10,351,000	$12,849,000	39,000
Aleutians	12	2	$364,000	$2,100,000	31,000
Lower Yukon-Kuskokwim	47	7	$2,733,000	$1,841,000	57,000
Bristol Bay	27	2	$710,000	$673,000	18,000
Bering Straits	16	1	$617,000	$551,000	14,000
Northwest Arctic	11	2	$877,000	$58,499	9,000
Copper River/Chugach	21	0	0	0	0
Kodiak Region	11	0	0	0	0
North Slope	8	0	0	0	0
Southeast	40	0	0	0	0
Total of AkAES study area	**243**	**17**	**$15,654,000**	**$18,073,000**	**370,000**

Table 31 includes only projects that had at least one feasibility study. Other communities may have a viable project, but AEA lacked the data to do an analysis. With the expansion of marine manifolds to Detroit Diesel 60 engines, the number of communities that will be able to increase their use of heat recovery is expected to expand.[418]

3. **Potential non-infrastructure solutions:** Over the years, there have been calls to regulate fuel distributors—companies such as Crowley, Petro Star, and others—with the belief that high retail prices were due to price gouging by these companies. With this as a target, several academic studies by ISER were unable to find that unusually high profits were being realized by fuel distributors.[419] Additionally, an investigation by the Alaska State attorney general, which had access to proprietary

[416] AEA Heat Recovery Fact Sheet. December 2016. http://www.akenergyauthority.org/Publications
[417] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0
[418] Devany Plentovich, Steve Stassel, Bill Thompson, Mark Bryan. "Enhancing Heat Recovery by Using Marine Manifolds with Detroit Diesel Series 60 Engines." May 2016.
[419] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

information, did not find any indication of excess profits from the distributors.[420] It does not appear that regulating fuel distributors would provide much benefit to communities.

Both the ISER studies and an investigation by the attorney general found large, unaccountable differences in the local markups by the retailers, even in communities that were geographically close. Multiple studies were unable to ascertain the cause of the differences in local retail markups.[421, 422] As was shown in Chapter 3, local retail pricing decisions can be an important driver for consumers' cost of energy. Because of these unaccountable differences and the de facto monopoly on fuel sales in many communities, it is possible that regulation of local fuel retailers could be warranted. Both the previous ISER studies and the attorney general's report determined that the cost of regulation and enforcement would have a net increase fuel costs.

The attorney general's investigation also provided another novel, non-regulatory solution to the conundrum of local markups. Instead of creating a regulatory structure to limit the markups, the retailer would be required to be transparent about the various components of the final retail cost—product, labor, capital, and profit. While it would not necessarily reduce the cost, the retail customers would have a better understanding of the final cost. This would require statutory approval, as it would create a unique class of retail products. It is difficult to know how retail fuel prices would respond to this requirement.

CONSUMER HEATING FUEL CONSUMPTION

1. **Building energy codes**: Recommended by a number of previous studies and policy papers, building energy codes for both the residential and non-residential sectors can assist in reducing future energy costs for consumers. Given the long life of buildings, 50 to 100 years is not uncommon for a residence; the initial design and construction can lock in the energy consumption for decades. For a relatively minimal increase in initial cost, decades of operational costs can be reduced significantly more cost-effectively than through retrofits.

   Even in Alaska, the housing market tends to be made up of older structures. In many communities, a sizeable percentage of the housing stock is more than 30 years old.[423] Based on data available through the Alaska Department of Labor and Workforce Development, new construction in communities does not appear to be tied to population but is a function of budgets and funding availability.[424]

---

[420] Alaska Attorney General. "Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General's gasoline pricing investigation", 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf

[421] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

[422] Meghan Wilson, Ben Saylor, Nick Szymoniak, Steve Colt, and Ginny Fay. Components of Delivered Fuel Prices in Alaska. June 2008. http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf

[423] Nathan Wiltse, Dustin Madden, By Valentine, Vanessa Stevens. "2014 Alaska Housing Assessment." Cold Climate Housing Research Center report for the Alaska Housing Financing Corporation. April 2014. https://www.ahfc.us/efficiency/research-information-center/housing-assessment/

[424] AEA analysis of DOL&WD housing starts and population data

In many parts of the state, particularly within the AkAES region, housing authorities are the primary builders of new buildings, with the private sector playing a very small role in new construction. Assuming that the rates for new construction hold steady, as shown in Table 32, this places limits on the effectiveness of strategies like residential building codes for new construction.

Table 32: Rate of housing construction in AkAES study area[425]

Number of occupied units	45,000	residences
New units 2000-2014	6,500	residences
Average new units/year	430	residences/year
Number of years to turnover housing at current rate	**100**	**years**

Building energy codes cannot be the only strategy used for reducing residential energy consumption, because, it will take more than 100 years at the current rate of housing construction to replace the current housing stock.

Related to building energy codes, the State could institute minimum product requirements, e.g. for boilers/furnaces, water heaters, etc., as recommended by the VEIC report commissioned for the AkAES.[426]

2. **Residential energy efficiency** is the primary strategy for reducing residential energy costs for existing structures. Through the State and federal low-income Weatherization Assistance Program and the State Home Energy Rebate program, thousands of residential buildings have been weatherized across the state. The data collected by these programs are invaluable in understanding the additional opportunity across the AkAES study area. Weatherization will be used generically in this section to indicate all residential thermal energy efficiency activities, even if they are not performed under the auspices of the Weatherization Assistance Program. The costs and benefits displayed in Table 33 are over the expected 15-year life of the projects.

[425] Data accessed from the Department of Labor and Workforce Development. 2015.

[426] Vermont Energy Investment Corporation. "Energy Efficiency Program Evaluation and Financing Needs Assessment." July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107

Table 33: Residential energy efficiency opportunity[427]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Heating oil displaced yearly
Southeast	40	25	$192,538,000	$69,066,000	4,087,000
Lower Yukon-Kuskokwim	47	44	$74,468,000	$50,676,000	1,231,000
Copper River/Chugach	21	20	$29,805,000	$43,226,000	972,000
Yukon-Koyukuk/Upper Tanana	50	40	$21,191,000	$31,689,000	478,000
Bering Straits	16	15	$45,469,000	$27,527,000	866,000
Northwest Arctic	11	11	$21,523,000	$21,290,000	429,000
North Slope	8	2	$24,557,000	$19,427,000	20,000
Kodiak Region	11	9	$24,402,000	$16,926,000	540,000
Bristol Bay	27	17	$16,101,000	$12,821,000	364,000
Aleutians	12	9	$20,657,000	$6,200,000	445,000
Total of AkAES study area	**243**	**192**	**$470,715,000**	**$298,852,000**	**9,436,000**

Building energy codes would take a very long time to improve the efficiency of the residential building stock in Alaska. There is a very large opportunity for weatherization to reduce Alaskans' energy costs. Even though the Weatherization Assistance Program and Home Energy Rebate programs have been successful, there are still thousands of residences that need to be weatherized. Though the total investment is large--nearly half a billion dollars total—every individual investment is relatively small. Based on a 2010 survey by the U.S. Forest Service, homeowners were willing to spend $250-$1,000 per year for increased energy efficiency.[428]

Residential efficiency appears to be cost-effective in almost all AkAES communities. While the opportunity is substantial–over 9 million gallons of heating fuel saved per year—it is less than the 11.1 million gallons in potential savings in the non-residential sector seen in Table 26. The relatively lower amount of residential heating fuel savings is from the greater number of heat sources for residences, including firewood and electricity, and the work already done to weatherize more than 10,000 residential buildings and the new housing built by housing authorities to high standards in the AkAES region.

Residential efficiency will also help to protect Alaskans from the fluctuations in the price of heating oil. Figure 101 shows the expected yearly savings of a weatherized home. The figure assumes the

[427] Alaska Affordable Energy Model version model 0.24.1, data 0.24.0
[428] David Nicholls, Allen Brackley, and Valerie Barber. "Wood Energy for Residential Heating in Alaska: Current Conditions, Attitudes, and Expected Use." July 2010. https://www.fs.fed.us/pnw/pubs/pnw_gtr826.pdf

average energy savings from weatherization in western Alaska and uses historical prices to estimte savings.

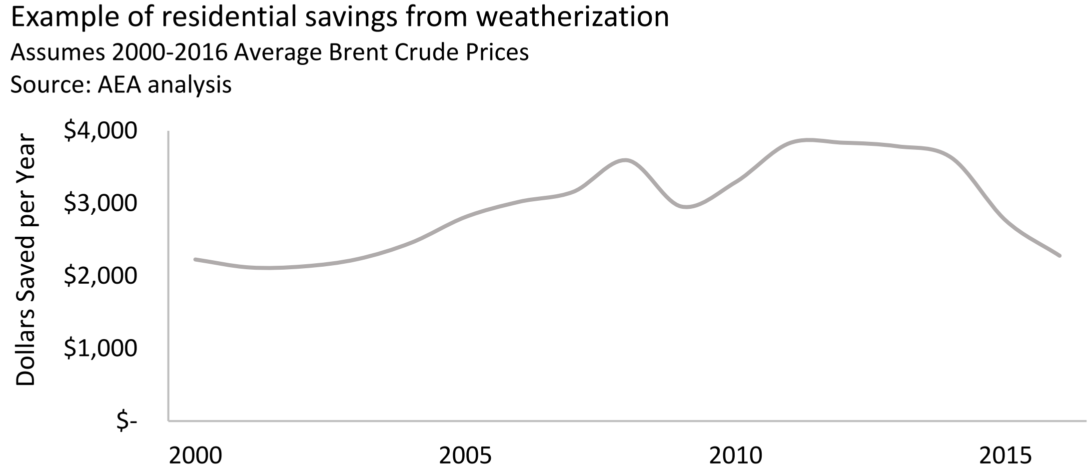


Figure 101: Example of residential savings from weatherization[429]

Based on the changes in the world oil market over the past 15 years, the amount of savings the resident could expect varied from approximately $2,000 to nearly $4,000 per year.

3. **Non-residential weatherization** was included in the previous section on reducing electricity consumption. See Table 28 for the results. The estimated savings in heating oil are slightly more than those for the residential sector. This may be due to a number of factors, including a greater diversity of heating fuels for residential buildings, greater total square footage of non-residential buildings, higher intensity use in some non-residential building types, and/or a disconnect between who operates the building and who pays the energy bills.[430]

4. **Water and wastewater efficiency** can include efficiencies in the use of both electricity and heat. Savings can be found through improved operations, lowering set points for water temperatures, replacing water heaters and inefficient pumps, and installing more efficient lighting. A common misconception is that the water and wastewater systems are primary consumers of energy in most communities. Based on the greater amount and quality of data developed through the AkAES, it is clear that water and wastewater systems are important consumers in many communities, but generally a small percentage of the overall consumption.

   The Alaska Native Tribal Health Consortium (ANTHC) has performed more than 60 energy audits on community water and wastewater systems over the past several years. This data, along with modeled consumption data when actuals were not available, were used to estimate the costs and benefits of water and wastewater efficiency opportunities over the expected 15-year life of the project.

[429] AEA analysis of multiple sources
[430] Richard Armstrong. "White Paper on Energy Use in Alaska's Public Facilities." For AHFC. October 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf

Table 34: Water & wastewater efficiency opportunity[431]

AEA energy region	Number of communities in region	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Net benefit of cost-effective projects	Heating oil displaced yearly	kWh saved yearly
Lower Yukon-Kuskokwim	47	33	$2,682,000	$10,050,000	99,000	777,000
Yukon-Koyukuk/Upper Tanana	50	26	$2,675,000	$6,735,000	89,000	518,000
Bering Straits	16	12	$2,404,000	$5,129,000	81,000	319,000
Northwest Arctic	11	8	$1,710,000	$4,655,000	27,000	536,000
Bristol Bay	27	17	$1,317,000	$3,211,000	35,000	299,000
Aleutians	12	9	$650,000	$1,280,000	17,000	135,000
Kodiak Region	11	6	$272,000	$600,000	9,000	75,000
Southeast	40	6	$292,000	$565,000	10,000	81,000
Copper River/Chugach	21	2	$101,000	$353,000	5,000	44,000
North Slope	8	0	$0	$0	-	-
Total of AkAES study area	**243**	**119**	**$12,106,000**	**$32,583,000**	**377,000**	**2,786,000**

Improvements to the efficiency of water and wastewater systems can represent locally important savings opportunities with excellent returns on investment. Although the total estimated savings is less than some other project types, the energy cost savings would be distributed across the entire community.

ARUC reported in 2013 that infrastructure improvements were expensive but easy, one-time fixes that were expected to benefit the community. Without changes to the operations and maintenance practices, which are less expensive but more difficult, new infrastructure, and the concurrent benefits, could not be expected to be maintained over time.[432]

5. **Non-infrastructure solutions** for reducing heating fuel consumption exist. While building occupant behaviors can have a marked impact on the building's electricity consumption (lights can be turned off, TVs unplugged, etc.), the energy needed to keep a building warm is more fixed by the physical constraints of the building and the climate. Certain occupant behaviors, such as the set point for the interior temperature, turning the thermostat down when the building is unoccupied, and if doors and windows are left open, will affect consumption considerably. Given that behavioral changes are often low- to no-cost actions, informing people on how their behavior can impact their energy costs is an important part of any energy education and outreach program.

---

431 Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

432 John Nichols. "Lessons Learned: Rural water systems & operational efficiency." Presentation to the Alaska Rural Energy Conference. April 30, 2013. http://www.uaf.edu/files/acep/2013_REC_Lessons%20Learned-Rural%20Water%20Systems%20&%20Operational%20Effciency_John%20Nickels.pdf

COMPARISON OF OPPORTUNITIES

The infrastructure opportunities presented in this chapter are compared in Table 37. The project types are arranged by the amount of diesel and heating oil that could be offset. In reading the table, it is important to remember the caveats and limitations of each project-type analysis. For instance, residential and non-residential ASHP rank high on the table, but the results do not include an analysis of if there is sufficient excess capacity in the communities to run the ASHPs. If new capacity must be built, the economics of ASHPs would change and would likely end up being uneconomic in most communities.

Annually, study area communities consume approximately 90 million gallons of heating oil and 30 million gallons of diesel for electricity generation. The table shows that around half of the heating oil could be displaced through a combination of project types, but there is overlap between projects within communities that is not addressed in the table, overstating the possible total savings.

Table 355 does not rule out potential double counting of energy cost reductions. Some of the savings identified by the AkAES project are mutually exclusive—cordwood, pellets, and non-residential ASHPs are displacing the heating oil for non-residential buildings in most of the same communities. There is also some overlap between non-residential efficiency and these previous three opportunities. Similarly, some overlap between the residential ASHP and residential weatherization exists. A number of communities had cost-effective wind and hydro resources, but only one of the resources would likely be developable.

All of the generation projects are compared against existing grant-funded projects under the assumption that they are debt-financed. Under the current assumption, few new generation infrastructure projects will decrease communities' energy costs. As existing infrastructure reaches the end of its useful life, it will be important to evaluate the options within the community to provide the necessary service at the lowest possible cost.

Table 35: Comparison of infrastructure opportunities[433]

Type	Number of communities/ interties	Number of communities with cost-effective projects	Investment needed for cost-effective projects	Lifetime net benefit of cost-effective projects	Annual diesel offset by generation &/or efficiency (gallons)	Annual heating oil displaced (gallons)	Extra capacity needed/offset (kW)
Non-residential efficiency	264	151	$412,503,000	$363,602,000	5,440,000	11,087,000	-17,000
Residential ASHP	243	18	$461,364,000	$240,417,000		17,879,000	30,000
Residential efficiency	243	192	$470,715,000	$298,852,000		9,436,000	
Hydro	397	16	$362,432,000	$191,459,000	5,900,000		
Non-residential ASHP	243	25	$95,072,000	$86,801,000		5,562,000	9,000
Wind	225	11	$127,961,000	$52,779,000	4,440,000		
Biomass--cordwood	243	34	$32,341,000	$13,165,000		1,204,000	
Water/wastewater efficiency	243	119	$12,106,000	$32,583,000	214,000	377,000	
Heat recovery	243	17	$15,654,000	$18,073,000		370,000	
Biomass--pellets	243	14	$4,372,000	$2,131,000		304,000	
Powerhouse replacement	186	1	$17,528,000	$1,919,000	288,000		
Solar	160	6	$127,000	$37,000	1,800		
Interties	186	1	$614,000	$588,000			

433 Alaska Affordable Energy Model version model 0.24.1, data 0.24.0

Based on AEA's analysis of the best available data, non-residential, residential efficiency, and water/wastewater efficiency projects are cost-effective in the largest number of communities and residential and non-residential efficiency have the two highest net benefits.

Thermal projects—biomass, ASHPs, and heat recovery—are the next tier of opportunity. Each of these project types has a somewhat limited geographic area of where they are cost-effective, and there is overlap between them. Additionally, the analysis does not include the costs associated to provide the excess generation capacity needed (39MW) to capture the full ASHP opportunity.

The cost-effectiveness of generation projects is very site specific. Replacing the status quo generation systems with new hydro, wind, powerhouse replacements, solar, and interties each have locally significant applications, but none of them are applicable in more than 10% of communities in the AkAES study area.

For generation projects, the greatest identified benefit is from hydro, although this includes projects that may not be possible because of permitting restrictions and overlap with projects currently under construction or recently finished. Also note that the net benefits of hydro are over the 50-year expected life of the projects, which accounts for its relatively high net benefit.

Technology and costs will likely change, and cost-effective opportunities may be different in the future. It will be important to continue to update and provide communities with the best available data about expected cost and performance.

A number of new technologies have not been included in this analysis, including tidal, water, in-river, and other technologies. The application of these future technologies to Alaska will require that the technical potential is carefully and realistically vetted to limit the amount of non-productive investments by the State and communities.

Table 36: Comparison of non-infrastructure opportunities

Potential Opportunity	Expected Benefit
Consolidation of utilities	$15M/year in non-fuel cost savings
Operational and management efficiencies	$5.3M, overlap with consolidation
Generation efficiency	2.1M gallons of diesel saved per year
Line loss reduction	1.0M gallons of diesel saved per year
Fuel transportation improvements	<$1M in operational savings per year
Fuel co-ops	Uncertain, but potentially viable
Training	Uncertain, but likely viable
Residential electricity efficiency	Uncertain, but likely viable
Regulate fuel distributors	Does not appear to be viable
Regulate fuel retailers	Does not appear to be viable
Switch to LNG, propane	Does not appear to be economically viable

Based on the AEA's data and analysis there appears to be significant cost savings that could be gained through consolidating utilities and/or improving the operational and management efficiency of utilities.

Reducing the retail costs of fuels is more complicated. Although a couple of potential sites for increased bulk fuel storage were identified, the other potential strategies for reducing retail costs were either uncertain or did not appear to be viable. Even though the local decisions on the retail price of fuel is an important driver of cost, AEA could not identify an effective way to influence this.

The potential savings from improving generation efficiency (over 2.1 million gallons of diesel or $4.7 million/year) and reducing line losses (over 1.0 million gallons of diesel or over $2 million/year) is sizeable and very likely cost-effective.

CHAPTER 7: PLAN AND RECOMMENDATIONS

Previous chapters have looked at the factors that impact energy affordability. Chapter 7 applies this research to develop a practical, achievable plan and actionable recommendations for the "design, development, construction, [and] financing of required infrastructure."

The plan and recommendations focus on six strategies:

1) **use data** to assist communities, program administrators and policy-makers in making more informed, data-driven decisions;
2) **strategically target** opportunities that are most likely to reduce the cost of energy in communities;
3) **evaluate all projects** as if they will be financed by loans;
4) increase access to **federal and private funding**, particularly loans;
5) **increase accountability** for the State, utilities, and communities; and
6) create a source of **stable and sustainable funding**.

The AkAES plan and recommendations will reduce the total need for State funding. Though implementing the plan may increase State operating costs, these will be offset by a reduction in State capital spending on energy projects in the AkAES study area achieved through a combination of data-driven decision making, diversification of financing sources, and improved accountability. Even if State revenues recover sufficiently to provide a stable source of funds, the plan will help improve coordination, provide greater accountability for State agencies and recipients of State funding, and increase the return on the State's community energy investments.

PLAN TO ADDRESS KEY BARRIERS TO AFFORDABLE ENERGY

It is difficult to reduce the cost of energy dramatically for communities in the AkAES study area without significant subsidy, as was shown in Chapter 6. Too many barriers exist that the State cannot meaningfully influence. The plan developed through the AkAES can provide for incremental improvement by connecting the research findings to potential policies. In addition to strategies for reducing energy costs for both heat and electricity, new strategies are needed to diversify project financing while ensuring sufficient State funds to implement the energy programs and projects.

Each of the following sections — "Energy costs for heat and electricity", "Transition from state grants to increased debt financing", and "Sustainable State energy funding" — summarizes research presented in this report on the cost drivers the State can and cannot influence. Recommended policy mechanisms are included for each of the sections. Footnotes provide references to other reports that have included similar recommendations.

ENERGY COSTS FOR HEAT AND ELECTRICITY

Energy costs are driven by complex variables. Some can be influenced by State actions; most cannot. For both electricity and heating fuels, energy cost is determined by two factors: the market rates paid by energy consumers and the amount of energy consumed by the end user.

AEA estimates that more than 120 million gallons of diesel and heating oil are consumed in the AkAES study area annually. Since these fuels must be imported into communities, a significant amount of the money spent on energy leaves Alaska communities.

At 2016 prices, AEA estimates total electricity costs at about $300 million per year for the study area, with diesel fuel accounting for about 20% of that cost. Since the largest consumers of electricity (Juneau, Sitka, Ketchikan and Kodiak) generate nearly 100% of their electricity from renewable resources, the percentage spent on imported diesel is much higher than 20% in the balance of the study area. Chapter 6 identified potential electric cost savings of approximately 10% through a combination of infrastructure and non-infrastructure changes.

At 2016 prices, AEA estimates that annual heating oil costs are about $330 million in the AkAES study area. The retail price of heating oil is more closely tied to global oil prices than electric rates are. Firewood is an important secondary heating fuel that accounts for as much as 40% of residential thermal loads in some regions, offsetting the total consumption of heating oil in these regions. Other heating fuels, such as propane, natural gas, and coal, are used significantly less across the study area.

Given the preponderance of petroleum fuel consumption as a driver of energy costs, the following sections on heat and electricity primarily focus on how to reduce costs associated with heating oil and diesel generation. Although there are many similarities across communities, there is no one-size-fits-all solution. Strategies deployed to increase access to affordable energy must be tailored to the specific resources, needs and capacity of the community and/or utility they are intended to benefit.

HEAT ENERGY COSTS

Heating residential and non-residential buildings account for approximately 75% of all non-transportation petroleum fuels consumed in the AkAES study area. Particularly in PCE communities where the cost of electricity is subsidized, heating oil constitutes the majority of consumers' energy costs.

Rates: In 2016, the retail price of heating oil ranged from a low of $1.40 in the North Slope Borough where the borough subsidizes residential heating fuel costs, to a high of $10 per gallon. The median was $4.55 per gallon.

Cost drivers the State cannot influence:

1. The international market price for oil.
2. Many of the delivery cost drivers, including:
    a. the large distances from refineries which increases the transportation component of fuel costs;
    b. the relatively shallow draft required to reach many coastal and riverine communities, which limits the volume of fuel that can be barged at one time; and
    c. the limited season that northern ports are ice-free and rivers are navigable. The short delivery window leads to lower utilization of capital for barge carriers, driving costs up.
3. The extra risks and costs of purchasing fuel one or two times per year. The retail price will only respond to changes in commodity costs very slowly, which could be beneficial or detrimental depending on

whether the price of oil is rising or falling. Regardless of price fluctuations, storing a year's worth of fuel ties up a significant amount of capital that cannot be used for other community purposes.

4. The availability of local alternative energy resources.

Cost drivers the State can influence:

1. Efficiencies in fuel delivery by supporting:
    a. local infrastructure improvements such as marine headers and moorings
    b. nonprofit fuel distributors
    c. regional bulk fuel facilities (locations on the upper Kuskokwim and upper Yukon have been found to be potentially cost-effective)
2. Economies of scale for fuel purchasing through regional organizations
3. The cost of storage (e.g. through improvements in infrastructure and management through the Bulk Fuel Upgrade program)
4. The identification of cost-effective alternative energy sources and fuels, such as air-source heat pumps (ASHPs), biomass and heat recovery
5. The risk local retailers face of not selling all the purchased fuel during the heating season and/or being unable to collect payment
6. The profit earned by fuel distributors and local retailer, neither of which are currently regulated (local retail markups are highly variable and sometimes exceed $3/gallon)
7. Energy efficiency standards for building and heating appliances

Recommended policy mechanisms the State can use to influence these cost drivers:

1. Strengthen data collection and analysis of alternate heating choices
2. Provide assistance in identifying, comparing, scoping and accessing financing for cost-effective alternative energy or energy efficiency projects
3. Provide assistance in rate setting[434, 435]
4. Provide assistance for regional organizations interested in providing fuel services to communities[436,437]
5. Provide access to financing for regional and/or site-specific bulk fuel storage[438]
6. Provide access to loans for bulk non-petroleum fuels (e.g. biomass)

Consumption: Average community residential heating oil consumption ranges from 500 gallons to more than 2,500 gallons per year in the AkAES study area. There are stark differences across regions and communities due to climate, building size, and building quality. Some consumers have chosen to use firewood and electricity as their primary heat source where it is cost-effective; this includes 40% of

---

[434] Alaska Attorney General. "Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General's gasoline pricing investigation", 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf

[435] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf

[436] Meghan Wilson, Ben Saylor, Nick Szymoniak, Steve Colt, and Ginny Fay. "Components of Delivered Fuel Prices in Alaska." June 2008. http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf

[437] Alaska Attorney General 2010.

[438] Wilson et al, 2008.

residences in the Yukon-Koyukuk/Upper Tanana that use wood as their primary heat source, and 20% of residences in Southeast that use electricity. Even with these exceptions, heating oil remains the predominant heating fuel in homes across the AkAES study area.

Non-residential buildings in the study area almost universally heat with heating oil. The exceptions are areas with local natural gas (Barrow and Nuiqsut) and some communities in Southeast with very low-cost hydropower. Of the approximately 10,000 non-residential buildings in the AkAES study area, less than 150 are known to use an alternative to heating oil for space heat. These include recovered heat from diesel generators, biomass, air-source and ground-source heat pumps, and secondary loads from renewable energy projects.

Cost drivers the State cannot influence:

1. Alaska's cold climates

Cost drivers the State can influence:

1. Building efficiency for new and existing residential and non-residential buildings
2. Consumer behaviors to conserve energy
3. Distribution of state funding and financial incentives for energy efficiency projects

Recommended policy mechanisms the State can use to influence the cost drivers:

1. Fulfill the intention of AS 44.99.115 and enact residential and non-residential building energy codes[439,440,441,442,443]
2. Extend residential energy efficiency program services to renters[444, 445]
3. Provide greater transparency of energy consumption data[446]
4. Assist communities to identify, compare, scope and access financing for cost-effective projects
5. Support regional entities interested in assisting communities with efficiency projects[447, 448]
6. Provide technical assistance for building audits and retrofits

---

[439] Walker/Mallot Transition Team Conference. "Team Report". *Consumer Energy*. November 21-24, 2014. https://gov.alaska.gov/Walker_media/transition_page/combined-report_final.pdf
[440] Cady Lister, Brian Rogers, and Charles Ermer. "Alaska Energy Efficiency Program and Policy Recommendations." June 5, 2008. http://www.cchrc.org/sites/default/files/docs/EE_Final.pdf
[441] John Davies, Nathaniel Mohatt, Cady Lister. "Alaska Energy Efficiency Policy and Programs Recommendations: Review and Update." June 27, 2011. http://www.cchrc.org/sites/default/files/docs/Interim_EE_Policy_Report.pdf
[442] Cold Climate Housing Research Center, "Energy Efficiency Policy Recommendations for Alaska." May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf
[443] Richard Armstrong. "White Paper on Energy Use in Alaska's Public Facilities." For AHFC. October 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf
[443] Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf
[444] Steve Colt, Ginny Fay, Matt Berman, Sohrab Pathan. "Energy Policy Recommendations Draft Final Report." January 25, 2013. http://www.iser.uaa.alaska.edu/Publications/2013_01_25-EnergyPolicyRecommendations.pdf
[445] Walker/Mallot Transition Team Conference. "Team Report". *Consumer Energy*. November 21-24, 2014. https://gov.alaska.gov/Walker_media/transition_page/combined-report_final.pdf
[446] Allen et al. 2016
[447] Colt et al, 2013.
[448] Allen et al. 2016

7. Provide funding for low income residential weatherization assistance program[449, 450, 451, 452, 453, 454]
8. Provide statutory authority for utilities, communities and boroughs to allow on-bill and/or property assessed financing options[455]
9. Require a measurable reduction in fuel consumption[456]

Electricity energy costs

The drivers of electricity costs are more complex than for heating fuels. The retail rate of a kWh of electricity is broadly divided into fuel costs and non-fuel costs. Fuel costs are determined by the unit cost of the fuel (free for renewables), generation efficiency and line losses. Non-fuel costs include personnel, overhead and operations and maintenance (O&M).

Setting aside data from the five large utilities in the study area that produce nearly 100% of their electricity with hydro and wind power (Juneau, Sitka, Kodiak, Ketchikan/Petersburg/Wrangell, Metlakatla), diesel used for electric generation accounts for nearly 50% of all non-transportation petroleum fuel consumed in communities. Total spending on electricity (including fuel and non-fuel costs) across the study area accounts for a little less than half of energy costs paid for by consumers and through government subsidies.

Power Cost Equalization provides $30 million to $40 million in subsidies to residential and qualifying community facility customers, representing about 28% of all sales in PCE-eligible communities. The subsidy is covered by investment income from the PCE Endowment, a savings fund established by the legislature.

Rates: The lowest electric rates in the AkAES study area—approximately $0.10/kWh—are in Southeast communities with access to State-financed hydropower. Outside of these communities, rates range from $0.15 to $1.80/kWh, with a median in PCE-eligible communities of $0.62/kWh. A number of communities and the North Slope Borough provide a direct subsidy to consumers to reduce the impact of high electric rates.

The cost of fuel as a percentage of the residential rate varies by community. Across the AkAES study area, the median value is 55%, but some communities have nearly no fuel costs, while in others the residential rates do not cover the full fuel costs either through intentional subsidy or poor rate setting.

---

[449] Lister et al, 2008.
[450] Davies et al, 2011.
[451] Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf
[452] Alaska Arctic Policy Commission. "Final Report of the Alaska Arctic Policy Commission." January 30, 2015. http://www.akarctic.com/wp-content/uploads/2015/01/AAPC_final_report_lowres.pdf
[453] Colt et al, 2013.
[454] Allen et al. 2016.
[455] Cold Climate Housing Research Center, "Energy Efficiency Policy Recommendations for Alaska." May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf
[456] Walker/Mallot Transition Team Conference, 2014.

Cost drivers the State cannot influence:

1. The drivers of the delivered cost of fuel as outlined in the "Heat Energy Costs" section above
2. The population size of communities and resulting economies of scale for generation and distribution
3. The availability of local renewable resources
4. The availability of local or borough taxes to provide local subsidies

Cost drivers the State can influence:

1. The efficiency of diesel transportation and delivery, as outlined above in "Heat Energy Costs"
2. The identification of cost-effective alternative energy sources and fuels
3. The efficiency and performance of existing infrastructure including generation efficiency and line loss
4. The economic life of infrastructure
5. Improvements in utility management, such as
    a. accurate and full reporting for eligible expenses to PCE
    b. effective rate setting
    c. encouraging virtual economies of scale by consolidating utility management functions
    d. identifying other revenue sources, such as heat sales
6. Distribution of capital and direct consumer subsidies
7. Requirements for accessing State funding

Recommended policy mechanisms the State can use to influence the cost drivers:

1. Assist communities to identify, compare, scope, and access financing for cost-effective projects[457, 458]
2. Assist regional organizations in providing energy services (financial, managerial, and/or technical assistance) to communities[459, 460, 461]
3. Prioritize State capital subsidies based on community financial need
4. Fund generation, transmission, and distribution projects, with performance, financial, and management standards to extend the economic life of energy infrastructure
5. Align incentives to maintain infrastructure[462]
6. Provide technical assistance to meet financial, managerial, and performance standards[463, 464]

---

457 Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. "Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects." December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280

458 Mark Foster & Northern Economics. "Alaska Rural Energy Plan, Initiatives for Improving Energy Efficiency and Reliability." April 2004. https://alaskastateenergy.files.wordpress.com/2007/12/2002ruralenergyplanaea-northernecon.pdf

459 Holdman et al, 2016.

460 Foster & Northern Economics, 2004.

461 Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf

462 Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm.

463 Colt et al, 2003.

464 Holdman et al, 2016

7. Support best practices and requirements to meet financial, managerial, and performance standards[465, 466, 467, 468, 469]
8. Establish requirements to cost-effectively reduce diesel consumption through improvements to generation and line loss efficiency, demand side efficiency and/or integration of renewables[470]

Consumption: Residential electric bills in the AkAES study area average approximately $100/month. In the lowest-cost communities (rates under $0.15/kWh), average monthly consumption is approximately 1,000 kWh. In the highest-cost communities (rates after subsidies above $0.60/kWh), the average is closer to 200 kWh/month. This indicates that targeting communities with low rates will be more effective in reducing electric consumption than targeting communities with higher rates, where high prices already provide a strong incentive to conserve energy. Many electric utilities have already experienced reduced per capita sales for residential electricity, in part due to federal energy efficiency standards for lighting and other consumer electronics.

In a typical AkAES community, the residential sector accounts for approximately half of all electric sales, but across the whole study area the percentage of residential sales relative to all sales ranges from 8% to 70%. With such great variation, it is clear that it will be important to target programs and projects by sector to achieve effective reductions in electricity consumption community-wide.

As many consumers lack perfect information to identify the value of efficiency and/or lack access to capital, it is widely recognized that there is a failure in the market for consumers to make choices that are in their own best interest. The State has limited mechanisms to mitigate this market failure, nine of which are outlined below.[471]

Cost drivers the State cannot influence:

1. Population changes in communities—which can reduce sales and spread fixed costs over fewer consumers and kWhs
2. Consumer appliance and technology changes—generally to be more efficient, but some new purchases increase consumption (bigger TV screens, for example)

Cost drivers the State can influence:

1. Non-residential and residential energy efficiency

---

465 Allen et al, 2016.
466 Colt et al, 2003.
467 Foster & Northern Economics, 2004
468 Riley et al, 2016.
469 Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017.
http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf
470 Commonwealth North. "Energy for a Sustainable Alaska: The Rural Conundrum." February 2012.
http://www.commonwealthnorth.org/download/Reports/2012_CWN%20Report%20-%20Energy%20for%20a%20Sustainable%20Alaska%20-%20The%20Rural%20Conundrum.pdf
471 Jim Lazar. "Electricity Regulation in the US: A Guide." Second Edition. The Regulatory Assistance Project. 2016.
http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf

2. State standards for consumer product energy efficiency
3. Consumer subsidies that affect energy consumption
4. Availability and interest rates on loans for energy efficiency
5. Distribution of grant funds for energy efficiency and conservation

Recommended policy mechanisms the State can use to influence the cost drivers:

1. Assist communities to identify, compare, scope, and access financing for cost-effective projects[472, 473]
2. Fulfill the intention of AS 44.99.115(1)(A) and enact residential and non-residential building energy codes[474,475,476,477,478]
3. Assist regional organizations interested in providing energy efficiency services to communities
4. Provide funding and flexible financing for energy projects
5. Prioritize State capital subsidies based on community financial needs
6. Institute energy efficiency standards to be met by utilities and facility owners that receive PCE
7. Use utility rate setting to offset any negative impacts of decreased kWh sales[479]
8. Require a measurable reduction in energy consumption[480, 481]
9. Enforce AS 42.45.130 and require utilities to pursue energy efficiency and demand-side management before increasing capacity[482]

TRANSITION FROM STATE GRANTS TO INCREASED DEBT FINANCING

Because the State has less money available for capital appropriations than it has historically, more projects will need to be financed through some combination of state loans, federal grants and loans, and private loans. The State can assist communities in making the transition from grants to loans by facilitating changes to the business models of the State, utilities, and communities. There are distinct barriers to

[472] Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. "Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects." December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280

[473] Mark Foster & Northern Economics. "Alaska Rural Energy Plan, Initiatives for Improving Energy Efficiency and Reliability." April 2004. https://alaskastateenergy.files.wordpress.com/2007/12/2002ruralenergyplanaea-northernecon.pdf

[474] Walker/Mallot Transition Team Conference. "Team Report". *Consumer Energy*. November 21-24, 2014. https://gov.alaska.gov/Walker_media/transition_page/combined-report_final.pdf

[475] Cady Lister, Brian Rogers, and Charles Ermer. "Alaska Energy Efficiency Program and Policy Recommendations." June 5, 2008. http://www.cchrc.org/sites/default/files/docs/EE_Final.pdf

[476] John Davies, Nathaniel Mohatt, Cady Lister. "Alaska Energy Efficiency Policy and Programs Recommendations: Review and Update." June 27, 2011. http://www.cchrc.org/sites/default/files/docs/Interim_EE_Policy_Report.pdf

[477] Cold Climate Housing Research Center, "Energy Efficiency Policy Recommendations for Alaska." May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf

[478] Richard Armstrong. "White Paper on Energy Use in Alaska's Public Facilities." For AHFC. October 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf

[478] Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf

[479] John Davies, Nathaniel Mohatt, Cady Lister. "Alaska Energy Efficiency Policy and Programs Recommendations: Review and Update." June 27, 2011. http://www.cchrc.org/sites/default/files/docs/Interim_EE_Policy_Report.pdf

[480] Walker/Mallot Transition Team Conference, 2014.

[481] Davies et al, 2011.

[482] Commonwealth North. "Energy for a Sustainable Alaska: The Rural Conundrum." February 2012. http://www.commonwealthnorth.org/download/Reports/2012_CWN%20Report%20-%20Energy%20for%20a%20Sustainable%20Alaska%20-%20The%20Rural%20Conundrum.pdf

accessing debt financing for communities, utilities, and building owners that are different from project-level barriers. As with other basic infrastructure—roads, airports, sanitation systems, landfills, health clinics, telecommunications—energy is necessary to a community's health, safety, and general well-being, yet not all communities have the rate or tax base to support the full cost of critical infrastructure or to secure a private-sector loan under market terms. Some combination of State funding and policies to reduce barriers to debt financing is needed to address energy affordability in these communities.

Cost drivers the State cannot influence:

1. The population size of communities, which strongly influences whether they have a sufficient rate or tax base to afford the full cost of energy infrastructure
2. The risk tolerance of private-sector investors, who typically require a higher return on investment or are less willing to invest in communities lacking strong financials and traditional collateral
3. Other financing decisions by non-State lenders

Cost drivers the State can influence:

1. The bankability of entities by strengthening their financial, management and technical capacity to reduce the financial and operational risks of projects
2. The bankability of projects by identifying cost-effective and risk-appropriate projects
3. The allocation of grant funds based on the ability to pay
4. Lowering the transaction costs for lenders/investors and borrowers
5. Building flexibility in funding opportunities to address utilities' and communities' needs
6. Developing or adopting financial instruments to help communities and utilities secure private-sector investments
7. Promoting knowledge of investment opportunities in rural Alaska
8. Permitting a return on equity to be an allowable expense for PCE reimbursement

Recommended policy mechanisms the State can use to influence the cost drivers:

1. Provide technical assistance to identify and scope bankable projects[483]
2. Assist regional entities to help communities, utilities, and facility owners to identify and scope bankable projects[484, 485]
3. Develop utility financial, managerial, and technical capacity standards[486, 487]
4. Create financial instruments to mitigate financial risk for private investors[488]

---

483 Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. "Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects." December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280
484 Holdman et al, 2016.
485 Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf
486 Allen et al, 2016.
487 Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm.
488 Allen et al, 2016.

5. Provide funding flexibility to address community needs[489]
6. Focus grant funding on project phases, technologies, and communities that are least able to secure conventional financing[490]
7. Maintain online resources with transparent, reliable, and up-to-date data and analysis to inform communities and investors of project potential[491]
8. Expand the types of financing to include on-bill financing and commercial property assessed clean energy (C-PACE)[492]

SUSTAINABLE STATE ENERGY FUNDING

Lack of sustainable program funding is a major barrier to the success of all current State energy programs, with the exception of PCE. Identifying "a source of rent, royalty, income or tax" is a requirement of the AkAES enabling legislation.

State energy programs have experienced large year-to-year variability—increases when State revenue is high and sharp declines when revenue is low. Since 2000, more than $1 billion has been spent in federal and state capital funding of energy programs and projects in the study area; more than three-quarters of which was federal spending. It appears unlikely that this level of funding will return in the foreseeable future. With fewer government grant dollars available, it is important to consider community energy costs in comparison with a less subsidized future, rather than a past with significant government subsidy.

Recommended policy mechanisms the State can use to fund energy programs and projects:

1. Future State revenue generated by the proposed North Slope gasline, as designated in the Alaska Affordable Energy Fund[493]
2. Use current State endowments to fund specific energy programs[494]
3. Universal service charge on the sale of electricity, heating oil and natural gas[495, 496, 497]

---

489 Allen et al, 2016.
490 Holdman et al, 2016.
491 Holdman et al, 2016.
492 Cold Climate Housing Research Center, "Energy Efficiency Policy Recommendations for Alaska." May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf
493 AK Stat § 37.05.610 (2015)
494 Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. "Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects." December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280
495 Cady Lister, Brian Rogers, and Charles Ermer. "Alaska Energy Efficiency Program and Policy Recommendations." June 5, 2008. http://www.cchrc.org/sites/default/files/docs/EE_Final.pdf
496 Cold Climate Housing Research Center, "Energy Efficiency Policy Recommendations for Alaska." May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf
497 Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf

RECOMMENDATIONS

The 20 recommendations that follow represent the most promising of the mechanisms identified above—those with the greatest potential to impact energy affordability in the AkAES study area. The recommendations begin with a new State energy goal, which is followed by 19 proposed changes in statute or regulation that will assist the State in achieving the goal. The recommendations build on the direct experiences of Alaska's energy programs within the study area, as well as research of best practices.

STRENGTHEN STATE GOALS

Given the critical importance of sustainable community energy systems that are safe, stable and reliable, it is recommended that the State energy goals be enhanced to include:

> *All communities will have safe, stable, reliable, and affordable energy by 2030.*

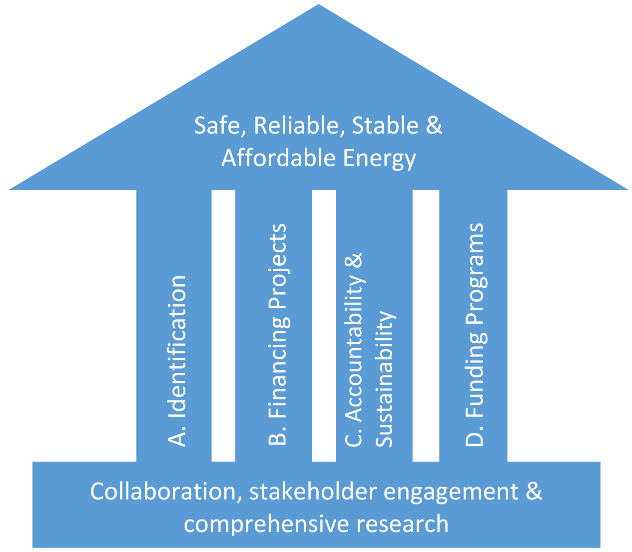
Barrier(s) addressed: State energy goals do not explicitly address the basic, underlying energy needs of communities. Current State goals speak to increasing renewable energy, efficiency, natural gas distribution, use of a loan program, and that the state should remain a leader in petroleum and natural gas production and become a leader in renewable and alternative energy development. None of these speak to the development and maintenance of basic, critical energy infrastructure.

Connections to other recommendations: All other recommendations aim to achieve this goal.

THE FOUR PILLARS OF THE ALASKA AFFORDABLE ENERGY STRATEGY

The AkAES proposes an evidence-based management framework to guide decision-making. Each recommendation aims to address barriers to achieving affordable energy in the study area. Implementation of the recommendations requires changes to statute, regulation and/or policy. The recommendations are organized into four categories, or pillars, that support the goal of delivering safe, reliable, stable, and affordable energy:

A. Identification of cost-effective projects
B. Financing cost-effective projects
C. Accountability and sustainability
D. Funding State energy programs



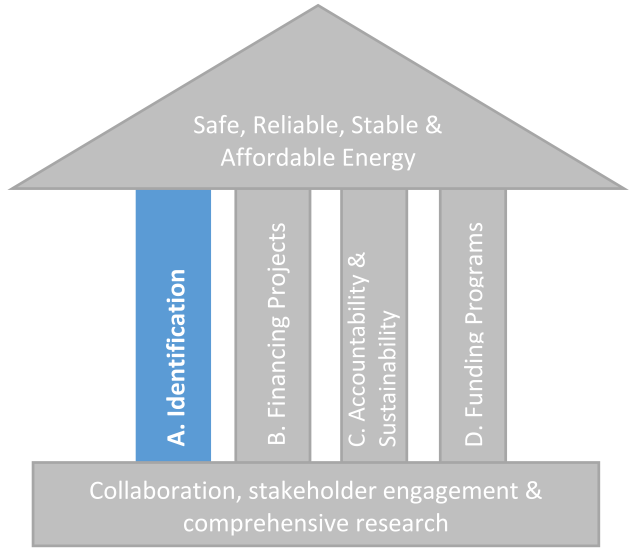
The State has a limited number of levers to influence its energy policy objectives. Since the State very rarely owns or operates energy infrastructure, it must use indirect measures to convince independent entities to achieve State energy goals. To this end, the recommendations proposed by the AkAES employ at least one of the following levers:

- direct financing (e.g. grants, loans, incentives)
- technical assistance (e.g. the collection and sharing of data, information, analysis/evaluation, consultation)
- requirements (e.g. mandates, regulations, performance standards)

To be most effective, policy objectives need to be addressed using more than one lever. Each policy objective is supported by a combination of direct financing, technical assistance, and requirements. While each individual recommendation would achieve benefits if implemented as a standalone action, the greatest benefit would come from implementing the recommendations together.

It is important that the State does not create unfunded mandates for communities, utilities, and facility owners that are affected by the recommendations. In cases where the recommendations are requirements, funding, whether as loans, grants, or technical assistance, should also be made available.

A. IDENTIFICATION OF COST-EFFECTIVE PROJECTS



As shown in Chapter 6, there are a limited number of ways to reduce the cost of energy in AkAES communities. A one-size-fits-all approach to creating affordable energy does not work for Alaska, and particularly not for the diverse communities in the study area. One way to improve decision-making and thereby reduce energy costs is to improve the quality and availability of community-level data needed to inform strategic decisions about energy projects and programs. Improved decision-making for programs and projects will benefit communities while also helping to safeguard the State's investments.

The AkAES has identified many infrastructure and non-infrastructure opportunities for reducing the cost of energy in communities. A greater variety of performance, financial, and managerial data, as well as specific types of community-level data, will need to be collected and analyzed in order to adequately evaluate these opportunities and identify the most cost-effective.

A1. IMPROVE DATA COLLECTION AND ANALYSIS

- Collect and make publicly accessible community-level energy data for all of Alaska's communities that receive PCE or have populations greater than 50.
- Collect and make publicly accessible data regarding State energy programs for the purpose of improving their cost-effectiveness.
- Maintain a regularly updated online reconnaissance-level analysis tool, the Alaska Affordable Energy Model, to provide guidance on the cost-effectiveness of energy opportunities in Alaska communities.

Benefits: High-quality energy data and analysis are important planning tools for communities, the State, and other investors. This data could help deliver savings through better project identification, risk management, and program design. Future data collection and analysis can build on tools developed for the AkAES like the Alaska Affordable Energy Model.

Barriers addressed: Communities and potential investors, both public and private, lack data and data-driven decision-support tools to identify potential infrastructure and non-infrastructure opportunities. Community energy data is not systematically captured and analyzed to help support the direction of energy programs. When the risks associated with community energy projects are not clearly understood, the result can increase costs and impede investment.

Connections to other recommendations: An energy data program, coordinated with the State's existing energy data initiatives, would collect and analyze data generated through the implementation of other recommendations. The data program would help identify projects for financing (Recommendations B2 and B4) and create efficiency in assisting communities (Recommendations A2, C1, and C2) through new data and analytic tools. The data collected could assist communities in meeting regulatory requirements (Recommendation C3).

A1.1: Community-level energy data

1. Basic community and utility data

Table 37: Recommendation A1—Basic community and utility data to be collected

Data need	Attribute	Frequency
Electricity	Rates	Yearly
	PCE rates	Yearly
	Fixed customer charges	Yearly
	Consumption by sector	Yearly
	Generation by source	Yearly
	Diesel price ($/gal)	Yearly
	Diesel price forecast	Every two years
Heat	Source—heating oil, propane, natural gas, biomass, etc.	Yearly
	Rates	Yearly
	Fixed customer charges	Yearly
	Consumption by sector	Yearly
	Heating fuel price forecast	Every two years
Other	Population—historical & forecast	Every five years

2. Current community infrastructure

Table 38: Recommendation A1—Current community infrastructure data to be collected

Infrastructure type	Attribute	Frequency
Petroleum bulk fuel	Tank capacity	Every five years
	Tank ownership	Every five years
	Tank age & condition	Every five years
	Code compliance	Every five years
Non-petroleum bulk fuel	Type	Every five years
	Storage capacity	Every five years
	Storage ownership	Every five years
	Storage age & condition	Every five years
	Code compliance	Every five years
Power systems	Type	Yearly
	Age	Every five years
	Condition	Every five years
	Diesel efficiency	Yearly
	Line loss	Yearly
	System balance	Yearly
	Frequency stability	Yearly
	Reliability	Yearly
	Regulatory/code compliance	Yearly
Building infrastructure	Housing—number, size, types, consumption, Wx status	Every five years
	Water/wastewater—size, types, consumption, Wx status	Every five years
	Non-residential buildings— number, size, types, use, consumption, Wx status	Every five years

3. Utility business management data

Table 39: Recommendation A1—Utility business management data to be collected

Utility standard	Attribute	Frequency
Financial	Revenue—sources	Yearly
	Expenses—fuel/non-fuel	Yearly
	Debt & savings	Yearly
Managerial	Business plan	Yearly
	Regulatory/code compliance	Yearly
	Best practices	Yearly
Technical	Training certification	Yearly
	Performance	Yearly

4. Local energy goals, such as the goals that have been identified through the Regional Energy Planning process (for example, local job creation, the elimination of diesel, reducing the local contribution to climate change, among others). The State should engage communities to reconfirm or update their goals at least every five years.

A1.2: State energy program data

Table 40: Recommendation A1—State energy program data to be collected

State programs	Attribute	Frequency
Infrastructure programs	Administrative costs	Yearly
	Project costs	Yearly
	Project reports	Yearly
	Infrastructure performance	Yearly
	O&M data	Yearly
	Lessons learned/risks	Every two years
Non-infrastructure programs	Savings—energy, cost	Yearly
	Administrative costs	Yearly
	Metrics associated with program success	Yearly

A1.3: Reconnaissance-level project analysis tool

The Alaska Affordable Energy Model (AAEM), developed as part of the AkAES, provides simplified access to and analysis of energy data from many state and federal sources. The tool, which was developed by AEA and coded by the University of Alaska's Geographic Information Network of Alaska (GINA), should continue to be updated and improved.

The usefulness of the model will increase over time as data and other analytic tools are added. The AAEM provides a high-level assessment of opportunities based on numerous data sources, including the Alaska Energy Data Gateway, the Alaska Retrofit Information System, the Alaska Energy Data Inventory, AEA's Renewable Energy Fund program, work performed by the Alaska Center for Energy and Power, Institute of Social and Economic Research, the Department of Energy, national laboratories, and numerous other sources.

The AAEM uses historical and status quo data on energy costs, consumption, generation, and infrastructure to create a snapshot of energy use and costs in a community. These data inputs should be updated yearly.

Forecasts are developed for the factors that will lead to changes in the consumption, generation and costs of energy in a community. These factors include the prices of diesel, heating oil and electricity, community population, and trends in consumption. Diesel and heating oil price forecasts should be updated every two years. Population forecasts should be updated every five years. Consumption trends are calculated by the model and do not need to be updated.

The most recent and best data on resource availability (including wind, hydro, solar, residential and non-residential efficiency, diesel efficiency, and heat pumps) are captured from multiple sources in the AEEM. If a study has estimated the costs and generation for a proposed project, those values can be incorporated into the model, otherwise average values will be used. Data from individual projects should be updated upon project completion. Generic resource data, such as the wind map, should be updated when sufficient new data warrants it. The costs and expected generation or savings from potential projects should be updated every three years or as warranted by the rate of technology change.

A community-level economic analysis is performed by integrating the status quo, forecasted and resource data for all potential resources in a community. A reconnaissance-level analysis is provided for each potential resource, which allows a community or potential investor to compare opportunities available to the community and identify the best, most cost-effective opportunities to pursue.

Metrics for success:

1. Up-to-date data
2. Access data and model
    a. number of communities, agencies, etc.

A2. Clarify State's role in working with communities on project identification, planning, and financing

Enacting this recommendation would clarify the policy under AS 44.99.115(2)(C) to establish a process for providing community assistance outside of grant fund management. The State can designate a sole agency to work with communities to identify, plan and secure financing for improvements to generation efficiency, line losses, fuel storage, use of renewable energy, residential and non-residential energy efficiency, and improvements to bulk fuel or utility management, operations and maintenance. Although

AEA performs this function through multiple programs in support of the organization's mission, there is no clear mandate to provide ongoing assistance to communities in identifying cost-effective projects with the potential to reduce their energy costs. This should be formalized as a core responsibility of the State energy office as the need is currently larger than existing programs can deliver.

Benefits: Reduced cost to communities through improved project selection and operation. Savings to the State through reduced PCE expenditures. Savings for participants in the Alaska Heating Assistance Program are also possible.

Barriers addressed: A clear process for communities engaging the State regarding energy projects outside of grants and loans does not exist. The selection of a State agency or program for this specific purpose creates responsibility, accountability and continuity for communities working on energy projects outside of the management of specific grant funds.

Connections to other recommendations: This recommendation would help utilities fulfill the cost-effective fuel reduction target under Recommendation C6 and the efficiency requirement outlined in Recommendation C4. By being involved early on in project development, project risks can be reduced and least cost solutions can be identified. Provide assistance with technical scoping for all phases of project development under the auspices of the Community Energy Fund for Alaska (Recommendation B2).

Additional info: For many communities, technical assistance is required for understanding both the potential consequences of integrating new projects into existing energy systems and the economic analysis of that opportunity. By combining the latest resource data with the latest technology, community, and project risk data, a reliable economic analysis is possible, which can be used as the basis for comparisons between projects. It is only with this sort of cross-sectional analysis that opportunities available to communities can adequately be identified and evaluated.

The State, along with its public- and private-sector partners, can provide valuable technical assistance to help communities discover and develop cost-saving energy opportunities from conception to completion. Given the risks associated with energy projects, improving project identification and development through technical assistance can be an important way to reduce risks for the State and private lenders while easing the burden on communities.

The State and its partners can provide different tiers of assistance and oversight. This could range from help developing Request for Proposals (RFPs) for communities to access services from Independent Power Producers (IPPs) to directly managing a project, as is done for most Rural Power System Upgrade projects. Clear standards, clearly communicated at each project stage can help ensure high-quality work is performed. Some entities may not need any assistance, but third party oversight or review can mitigate project financing risks.

Metrics for success:

1. Communities assisted
    a. Analyses performed

    b. Projects pursued or determined to be uneconomic
2. Non-State financing accessed
3. Money saved
    a. Community
    b. State
4. Energy saved (efficiency)
5. Energy delivered (generation, storage)

A3. Establish Residential and Non-Residential Building Energy Codes for New Construction and Major Renovations

- Recall 134 statutory references to building codes back into one section of State statute.
- Grant authority for code administration to one or two agencies.
- Authorize a code commission through a public regulation process to determine and update building and energy codes.

Benefits: By enacting the intention of AS 44.99.115((1)(A), building to a higher standard is cost-effective and less expensive than retrofitting a poorly built building later. There are direct savings to the Power Cost Equalization and Alaska Heating Assistance programs as well as potential benefits to public health, safety and the environment. Alaska Housing Finance Corporation has already compiled all instances of building codes in statute and drafted options in regard to a methodology to incorporate and update future code changes, along with a model for enforcement.

Barriers addressed: Buildings consume the most energy in communities. New buildings that are not built to an efficient standard have higher operational and lifetime costs. Currently, building codes are referenced in more than 134 Alaska statutes with authority for enforcement spread throughout six state agencies. Consolidation of these codes and agency responsibilities will create cost savings for the State and clarity for communities and builders.

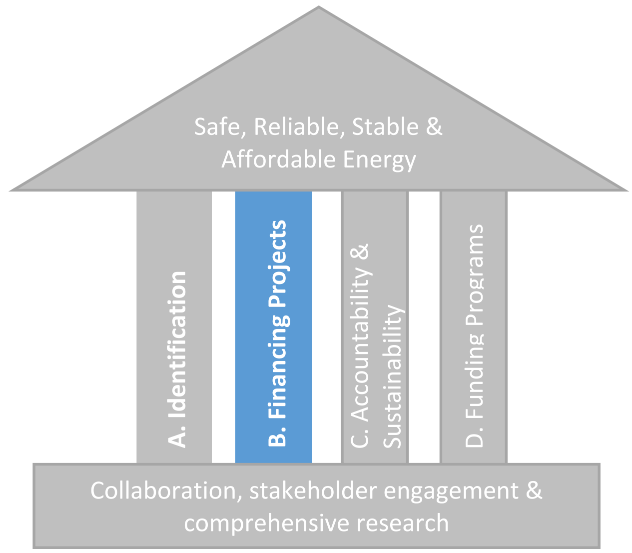
Connections to other recommendations: Building energy codes will reduce the need for some services in the future, such as energy retrofit programs and PCE (Recommendations B5 and D4).

Metrics for success:

1. Measurement and verification standards available through the US Department of Energy for building codes including:
    a. Compliance with new codes
    b. Energy and cost savings relative to status quo

B. STATE ASSISTANCE IN FINANCING COST-EFFECTIVE PROJECTS

After the identification of cost-effective projects, money must be available for implementation, either in the form of grants or loans. With a constrained State budget, it is likely that State-backed loans will be more prevalent in the future. Research from the AkAES demonstrated a need for greater flexibility in financing options that align with community needs.



The reality is that as loan-funded infrastructure replaces grant-funded infrastructure, it is likely unavoidable that consumer energy costs will rise. In this funding climate, it becomes even more important that communities pursue the most cost-effective project that suits their needs.

Constrained budgets make it more difficult for the State and federal governments to grant funds at the rate seen over the past fifteen years. The State must now leverage its funds more effectively by reducing transaction costs for both potential investors and recipients, encouraging more debt financing and assisting in the transition from grants to loans. Grants should be targeted to bring a project or utility to a bankable position (e.g. partial subsidy to allow for financing).

The recommendations under this pillar provide mechanisms to reduce loan transaction costs for borrowers and lenders, match communities with appropriate funding, create incentives for project performance, and improve financial outcomes for project owners and their lenders.

B1. ALLOW BULK FUEL LOAN PARTICIPANTS TO PURCHASE NON-PETROLEUM FUELS

- Communities in the State's Bulk Fuel Loan Program could use loans to purchase alternative fuels, such as cordwood, pellets and liquefied natural gas (LNG).

Benefits: Extends the same financial risk reduction for communities that use non-petroleum fuels as the State provides for communities using petroleum fuels.

Barriers addressed: Some energy infrastructure projects use non-petroleum fuels. There is currently no State-funded loan that allows for the purchase of those fuels. Inclusion of other fuels in the Bulk Fuel Loan program resolves this issue.

Connections to other recommendations: Alternative fuel sources may be identified through mechanisms created by other recommendations; communities that currently rely on the Bulk Fuel Loan program would need similar financial risk reduction for these fuels.

Metrics for success:

1. Number of non-petroleum fuel loans issued

B2. CREATE A ONE-STOP-SHOP FUND FOR COMMUNITIES THAT ALLOWS FOR SEGREGATED STATE, FEDERAL, AND PRIVATE GRANTS AND LOANS TO BE BLENDED TO DEVELOP ENERGY PROJECTS

Communities often face a similar set of barriers and opportunities when seeking energy project funds. The State can create cost efficiencies by consolidating funding information in one location and reducing lines of repetitive inquiry and overlap by multiple agencies.

The Community Energy Fund for Alaska (CEFA) would:

- be a one-stop-shop for communities to access funding options.
- be utilized as a broad service, offering public and private funding sources.
- offer assistance in accessing existing grants and loans for energy projects.
- be accessible to utilities, municipalities, boroughs, cities, Tribes and non-residential facility owners to the extent allowed for by the original funding source.
- be available for generation, distribution, transmission, and energy efficiency projects.
- require that the State make a determination that the project represents a cost-effective strategy for meeting a community energy need.

NOTE: For utility-scale generation projects, the use of CEFA funds would require adherence to the proposed management, financial, and performance standards (Recommendation C3).

Benefits: This recommendation reduces the need for State grant funds and increases involvement of non-State investors. The CEFA has potential to reduce transaction costs for borrowers and investors. Existing State energy infrastructure grant and loan programs could be consolidated under CEFA to create cost-efficiencies. New financial products with greater flexibility would be added to allow communities to more easily pursue a greater range of cost-effective projects than is currently possible.

Barriers addressed:

- Lack of administrative capacity can be the limiting factor in accessing funding needed to complete a project.
- Fewer State grant opportunities are available for energy projects, and communities may have difficulty identifying and securing alternative funding/financing sources.
- Funding sources are not always available for identified community needs. As a result, communities develop sub-optimal projects based on the type of funding available.
- Transaction costs for projects in communities with small populations can negatively impact the project's economics and create barriers to achieving a financing deal.
- Enacting this recommendation would allow communities to focus on identifying and developing the best project options rather than pursuing myriad funding options.
- Many current programs provide insufficient incentives for communities and utilities to maintain new energy infrastructure.
- Incomplete financing plans stall and cancel projects.

Connections to other recommendations: Taken together, the recommendations related to project identification could create a pipeline of projects for this new fund. The proposed utility standards

[Recommendation C3] would help to reduce risk for State and other investors. CEFA could be accessed by regional organizations assisting communities (Recommendations C2) or as a source of financing for residential and non-residential efficiency programs (Recommendation B4). Recommendation B3 is a subset of this recommendation.

Additional information: The Community Energy Fund for Alaska would make it easier for projects to connect with multiple funding sources, allowing the State to better leverage its resources. To the extent that other public and private entities also desire to leverage their investment (or benefit from the financial risk mitigation that the leveraging represents), the CEFA represents a win-win for investors and communities.

Use of multiple funding sources can increase administrative burden; the State can assist by reducing the transaction costs of accessing federal and private loans and grants. This can be done by shifting some of the burden to the State and/or simplifying the processes for applicants.

By focusing on the opportunities in communities, greater flexibility in financing, such as is needed for non-residential energy efficiency projects, can be achieved for communities. This will also allow State expertise to be leveraged by interested investors to expand into currently underserved markets, such as commercial energy efficiency.

For investors, several means would be available to mitigate project and financial risks. Match requirements could be flexible to account for a community's ability to pay and the project phase. Preliminary resource evaluations are the highest risk portion of any project. It would be appropriate that the State take on more financial responsibility for the higher risk phases of project development, requiring greater levels of match as projects move toward construction.

Greater levels of accountability for applicants would also increase the likelihood of the project achieving its long-term goals.

In funding projects, a stepwise approach with clear go/no-go decision points is imperative. Fatal flaws are sometimes identified only after significant study, and it is easy for project participants to be ensnared by the sunk-cost fallacy—that shutting down a project would constitute a waste of the money already spent on previous phases. Clear guidelines for what is necessary for a project to move forward would be developed for each project type and phase.

Early in the new funding paradigm, it may be necessary to provide incentives for private financing to enter the market, in addition to loan products that reduce the risks for private lenders, such as loan-loss reserves or similar financial risk mitigation products.

Metrics for success:

1. Number of "at risk"/high-cost communities served
2. Financing leveraged
    a. Federal grants
    b. Federal loans

    c. Private loans
    d. Private grants
3. Money saved by communities
4. Energy saved
5. Financial risks
    a. Defaults, late payments

B3. Create a loan program with refund provisions that rewards project performance

> The loan provisions, as a financing product available through the Community Energy Fund for Alaska, will allow for partial annual reimbursements over the economic life of the project to incentivize meeting performance and reporting objectives.

Benefits: The opportunity to receive a refund creates an additional incentive for communities to maintain infrastructure, achieve energy project objectives, and meet reasonable performance standards. The State will experience savings through reduced need for PCE, fewer emergency technical calls to repair equipment, and less frequent capital grant requests for infrastructure repair and replacement. The increased performance and life of the infrastructure will also reduce costs for consumers.

Barriers addressed: Once a project is completed, it is difficult to ensure good maintenance protocols are followed. Without proper equipment maintenance, communities will not receive the full economic benefit from energy infrastructure projects, resulting in increased costs for the community through higher O&M costs and shorter infrastructure lifespans.

Connections to other recommendations: This recommendation is a key financial product of the Community Energy Fund for Alaska (Recommendation B2). It also directly ties in with the goals associated with accountability and sustainability. The enhanced business and financial assistance to utilities being proposed (Recommendation C3) will ensure that utilities are able to meet performance standards.

Additional information: The refund provisions would only apply to State contributions, unless specifically agreed upon by other financial partners. Depending on specific contractual elements, multiple metrics could be tracked, with specific measurable goals, resulting in partial reimbursement for achieving each standard. The refund could apply to interest and/or principal payments, depending on the nature of the loan.

Metrics for success:
1. Participation
2. Reporting
3. Within performance
4. Current/default

B4. Statutorily Allow Voluntary On-Bill Financing and Commercial Property Assessed Clean Energy

Benefits: On-bill financing and Commercial Property Assessed Clean Energy (C-PACE) are voluntary programs that allow financing of building-level renewable energy and efficiency projects to be bound to the property rather than the property owner, removing as a barrier to investment the number of years the owner expects to keep the property. C-PACE was introduced in 2016 and has been reintroduced in 2017.

C-PACE financing is a voluntary loan for qualifying energy efficiency measures that is placed on the property tax bill. Since not all communities in the AkAES study area have property taxes, it would not be available to all consumers. The repayment obligation is transferred with the property upon sale.

On-bill financing allows for a voluntary loan for qualifying energy efficiency measures that can be paid back through a customer's utility bills. The utility can act as the source of funds or just a mechanism for paying back the loan.

Both on-bill financing and C-PACE can also be tools in a demand-side management program to extend the time before a utility needs to invest in new generation capacity. Each of these financial mechanisms can allow for extended loan terms and off-book debt, easing cash flow restraints and concerns about limiting future access to debt financing.

Barriers addressed: The length of time a building stays in the same hands is variable and sometimes difficult to predict. Individuals and organizations, therefore, may not fully recoup their energy efficiency or renewable energy investments through lower energy bills. If the payback period is longer than their planned tenure as owner, they will be reluctant to address needed efficiency measures or integrate renewable energy systems into building design or renovations. Commercial property owners want to minimize how much debt is booked.

Connections to other recommendations: The CEFA (Recommendation B2) could act as a funding source for on-bill financing or C-PACE. Either of these financing mechanisms could assist large public facilities in financing the cost-effective retrofits required in Recommendation C4. Regional entities, supported under Recommendation C2, could provide services needed for making these financial instruments available in communities.

Metrics for success:

1. Percent of eligible communities using either of the financing tools
2. Number of loans
3. Default rate
4. Money saved
5. Energy saved

B5. Stabilize the State's funding for residential efficiency programs

- Ensure a $10M per year baseline for the low-income weatherization assistance program.
- Modify rules of the Home Energy Rebate (HER) program to expand weatherization services if the program receives new funding. Develop income-based match requirements to better leverage State investment in residential efficiency and allow participation by households whose incomes are too high for low-income weatherization but may be too low for the Home Energy Rebate program as it is currently structured.

Benefits: The recommendation allows households above maximum income limits for the Weatherization Assistance Program to receive residential efficiency services. The new match approach for the Home Energy Rebate program effectively leverages greater private investment, while stabilizing funding for the Weatherization Assistance Program secures a well-trained workforce and provides services to those with the highest need.

Barriers addressed: Funding uncertainty jeopardizes the maintenance and reduces the capacity of energy efficiency programs that serve consumers with the highest need. Low-income residents are least able to access the efficiency savings that will have the most direct effect on their ability to afford energy. Existing income limits are rigid, leaving many consumers without access to residential efficiency services. The AkAES study area was underserved by the HER program; smaller rural communities especially need more assistance to access weatherization services and increase participation in the HER program.

Connections to other recommendations: On-bill financing (Recommendation B4) could be used to assist HER participants in financing the match requirement. CEFA (Recommendation B2) could be a source for stable loan funding for improvements.

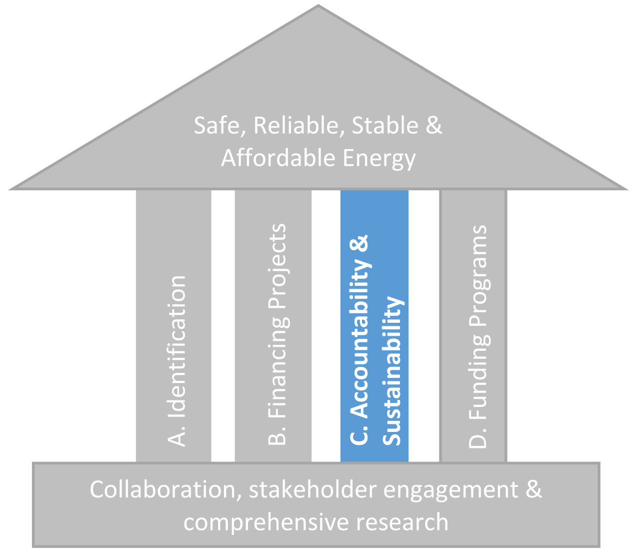
Additional information: Regional entities (Recommendation C2) could be leveraged and/or created to assist with the delivery of residential efficiency services to make the revised HER program successful in the AkAES study area.

Metrics for success:

1. Low Income Weatherization Assistance Program
    a. Number completed
    b. Energy saved
    c. Money saved
2. Home Energy Rebate Program
    a. Number completed in AkAES study area
    b. Energy saved
    c. Money saved
    d. Private dollars leveraged

C. ENSURING THE ACCOUNTABILITY OF PROJECT PARTICIPANTS AND ACHIEVING THE SUSTAINABILITY NEEDED FOR BRINGING AFFORDABLE ENERGY TO COMMUNITIES

At both the state and local levels, the systems for delivering affordable energy frequently lack the incentives and requirements needed to create accountability and sustainability. For instance, while the PCE program has established technical standards related to diesel efficiency and levels of line loss, there are no standards related to utility operational efficiency, e.g. proper maintenance and financial management. Few State programs are required to track or report the ongoing performance of the systems they fund; often there are no external incentives or disincentives for grantee performance and reporting.



Greater accountability will improve project performance and foster the development of utilities with greater internal technical, managerial and financial capacity. Poor performance often results in consumers paying more than necessary for electricity due to excessive line loss, lower than expected generation, and/or higher than average administrative costs. The State pays more on increased PCE payments, technical assistance, and capital grants than would be necessary with greater utility accountability. Greater accountability would improve access to non-State financing, creating a structure within which utilities and communities become more financially healthy.

While government requirements are frequently viewed negatively, regulations and codes do not necessarily impede development. They can be assets in developing new markets while providing needed consumer protection. For example, the Department of Transportation and Public Facilities was required to retrofit 25% of all State-owned facilities that are 10,000 square feet or larger by 2020. Having met this requirement early, the State is saving $2.8 million per year in energy costs. By signaling the importance of certain actions or behaviors, new codes and regulations can enable the private and public sectors to capture cost savings that have been historically overlooked. However, if the overarching goal is to make energy more affordable in the AkAES study area, the following recommendations must be paired with access to sufficient technical assistance and funding so that the State does not burden communities and utilities with unfunded mandates that offset any reductions in the cost of energy.

C1. STRENGTHEN BUSINESS AND FINANCIAL MANAGEMENT ASSISTANCE FOR PCE-ELIGIBLE UTILITIES

Benefits: Improving utility management and financial practices can reduce non-fuel costs, which average approximately 40% of retail electric rates, saving millions of dollars for consumers and the State. Improved business practices will also improve a utility’s ability to access financing.

Barriers addressed: Research indicates that inefficient business operations increase consumer electricity costs. Analysis also shows that many utilities actually underreport their PCE-eligible expenses, thereby reducing their PCE payments, increasing financial risks and decreasing potential access to non-State financing of energy projects.

Connections to other recommendations: Recommendation C3 will identify communities in need of business and financial management assistance. The data compiled and analyzed in Recommendation A1 will facilitate this identification. The CEFA (Recommendation B2) would require better business and financial management from participants.

Additional information: This recommendation will assist in implementing the requirements set out in AS 42.45.900. Assistance can be provided through the identification of key performance indicators (KPIs) that will allow utilities to benchmark their own performance, assistance in data collection for the KPIs, the creation of business management templates that provide guidance for achieving best practices, and direct assistance for communities where needed.

Metrics for success:
1. Number of communities assisted
2. Effective rate for communities within 5 cents of the PCE floor
3. Reduction in utility non-fuel costs
4. Number of utilities with business plans, and number following plan successfully
5. Improved financial ratios
6. Increased percent of utilities attaining standards
7. Increased in additional revenue sources for utilities

C2. Draw on the State's partnerships with regional and statewide entities to more cost-effectively provide needed assistance

> Assistance could include: technical and managerial services such as utility financials; record keeping and management; energy project management, bulk fuel and power systems operations, maintenance, and technical services; and non-residential efficiency.

Benefits: Increasing the economy of scale of management could unlock millions of dollars of savings through improved utility operations. Regional entities are likely to know more details about a local energy provider and may be able to quickly identify and respond to a need. AEA's relationships with regional organizations, including the recent regional planning efforts, could be effectively leveraged to assist with this recommendation.

Barriers addressed: Many communities do not have adequate capacity or the economy of scale to cost-effectively manage local energy systems.

Connections to other recommendations: This recommendation will assist utilities in meeting the standards proposed in Recommendation C3. The regional entity could help communities to access CEFA funds (Recommendation B2) to communities. Partnerships could also assist with non-residential efficiency (Recommendation C4) and utility fuel reduction strategies (Recommendation C6).

Additional information: A number of regional entities, including regional co-ops, non-governmental organizations, Tribes, boroughs, and Native corporations, could assist with this recommendation through formal contracts and informal coordination. The types of activities that could result from this recommendation encompass many ways to reduce the cost of energy in communities. These include:

1. Public purpose energy service companies (so-called PPESCOs),
2. Expansion of fuel and electric co-ops
3. Expand financial, managerial, and technical assistance for communities
4. Assistance to manage the technical and financial needs of efficiency programs
5. Shared use of high cost resources

Metrics for success:

1. Number of agreements between State and regional organizations
2. Effective rate for communities within 5 cents of the PCE floor
3. Increase in additional revenue sources for utilities
4. Reduction in utility non-fuel costs
5. Reduction in utility fuel costs
6. Energy saved
7. Number of utilities with business plans, and number following plan successfully
8. Increase in percent of utilities attaining standards outlined in C3

C3. Develop a cost-effective regulatory system to ensure rural electric utilities continue to meet standards to be "fit, willing, and able"

Benefits: The recommendation will help reduce community energy costs and State expenditures for energy programs through improved oversight of operations and access to non-State financing. The recommendation will help improve the quality of utility services in communities and the efficiency of State energy programs.

Barriers addressed: There are currently no requirements that unregulated electric utilities provide proof of operational practices that provide safe, stable, reliable, and affordable energy after they have received their Certificate of Public Convenience and Necessity (CPCN). Insufficient data is currently collected to assess the ability of utilities to deliver the service required by the CPCN.

Connections to other recommendations: The data gathered from the periodic review of utility operations could feed into the State Energy Data program (Recommendation A1). The recommendation will reduce risk for investors and provide standards for participation in the CEFA (Recommendation B2). Recommendations C1 and C2 aim to improve utility operations and would help to support this recommendation.

Additional information: It is important that an unfunded mandate is not created without support, and that this recommendation is not enacted without sufficient support for communities and utilities to be successful. The recommendation is in the public interest, both for the consumers of the utilities as well as the state government, as one of the main sources of funding for many utilities.

To receive a CPCN, the RCA must determine that a utility is fit, willing, and able to perform the functions. The RCA further defines these requirements as financial, managerial and technical fitness: these definitions are provided in the metrics section for this recommendation.

Additional statutes and regulations provide guidance for utility operation:

1. AS 42.05.291. Standards of Services and Facilities. Requires public utilities to "furnish and maintain adequate, efficient, and safe service and facilities."
2. 3 AAC 52.470. Engineering standards; energy purchase contracts. Requires a utility to construct, maintain and operate its plant to "assure service reliability, service quality, and the safety of persons and property".
3. 3 AAC 52.475. Maintenance and testing standards. Requires utilities to adopt and pursue a maintenance program to "permit safe, adequate, and reliable service".

These statutes and regulations do not include reporting requirements to ensure that utilities, economically or non-economically regulated, meet the standards.

As the intent of the recommendation is to improve consumer protection and reduce the risk to investors, a review could be triggered by:

1. An effective electric rate outside the normal range (within $0.10/kWh of the theoretical calculated level) for more than two consecutive years
2. Underperformance on other standard measures, such as generation efficiency and line loss, for more than two consecutive years
3. Inadequate reporting for two consecutive years

Metrics for success:
Factors used to determine if an electric utility is "fit, willing, and able" should be based on the following definitions of "financial, managerial, and technical fitness." The actual performance metrics would be determined through a public process in which potentially impacted utilities participate.

Financial Fitness: The utility must be able to pay the expenses incurred in delivering service to its customers.

Maintain the financial health of the utility

a. Accurately account for all utility expenses and revenues
b. Maintain adequate financial ratios—current account, debt and debt-equity ratios
c. Maintain a reserve account in case of accidents, fuel price spikes or other unforeseen events

Managerial Fitness: The utility must be able to plan for the current and future needs of delivering service to its customers.

1. Encourage best practices
    a. Independent performance-driven board of directors
    b. Professional staff
    c. Price, performance and management transparency
    d. Clear mechanisms for evaluating performance
2. Maintain and follow an adequate business plan including updating and planning for repair and replacement of utility assets, staff training, etc.
    a. Sustainable management improvement plan
    b. Capital improvement plan

Technical Fitness: The utility must have the technical capacity to maintain a level of service consistent with the needs of its customers and to construct, operate and maintain needed infrastructure.

1. Set standards for operator training
2. Stability and reliability
    a. Frequency and voltage stability
    b. Acceptable number and duration of unplanned outages
    c. Availability of generation infrastructure
3. Performance requirements
    a. Generation efficiency (for example, minimum of 13 kWh/gallon)
    b. Line losses (for example, maximum of 12%)
    c. System balance (for example, maximum of 10% out of balance between phases)

C4. Require PCE-eligible non-residential buildings larger than 5,000 Sq. ft. to have an energy audit and perform cost-effective retrofits

Public and/or community buildings greater than 5,000 square feet would be required to perform energy retrofits resulting in net savings within 10 years.

Benefits: Reducing the amount of energy consumption in community facilities frees up funding for other community needs and will help ensure that the State is not paying more to operate facilities than is necessary.

Barriers addressed: Many large community facilities are not energy efficient, increasing their operating costs and reducing funds available for other community needs.

Connections to other recommendations: The Community Energy Fund for Alaska (Recommendation B2) provides a path to financing efficiency projects. Recommendation B4, to allow on-bill financing and C-PACE, would provide instruments to finance these retrofits. Technical assistance provided by State and regional entities, through Recommendations A2 and C2 respectively, would support this recommendation.

Additional information: It is imperative that additional technical and financial assistance be available to prevent this recommendation from becoming an unfunded mandate. The recommendation also supports

AS 42.45.130(a)—Cost Minimization, which requires PCE-eligible utilities to "cooperate with appropriate state agencies to implement cost-effective energy conservation measures and to plan for and implement feasible alternatives to diesel generation."

Metrics for success:

1. Money saved by community
2. Money saved by PCE
3. Energy saved
    a. Electricity
    b. Heat

C5. Empower the Regulatory Commission of Alaska (RCA) to have siting authority over generation and transmission for economically regulated utilities in the study area

Benefits: The recommendation provides a measure of oversight and consumer protection by reducing the risk of building unnecessary infrastructure that must be paid for through increased rates. Low cost, but less standard resources, such as efficiency and demand-side management, which are consistent with State energy policy, would be more likely to be implemented. This recommendation also provides certainty that utility investments will be recovered through rates.

Barrier(s) addressed: The identification and pursuit of least cost and low volatility resources, particularly efficiency and demand-side management, by utilities has been historically underutilized in favor of traditional generation projects. This potentially leads to greater costs and cost volatility for consumers.

The current ex post facto determination also complicates the achievement of the State's non-binding energy policy for efficiency and renewable energy by not including a formal process to consider this public good in the implementation of the utilities' plans.

The possibility that the RCA might not allow a utility to recover costs from a new generation plant is a source of uncertainty for energy project investors and developers.

Connections to other recommendations: The recommendation could provide more certainty for investors participating in the CEFA (Recommendation B2).

Additional information: Currently, the RCA makes a determination on the eligibility of energy infrastructure to be included in the rate base ***after*** it has been built. Empowering the RCA with siting authority would require that eligibility is determined prior to construction.

In many states, an initial review, through siting authority, is made to determine if infrastructure is necessary, useful, and consistent with statutes and regulation. Post-construction, a second review or a prudency review, is performed to ensure that the infrastructure was constructed and sized properly for the customer base and the costs were reasonable. These factors determine if all or some of the infrastructure can be included within the rate base.

C6: Require a 1% per year fuel reduction target for electric utilities until cost-effective gains have been realized

> Measurement of the reduction will be on a per residential customer basis to avoid penalizing utilities with load growth.

Benefits: Cost-effective gains will reduce costs to consumers through lower electric rates and to the State through reduced PCE. It will increase the market for energy services to utilities and provides flexibility for individual communities as the savings can be achieved through diesel efficiency, line loss reduction, renewable energy installation and energy efficiency improvements.

Barriers addressed: The State has no requirement that utilities pursue cost savings through efficiency and renewable energy projects. There is no requirement for continued improvement.

Connections to other recommendations: This recommendation helps spur the involvement of utilities in all other recommendations.

Additional information: The recommendation will require a measurable and continuous improvement by Alaska's electric utilities and support the 2010 state energy policy of 50% renewable energy and 15% improvement in energy efficiency. The recommendation also supports AS 42.45.130(a)—Cost Minimization, which requires PCE-eligible utilities to "cooperate with appropriate state agencies to implement cost-effective energy conservation measures and to plan for and implement feasible alternatives to diesel generation."

The reduction would be measured by the amount of fuel consumed to supply the residential sector. It could start with a reasonable baseline year in order to give credit to utilities that have recently taken actions to reduce their fuel consumption. At least 26 states have policies that could be useful in defining the specific mechanisms by which this recommendation is implemented.

Reports of past, current and planned activities will be required every five years. The requirement will be evaluated every five years to ensure that it continues to be cost-effective for consumers and the State. It is important that the requirement not be an unfunded mandate, but that there is adequate access to funds and technical assistance for utilities to be successful.

A number of potential methods for providing a financial incentive meeting the target could be provided to utilities. Examples from other states include an increase on the return on equity allowed to the utility or performance-based incentives that allow utilities to receive revenue based on actual savings. Potential sources would be through rates and/or PCE payments.

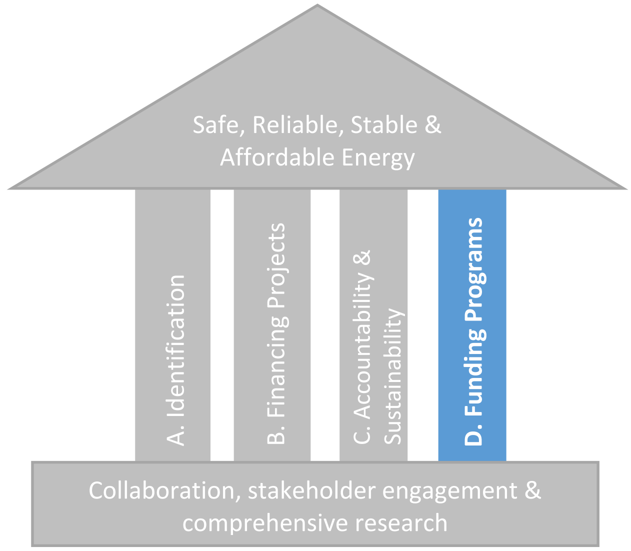
Metrics for success:

1. Fuel saved
2. Money saved
    a. By customer class

    b. By PCE

3. Types of measures used to achieve target

D. SUSTAINABLE PROGRAM FUNDING



Identifying "a source of rent, royalty, income or tax" is a requirement of the AkAES enabling legislation. In the past fifteen years, the State has spent over $200 million in identified capital grants and $527 million in direct consumer subsidies in the study area. The federal government, through the Denali Commission and USDA, provided an additional $880 million in capital grants and over $200 million in direct consumer subsidies in the study area. The needs that were addressed by those appropriations will still exist in the future. Although the AkAES recommendations provide mechanisms to stretch State dollars by using them more efficiently, new sources of funding will still be required to ensure communities' needs for safe, reliable, and affordable energy are met.

D1. USE THE ALASKA AFFORDABLE ENERGY FUND (AS 37.05.610) WHEN IT BECOMES AVAILABLE

- Chapter 14, SLA 14 created a special account in the General Fund from which the Legislature could appropriate money to develop energy infrastructure and programs in the areas of the state not expected to have direct access to a North Slope natural gas pipeline.
- AS 37.05.610 suggests that up to 20% of the revenue from the State's royalty gas from an Alaska LNG project (after the payment of rents and royalties to the Permanent Fund) may be placed in this special account to assist with energy delivery in the AkAES target area.

Benefit: The Alaska Affordable Energy Fund could provide a sustainable source of funding.

Barrier addressed: Reduced State general fund dollars and reduced federal spending on energy infrastructure in Alaska.

D2. PROVIDE FOR PAYMENT OF PCE ADMINISTRATIVE EXPENSES AND FUND SPECIFIC ENERGY PROGRAMS WITH PCE FUNDS.

Benefit: This recommendation would reduce the need to draw on the Undesignated General Fund for State PCE administration and those energy programs that have a direct impact on operations of PCE-eligible utilities.

Barrier addressed: Reduced State general fund dollars and reduced federal spending on energy infrastructure in Alaska.

Additional information: Given the importance of the PCE program to rural Alaska and the role that the PCE Endowment has in ensuring the long-term viability of the program, it is only suggested that a small portion of the earnings would be used to pay for administrative costs and directly related critical support services. Funding these services, such as circuit rider, operator training, and technical assistance, should not reduce the amount of funding available to PCE communities and should not come directly from the endowment or endanger the inflation-proofing of the fund.

D3. Establish a universal service charge to support community energy projects and programs

Benefits: This recommendation could provide needed community energy projects with a sustainable source of funding. It would also provide needed but currently unavailable data on heating oil consumption.

Barriers addressed: Reduced State general fund dollars and reduced federal spending on energy infrastructure in Alaska.

Connections to other recommendations: Creating a sustainable source of funding will allow for greater benefit to Alaska's energy consumers and a sustainable source of funding for the CEFA (Recommendation B2) and Weatherization and the HER programs (Recommendation B5). Access to data on heating fuels consumption would improve the quality of data compiled in Recommendation A1 for the analysis of community energy projects.

Additional information: Previous energy policy reports have identified per unit energy surcharges as a means by which other states generate receipts to fund their energy-related programs. In Alaska, this could be accomplished by removing the existing tax exemption that applies to heating oil sales. Comparable energy unit charges could be levied on the sale of other energy commodities to maintain parity among major energy sources. Collection would be by the local utility or retailer from all communities within the study area.

In the AkAES study area, at a rate of $0.07/gallon for heating oil, $0.06/ccf for natural gas, and $0.005/kWh for electricity, approximately $13 million a year in revenue would be available for energy projects within the study area.

D4. Continue the Power Cost Equalization program & revive the Alaska Heating Assistance Program

Benefits: The Power Cost Equalization and Alaska Heating Assistance Programs are proven programs that help to underwrite the cost of energy in the AkAES study area.

Barrier(s) addressed: For those communities without access to cost-effective infrastructure, AEA was instructed by the Legislature to identify a way to directly underwrite the cost of energy.

Additional information: The Power Cost Equalization program is the largest and most broad-based consistent source of energy funding in the AkAES study area. The other AkAES recommendations and identified opportunities for reducing the cost of energy in communities are expected to reduce costs but not enough to eliminate communities' need for the PCE program. It is also extremely important to maintain the integrity of the PCE Endowment fund to ensure the sustainability of the PCE benefit to eligible consumers.

Additional opportunity for consideration

Consider giving a State entity the authority to consolidate and manage State consumer energy programs

Benefits: A State entity with the authority to consolidate and manage consumer energy, to the extent that it is reasonable, would increase efficiency of delivering State energy programs to communities. This would assist in enacting State policy as expressed in AS 44.99.115(4)(B), to use one State office or agency "to serve as a clearinghouse in managing the state's energy-related functions to avoid fragmentation and duplication and to increase effectiveness."

Barriers addressed: Forces outside of communities can create barriers to optimum project identification and selection; many energy programs are governed by a multitude of State and federal agencies, and evaluation criteria for projects are not always consistent across programs. Implementation of previous recommendations may spread state energy programs over a half dozen agencies. This could create or exacerbate institutional gaps and competing agency mandates. Developing a coordinated and strategic plan to best assist communities is more difficult without a clear chain of command.

Connections to other recommendations: The State entity would coordinate almost all other aspects of these recommendations, although the RCA would remain independent.

Housing all the supply, generation and efficiency programs under the same banner supports a more comprehensive, holistic approach that will benefit communities. No individual agency has the breadth of technical expertise needed, but across the relevant agencies, the State does have the current capacity to implement the previous recommendations if they were less fragmented. Energy is an extremely important issue, warranting representation by a high-level position within state government.

All loans, grants, and incentive programs would be administered by the new department. The Community Energy Fund for Alaska would be the primary funding mechanism for community energy projects and be managed by the new department. Technical assistance for utilities and communities would leverage the expanded technical and community knowledge available through the entity. Additionally, statewide, regional, and community planning efforts could more easily tap into the larger pool of expertise and knowledge.

Metrics for success:

1. Administrative cost savings
2. Energy savings
3. Communities served

REFERENCES AND RESOURCES

ENERGY PLANNING AND POLICY

1. Alaska Arctic Policy Commission. “Final Report of the Alaska Arctic Policy Commission.” January 30, 2015. http://www.akarctic.com/wp-content/uploads/2015/01/AAPC_final_report_lowres.pdf
2. Alaska Attorney General. “Rural Fuel Pricing in Alaska: A supplement to the 2008 Attorney General’s gasoline pricing investigation”, 2010. http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf
3. Alaska Energy Authority. “Alaska Energy Pathway Toward energy independence.” July 2010. ftp://ftp.aidea.org/2010AlaskaEnergyPlan/2010%20Alaska%20Energy%20Plan/Narrative/Narrative%202010%20Energy%20Plan.pdf
4. Alaska Energy Authority. “Alaska Energy: A first step toward energy independence.” January 2009. http://www.akenergyauthority.org/Content/Publications/AKEnergyJan2009.pdf
5. Black & Veatch. “Southeast Alaska Integrated Resource Plan.” July 2012. http://www.akenergyauthority.org/Content/Publications/SEIRP/SEIRP-Vol1-ExecSumm.pdf
6. Commonwealth North. “Energy for a Sustainable Alaska: The Rural Conundrum.” February 2012. http://www.commonwealthnorth.org/download/Reports/2012_CWN%20Report%20-%20Energy%20for%20a%20Sustainable%20Alaska%20-%20The%20Rural%20Conundrum.pdf
7. Dane and L Doris. “Alaska Strategic Energy Plan and Planning Handbook.” 2013. National Renewable Energy Laboratory. https://energy.gov/sites/prod/files/2014/05/f16/AKStrategicPlanningHandbook_v17.pdf
8. Environmental Protection Agency. “Energy and Environment Guide to Action: State Policies and Best Practices for Advancing Energy Efficiency, Renewable Energy, and Combined Heat and Power.” 2015 Edition. https://www.epa.gov/sites/production/files/2015-08/documents/guide_action_full.pdf
9. Alaska Energy Authority. “Regional Energy Planning.” http://www.akenergyauthority.org/Policy/RegionalPlanning
10. Information Insights & WHPacific. “Interior Alaska Regional Energy Plan.” December 2015. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Interior%20Alaska%20Regional%20Energy%20Plan.pdf?ver=2016-06-09-200432-767
11. Information Insights. “Aleutian and Pribilof Islands Regional Energy Plan.” December 2015. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/AleutianPribilofIslands%20Regional%20Energy%20Plan.pdf?ver=2016-06-22-095050-343
12. Information Insights. “Bristol Bay Regional Energy Plan.” December 2015. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Bristol%20Bay%20Regional%20Energy%20Plan.pdf?ver=2016-06-22-095055-430
13. Information Insights. “Copper River Regional Energy Plan.” June 2015. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Copper%20River%20Regional%20Energy%20Plan.pdf?ver=2016-06-09-200431-897
14. Information Insights. “Kodiak Regional Energy Plan Volume 1.” March 2015. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Kodiak%20Regional%20Energy%20Plan%20Volume%201.pdf?ver=2016-06-20-141606-807

15. Information Insights. "Kodiak Regional Energy Plan Volume 2." March 2015. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Kodiak%20Regional%20Energy%20Plan%20Volume%202.pdf?ver=2016-06-20-141608-333
16. MAFA & Northern Economics. "Alaska Rural Energy Plan, Initiatives for Improving Energy Efficiency and Reliability." April 2004. https://alaskastateenergy.files.wordpress.com/2007/12/2002ruralenergyplanaea-northernecon.pdf
17. National Association of State Energy Officials. "State Energy Planning Guidelines: A Guide to Develop a Comprehensive State Energy Plan Plus Supplemental Policy and Program Options." https://www.naseo.org/data/sites/1/documents/publications/NASEO-State-Energy-Planning-Guidelines.pdf
18. Riley Allen, David Farnsworth, Rich Sedano, and Peter Larsen. "Sustainable Energy Solutions for Rural Alaska." April 2016. https://emp.lbl.gov/sites/all/files/lbnl-1005097_0.pdf
19. Rural Energy Action Council. "Rural Energy Action Council. Findings and Action Recommendations for Governor Frank Murkowski." April 15, 2005. http://www.arlis.org/docs/vol1/60412439.pdf
20. Steve Colt, Ginny Fay, Matt Berman, Sohrab Pathan. "Energy Policy Recommendations Draft Final Report." January 25, 2013. http://www.iser.uaa.alaska.edu/Publications/2013_01_25-EnergyPolicyRecommendations.pdf
21. Walker/Mallot Transition Team Conference. "Team Report". Consumer Energy. November 21-24, 2014. https://gov.alaska.gov/Walker_media/transition_page/combined-report_final.pdf
22. WHPacific & Information Insights. "Prince William Sound Regional Energy Plan." June 2016. http://www.akenergyauthority.org/Portals/0/DNNGalleryPro/uploads/2017/1/25/PrinceWilliamSoundRegionalEnergyPlan.pdf
23. WHPacific "Northwest Arctic Regional Energy Plan." June 2016. http://www.akenergyauthority.org/Portals/0/Policy/RegionalPlanning/Documents/Northwest%20Arctic%20Regional%20Energy%20Plan.pdf?ver=2016-06-27-135917-753
24. WHPacific. "North Slope Borough Energy Plan." http://www.north-slope.org/information/north-slope-regional-energy-plan
25. WHPacific. "Yukon-Kuskokwim Delta Regional Energy Plan." June 2016. http://nuvistacoop.org/wp-content/uploads/2016/08/080316_YK-Delta-Regional-Energy-Plan-web.pdf

STATE PROGRAMS

1. Alaska Energy Authority. "Bulk Fuel Inventory Assessment Report." 2016
2. Alaska Energy Authority. "Emerging Energy Technology Fund Project Status Updates." February 2016. http://www.akenergyauthority.org/Portals/0/Programs/EETF/Documents/EETFProjectUpdatesFeb2016.pdf?ver=2016-03-23-095100-640
3. Alaska Energy Authority. "Power Cost Equalization Program Guide." http://www.akenergyauthority.org/Content/Programs/PCE/Documents/PCEProgramGuideJuly292014EDITS.pdf
4. Alaska Energy Authority. "Renewable Energy Fund Round Status Report and Round IX Recommendations." May 2016. http://www.akenergyauthority.org/Portals/0/Programs/RenewableEnergyFund/Documents/REFRound9StatusRptPrintSpreads.pdf

5. Alaska Energy Authority. “Renewable Energy Fund.” http://www.akenergyauthority.org/Programs/RenewableEnergyFund
6. David Hill, Chris Badger, Leslie Badger, Nikki Clace, and Molly Taylor. “Alaska Energy Authority: Renewable Energy Grant Recommendation Program Impact Evaluation Report.” 2012. https://www.veic.org/resource-library/alaska-energy-authority-renewable-energy-grant-recommendation-program-process-and-impact-evaluation-reports
7. Rashah McChesney. KTOO Public Media. “In rural Alaska, loss of heating assistance hits hard.” 11/11/2016, http://www.ktoo.org/2016/11/11/rural-alaska-loss-heating-assistance-hits-hard/
8. Vermont Energy Investment Corporation. Renewable Energy Grant Recommendation Program Impact Evaluation. 2012. https://www.veic.org/documents/default-source/resources/reports/veic-alaska-energy-authority-rgrp-impact-and-process-evaluation-report.pdf?sfvrsn=2

END USE ENERGY AND ENERGY EFFICIENCY

1. Armstrong, Richard. “Measurement and Verification Review of 2010/2011 VEEP & EECBG Energy Efficiency Retrofits.” December 17, 2013.
2. Brian Saylor & Associates. “Energy Impacts of the RurAL CAP Energy Wise Program from Program Years 2009-2010 and 2011-2012.”
3. Cady Lister, Brian Rogers, and Charles Ermer. “Alaska Energy Efficiency Program and Policy Recommendations.” June 5, 2008. http://www.cchrc.org/sites/default/files/docs/EE_Final.pdf
4. Alaska Energy Authority. “End Use Study: 2012” April 30, 2012. http://www.akenergyauthority.org/Content/Efficiency/EndUse/Documents/AlaskaEndUseStudy2012.pdf
5. Alaska Housing Finance Corporation. “2014 Alaska Housing Assessment.” https://www.ahfc.us/efficiency/research-information-center/housing-assessment/
6. Cold Climate Housing Research Center, “Energy Efficiency Policy Recommendations for Alaska.” May 2, 2012. http://www.akenergyauthority.org/Content/Efficiency/Efficiency/Documents/EfficiencyPolicyRecommendations2012.pdf
7. Cold Climate Housing Research Center. “Weatherization Assistance Program Outcomes.” August 6, 2012. http://www.cchrc.org/sites/default/files/docs/WX_final.pdf
8. Daniel Reitz, Art Ronimus, Carl Remley, Emily Black. “Energy Use and Costs for Operating Sanitation Facilities in Rural Alaska: A survey.” October 2011.
9. Department of Transportation and Public Faculties. “Alaska Sustainable Energy Act: Annual Report. 2015 Progress Report.” January 2016
10. Golden Valley Electric. “Energy Sense Program.” http://www.gvea.com/resources/energysense
11. https://www.ahfc.us/efficiency/energy-programs
12. Information Insights, Inc. “Electric Energy Efficiency, Environmental Scan: Barriers & Opportunities” October 7, 2011. http://www.cchrc.org/sites/default/files/docs/Electric_EE_Environmental_Scan_Lit_Review.pdf
13. Jesse Jenkins, Ted Nordhaus, and Michael Shellenberger. “Energy Emergence: Rebound & Backfire as Emergent Phenomena.” February 2011. http://thebreakthrough.org/blog/Energy_Emergence.pdf
14. John Davies, Nathaniel Mohatt, Cady Lister. “Alaska Energy Efficiency Policy and Programs Recommendations: Review and Update.” June 27, 2011. http://www.cchrc.org/sites/default/files/docs/Interim_EE_Policy_Report.pdf

15. Juliet Agne. “Energy Star Rebate Program: Final Report”. May 20, 2013. http://www.cityofsitka.com/government/departments/electric/documents/EnergyStarRebateProgramFinalReportwithAppendices.pdf
16. Katie Conway. “Nightmute Whole Village Retrofit—then and now.” Alaska Energy Authority. January 15, 2015. http://www.akenergyauthority.org/Content/Efficiency/Veep/Documents/NightmuteWVR20082014FINAL11515.docx
17. Vermont Energy Investment Corporation. “Energy Efficiency Program Evaluation and Financing Needs Assessment.” July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESEEFinancingAssessment.pdf?ver=2016-08-08-135352-107
18. Katie Spataro, Marin Bjork, Mark Masteller for AHFC, “Comparative Analysis of Prescriptive, Performance-Based, and Outcome-Based Energy Code Systems,” 2011. https://www.ahfc.us/files/9013/5754/5384/cascadia_code_analysis_071911.pdf
19. Building Codes Assistance Project for AHFC, “Alaska Gap Analysis,” 2012. http://bcapcodes.org/wp-content/uploads/2016/01/Alaska-Gap-Analysis-Report.pdf
20. The Compliance Planning Assistance Program for AHFC, “Alaska Strategic Compliance Plan,” 2012. http://energycodesocean.org/resource/alaska-strategic-compliance-plan
21. DOL&WD for AHFC, "Construction Cost Survey: 2014". https://www.ahfc.us/files/7313/9664/6819/Const_Cost_2014.pdf.
22. “Energy Savers Tips for Rural Alaska.” 2014. https://www.ahfc.us/files/4713/9327/8963/energy_saver_tips_2014.pdf
23. Richard Armstrong. “A White Paper on Energy Use in Alaska’s Public Facilities.” 2012. https://www.ahfc.us/files/3313/5769/3854/public_facilities_whitepaper_102212.pdf
24. Northern Economics. “The AHFC Home Energy Rebate Program and Electric Consumption by Chugach’s Residential Customers.” May 2013.
25. Kathryn Dodge, Nathan Wiltse, Virginia Valentine. “Home Energy Rebate Program Outcomes.” June 26, 2012. http://www.cchrc.org/docs/reports/HERP_final.pdf
26. David Nicholls, Allen Brackley, and Valerie Barber. “Wood Energy for Residential Heating in Alaska: Current Conditions, Attitudes, and Expected Use.” July 2010. https://www.fs.fed.us/pnw/pubs/pnw_gtr826.pdf
27. United States Census Bureau. “B25040: House Heating Fuel [10]”. 2008-13 U.S. Census Bureau’s American Community Survey Office, 2013. Web. January 2015 <http://ftp2.census.gov/>.

FUEL COST DRIVERS

1. Dominique Pride, Matthew Snodgrass, Antony Scott. “Correlating Community Specific Rural Diesel Fuel Prices with Published Indices of Crude Oil Prices, and Potential Price Projection Applications” June 2015. http://www.akenergyauthority.org/Content/Programs/RenewableEnergyFund/Documents/Round%209/RuralFuelModelReportFinalDraft.pdf
2. Europe Brent Spot Price FOB (Dollars per Barrel), March 2, 2016. http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RBRTE&f=A
3. Ginny Fay, Ben Saylor, Nick Szymoniak, Meghan Wilson and Steve Colt. “Study of the Components of Delivered Fuel Costs in Alaska January 2009 Update.” Prepared for: Alaska State Legislature, Senate

Finance Committee. January 2009. http://www.iser.uaa.alaska.edu/Publications/fuelpricedeliveredupdate.pdf
4. Lisa Demer. "Bush Alaska locked into high gas prices for fuel delivered last summer and fall." Alaksa Dispatch News. May 31, 2016. https://www.adn.com/rural-alaska/article/bush-alaska-locked-high-gas-prices-fuel-delivered-last-summer-and-fall/2015/01/01/
5. Meghan Wilson, Ben Saylor, Nick Szymoniak, Steve Colt, and Ginny Fay. "Components of Delivered Fuel Prices in Alaska." June 2008. http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf
6. Nick Szymoniak, Ginny Fay, Alejandra Villalobos-Melendez. "Component of Alaska Fuel Costs: An Analysis of the Market Factors and Characteristics that Influence Rural Fuel Prices." February 2010. http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf
7. Northern Economics. "Cost Assessment for Diesel Fuel Transition in Western and Northern Alaska Communities." December 2007. https://dec.alaska.gov/air/anpms/ulsd/cost_rpt.pdf
8. Real Petroleum Prices Crude Oil Brent Spot (Case Reference case), http://www.eia.gov/forecasts/aeo/data/browser/#/?id=12-AEO2015

TRANSPORTATION OF FUELS

1. Jeannette Le Falsey. "Coast Guard: No spill in grounding of tanker carrying fuel to Southwest Alaska villages." Alaska Dispatch News. June 25, 2016. http://www.adn.com/alaska-news/2016/06/25/coast-guard-no-spill-in-grounding-of-tanker-carrying-fuel-to-southwest-alaska-villages/
2. Laurel Andrews. "New fuel barges deliver energy savings to rural Alaska." Alaska Dispatch News. May 6, 2013. https://www.adn.com/rural-alaska/article/new-barges-brought-energy-savings-rural-alaska-electric-co-op-says/2013/05/07/
3. U.S. Corps of Engineers, Alaska District. "Alaska Barge Landing System Design Statewide Phase 1, Various Locations Final Report." January 2009. http://www.poa.usace.army.mil/Portals/34/docs/civilworks/archive/alaskabargelandingsystemdesignstatewidephase1.pdf
4. U.S. Corps of Engineers, Alaska District. "Fuel Transportation Improvement Report." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AEAfueltransportationreport101416.pdf

NATURAL GAS, LNG & PROPANE

1. Tobias Schwoerer and Ginny Fay. "Economic Feasibility of North Slope Propane Production and Distribution to Select Alaska Communities." 2010. https://scholarworks.alaska.edu/handle/11122/4276
2. ACEP. "Screening Level Assessment of LNG for Alaska: SW and SE Alaskan Coastal PCE Communities." Feb. 2, 2014. http://acep.uaf.edu/projects/alaska-micro-lng-market-assessment.aspx
3. Alaska Gasline Development Corp. "Greenfield Natural Gas (LNG) Economic Feasibility Study", June 8, 2011. http://www.arlis.org/thepipefiles/Record/1464950
4. Alaska Gasline Development Corp. In-State Propane Utilization Study for the Alaska Gasline Development Corporation. July 1, 2011. http://www.arlis.org/thepipefiles/Record/1465394
5. Alex DeMarban. "Native Wildcatters push ahead with exploration at oil and gas projects." Alaska Dispatch News. November 17, 2016. https://www.adn.com/business-

economy/energy/2016/11/17/native-wildcatters-pushing-ahead-with-exploration-at-oil-and-gas-prospects/
6. Bartz Englishoe and Associates. "Yukon-Kuskokwim Propane Demonstration Project Implementation Report." 2009
7. Cardno Entrix. "IEP Natural Gas Conversion Analysis." 2014. http://www.interiorenergyproject.com/Resources%20and%20Documents/IEP_Conversion_Analysis_Final.pdf
8. Ellis, Tim. "Utility officials: Test project shows LNG could help reduce cost of generating electricity in Tok." Nov. 4, 2016. http://fm.kuac.org/post/utility-officials-test-project-shows-lng-could-help-reduce-cost-generating-electricity-tok
9. Fuhs, Paul. "Propane Production, Transportation and Utilization in Rural and Urban Alaska." Undated presentation
10. Scott Goldsmith and Nick Szymoniak. "Propane from the North Slope: Could it Reduce Energy Costs in the Interior?" 2009. https://scholarworks.alaska.edu/handle/11122/4305
11. MAFA. "Rural Alaska Natural Gas Study: A Profile of Natural Gas Energy Substitution in Rural Alaska." 1997. ftp://ftp.aidea.org/AlternativeEnergyPublications/RNGSExecutiveSummary.pdf
12. Northern Economics, Inc. "LNG Feasibility for Alaska Affordable Energy Strategy Communities." Prepared for Alaska Energy Authority. July 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/LNGFeasibilityStudy2016.pdf?ver=2016-07-29-145517-400
13. Northern Economics. "In-state Gas Demand Study." 2010. http://www.arlis.org/thepipefiles/Record/1465927
14. Northern Economics. "Memorandum: Estimated Natural Gas Demand for the NS LNG Project" 2013. http://www.interiorenergyproject.com/Resources%20and%20Documents/Estimated%20Natural%20Gas%20Demand.pdf
15. Western Alaska Propane Conversion. Discussion Paper. 2010. ftp://ftp.aidea.org/2010AlaskaEnergyPlan/2010%20Alaska%20Energy%20Plan/Propane%20Study/AEA_Plan_Propane.pdf

GENERATION TECHNOLOGY

1. "Diesel Efficiency" Alaska Rural Energy Plan. 2004
2. Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117
3. Alex DeMarban. "Department of Energy eyes hydropower to help Alaska." Alaska Dispatch News. October 16, 2016. http://www.adn.com/business-economy/energy/2016/10/16/department-of-energy-eyes-hydropower-to-help-alaska/
4. Alex DeMarban. "Valdez hydropower project makes utility all-renewable in the summer." Alaska Dispatch News. October 14, 2016. http://www.adn.com/business-economy/energy/2016/10/14/valdez-hydropower-project-makes-utility-all-renewable-in-summer/
5. Devany Plentovich, Steve Stassel, Bill Thompson, Mark Bryan. "Enhancing Heat Recovery by Using Marine Manifolds with Detroit Diesel Series 60 Engines." May 2016.
6. Elizabeth Jenkins, "Is hydropower renewable? One village in SE Alaska needs it to be." January 6, 2017. KTOO Public Media. http://www.ktoo.org/2017/01/06/hydropower-renewable-energy-one-village-se-alaska-needs/

7. Emily Kwong. KCAW. “Green Lake dam awaits replacement part to get back up and running.” December 26, 2016. http://www.alaskapublic.org/2016/12/26/green-lake-dam-awaits-replacement-part-to-get-back-up-and-running/
8. Leila Kheiry, “KPU back on hydro after warm, wet weekend.” KRBD. January 17, 2017. http://www.krbd.org/2017/01/17/kpu-back-on-hydro-after-warm-wet-weekend/
9. National Renewable Energy Laboratory. PVWatts Calculator. http://pvwatts.nrel.gov/
10. US Army Corps of Engineers, Alaska District. “Alaska Hydropower Evaluation.” May 2014.
11. Vanessa Stevens, Colin Craven, Robbin Garber-Slaght. “Air Source Heat Pumps in Southeast Alaska: A review of the literature, a market assessment, and preliminary modeling on residential air source heat pumps in Southeast Alaska.” April 2013. http://www.cchrc.org/sites/default/files/docs/ASHP_final_0.pdf

DATA SOURCES

1. Alaska Affordable Energy Model
2. Alaska Department of Commerce, Community, and Economic Development, Division of Community and Regional Affairs. Alaska Community Database Online. Accessed September 2015. https://www.commerce.alaska.gov/dcra/DCRAExternal
3. Alaska Energy Data Gateway (https://akenergygateway.alaska.edu/)
4. Alaska Energy Data Inventory. http://www.akenergyinventory.org/data
5. Alaska Energy Efficiency Map. http://www.akenergyefficiencymap.org/
6. Alaska Energy Statistics (2013) http://www.akenergyauthority.org/Portals/0/Publications/2013DetailedSumTbl.xlsx
7. Department of Labor and Workforce Development Research and Analysis. Alaska Local and Regional Information. http://live.laborstats.alaska.gov/alari/
8. Steve Colt and Tobias Schwoerer. “Alaska Village Energy Model.” 2013. http://www.iser.uaa.alaska.edu/Publications/2013-07_Village_energy_model_notes.pdf
9. US Census Bureau. “American Community Survey 2009-2013 5-Year Estimates.” Accessed from Division of Community and Regional Affairs Community Database Online. https://www.commerce.alaska.gov/dcra/DCRAExternal/community/Details/5db73dd9-b52c-486a-acf4-a323b8d8f3cf

CLIMATE CHANGE

1. Environmental Change (2008), http://climatechange.alaska.gov/aag/docs/O97F18069.pdf
2. General Accountability Office. GAO-09-551. “Alaska Native Villages: Limited Progress Has Been Made on Relocating Villages Threatened by Flooding and Erosion.” 2009. http://www.gao.gov/new.items/d09551.pdf
3. Peter Larsen, Scott Goldsmith, Orson Smith, Meghan Wilson, Ken Strezepek, Paul Chinowsky, Ben Saylor. “Estimating future costs for Alaska public infrastructure at risk from climate change.” Global Environmental Change. Vol. 18, Issue 3. August 2008, pp. 442-457. http://climatechange.alaska.gov/aag/docs/O97F18069.pdf

FINANCING

1. Alaska Department of Commerce, Community, and Economic Development, Division of Community and Regional Affairs. Alaska Taxable Database. Accessed September 2014. https://www.commerce.alaska.gov/dcra/DCRARepoExt/Pages/AlaskaTaxableDatabase.aspx

2. Castalia Strategic advisors. Estimating WACC for Regulated Utilities in the United States. April 2014. http://www.castalia-advisors.com/files/updated_2014/TP_WACC_Sub_Attachment_B_Castalia_Estimating_WACC.pdf
3. DCRA, “Bulk Fuel Revolving Loan Program Annual Report 2014”
4. DCRA, “Bulk Fuel Revolving Loan Program Annual Report 2015” https://www.commerce.alaska.gov/web/Portals/4/pub/BulkFuelAnnualReport.pdf
5. Dept. of Energy. Energy Investment Partnership: How state and Local Government Are Engaging Private Capital to Drive Clean Energy Investment. Dec. 2015. https://energy.gov/sites/prod/files/2016/01/f28/Energy%20Investment%20Partnerships.pdf
6. Gwen Holdman, Dominique Pride, John McGlynn, Amanda Byrd. “Barriers to and Opportunities for Private Investment in Rural Alaska Energy Projects.” Alaska Center for Energy and Power. December 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/BarriersReportFinal.pdf?ver=2016-12-19-124505-280
7. K. Ardani, D. Hillman, and S. Busche. National Renewable Energy Laboratory. “Financing Opportunities for Renewable Energy Development in Alaska.” April 2013. http://www.nrel.gov/docs/fy13osti/57491.pdf
8. National Institute of Building Sciences. Financing Small Commercial Building Energy Performance Upgrades: Challenges and Opportunities. https://c.ymcdn.com/sites/www.nibs.org/resource/resmgr/CC/CFIRE_CommBldgFinance-Final.pdf

UTILITY MANAGEMENT

1. Alaska Rural Utility Collaborative. “2014 Report on Activities.” https://anthc.org/wp-content/uploads/2015/12/2014-ARUC-Report-on-Activities-v2_02.09.15_email.pdf
2. Denali Commission Policy. “Rural Alaska Energy Infrastructure Criteria for Sustainability.” 2002.
3. Denali Commission. “Analysis of R&R Accounts as Highlighted in the FY2012 Second Half Semi-Annual Report to Congress.” June 2013.
4. James Brooks. “Yakutat power sale draws ample opposition.” Juneau Empire. November 18, 2016. http://juneauempire.com/state/2016-11-18/yakutat-power-sale-draws-ample-opposition
5. James Brooks. “Yakutat sells its power company to statewide cooperative.” Juneau Empire. October 24, 2016. http://m.juneauempire.com/state/2016-10-24/yakutat-sells-its-power-company-statewide-cooperative#gsc.tab=0
6. James Layne. “Electric Utility Outage Reporting 2003 to 2013.” Presentation. Regulatory Commission of Alaska. April 22, 2015.
7. Janine Migden-Ostrander. “Technical Conference: Alternative Cost Recovery Mechanisms.” Presentation to Maryland Public Service Commission. October 20, 2015. http://www.raponline.org/wp-content/uploads/2016/05/rap-jmo-mdpsc-altcostrecmech-2015-oct-20.pdf
8. Jim Lazar. “Electricity Regulation in the US: A Guide.” Second Edition. The Regulatory Assistance Project. 2016. http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf
9. John Nichols. “Lessons Learned: Rural water systems & operational efficiency.” Presentation to the Alaska Rural Energy Conference. April 30, 2013. http://www.uaf.edu/files/acep/2013_REC_Lessons%20Learned-Rural%20Water%20Systems%20&%20Operational%20Effciency_John%20Nickels.pdf

10. Mark Foster and Ralph Townsend. "Determinants of the Cost of Electricity Service in PCE Eligible Communities." January 20, 2017. http://www.akenergyauthority.org/Portals/0/DNNGallery/uploads/2017/1/23/RuralAlaskaEnergyServicesAlternatives%20final.pdf
11. Office of Inspector General, Denali Commission. Analysis of R&R Accounts as Highlighted in the FY2012 Second Half Semi-Annual Report to Congress. June 12, 2013. http://oig.denali.gov/wp-content/uploads/2015/01/SAR-2012-09.pdf
12. Regulatory Commission of Alaska. Order U-15-012(2) Order Denying Request for Expedited Consideration; Approving Application for Certificate of Public Convenience and Necessity; Approving Service Area Description, Tariff Sheets, and Power Sales Agreement; Requiring Filing; and Closing Docket. http://rca.alaska.gov/RCAWeb/ViewFile.aspx?id=69f102f0-4fdb-4475-bfd8-471318c96bff
13. Steve Colt and Mark Foster. "True Cost of Electricity in Rural Alaska and True Cost of Bulk Fuel in Rural Alaska." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/AKAESTrueCostElectricityFuel102616.pdf?ver=2016-10-27-083402-423
14. Steve Colt, Scott Goldsmith, Amy Wiita "Sustainable Utilities in Rural Alaska Effective Management, Maintenance and Operation of Electric, Water, Sewer, Bulk Fuel, Solid Waste" July 15, 2003. http://www.iser.uaa.alaska.edu/Home/ResearchAreas/RuralUtilities.htm
15. University of Alaska Center for Economic Development. "Utility Financial Analysis and Benchmarking Study Draft." October 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/Utilityfinancialanalysisandbenchmarkingstudy.pdf
16. USDA & EPA. "Rural and Small System Guidebook to Sustainable Utility Management." 2016. https://www.epa.gov/sustainable-water-infrastructure/rural-and-small-systems-guidebook-sustainable-utility-management
17. Wesley Loy. "Electric co-op seeks bankruptcy after well cost overruns." Alaska Dispatch News. October 16, 2010. https://www.adn.com/alaska-news/article/electric-co-op-seeks-bankruptcy-after-well-cost-overruns/2010/10/17/
18. Wikipedia. "Used and Useful Principle." https://en.wikipedia.org/wiki/Used_and_Useful_Principle

POPULATION CHANGE

1. E Lance Howe, Lee Huskey, and Matthew Berman. "Migration in Arctic Alaska: Empirical evidence of the stepping stones hypothesis." Migration Studies (2014) 2 (1): 97-123.doi: 10.1093/migration/mnt017
2. Matt Berman and Eddie Hunsinger, "Energy Cost and Rural Alaska Out-migration," 2016.
3. Stephanie Martin, Mary Killorin, and Steve Colt, "Fuel Costs, Migration, and Community Viability", May 2008. http://www.iser.uaa.alaska.edu/Publications/Fuelcost_viability_final.pdf
4. United States Census Bureau. Table 1. General mobility, by race and Hispanic origin, region, sex, age, relationship to householder, educational attainment, marital status, nativity, tenure, and poverty status: 2014 to 2015. http://www.census.gov/data/tables/2015/demo/geographic-mobility/cps-2015.html

APPENDIX A: RELEVANT STATUTORY LANGUAGE FROM SB 138

See http://www.legis.state.ak.us/PDF/28/Bills/SB0138Z.PDF

Sec. 75. The uncodified law of the State of Alaska is amended by adding a new section to read:

PLAN AND RECOMMENDATIONS TO THE LEGISLATURE ON INFRASTRUCTURE NEEDED TO DELIVER AFFORDABLE ENERGY TO AREAS IN THE STATE THAT DO NOT HAVE DIRECT ACCESS TO A NORTH SLOPE NATURAL GAS PIPELINE. (a) The Alaska Energy Authority, in consultation with the Alaska Gasline Development Corporation, the Alaska Industrial Development and Export Authority, and the Department of Revenue, shall, after considering the state energy policy under AS 44.99.115 and sec. 1, ch. 82, SLA 2010, develop a plan for developing infrastructure to deliver more affordable energy to areas of the state that are not expected to have direct access to a North Slope natural gas pipeline. The plan must identify ownership options, different energy sources, including fossil fuels, hydro projects, tidal, and other alternative energy sources, and describe and recommend the means for generating, delivering, receiving, and storing energy in the most cost-efficient manner. For those citizens for whom there is no economically viable infrastructure available, the plan must recommend the means for directly underwriting the energy costs of the citizens to make their energy costs more affordable. The Alaska Energy Authority may consider the development of regional energy systems that can receive and store bulk fuel in quantity and distribute that fuel as needed within the region.

(b) The Alaska Energy Authority, in consultation with the Department of Revenue, shall recommend a plan for funding the design, development, and construction of the required infrastructure and may identify a source of rent, royalty, income, or tax received by the state that may be appropriated by the legislature to implement the plan.

(c) The Alaska Energy Authority shall provide the plan and suggested legislation for the design, development, construction, and financing of the required infrastructure to the legislature before January 1, 2017.

APPENDIX B: DESCRIPTION OF ALASKA AFFORDABLE ENERGY MODEL

Contents

PURPOSE

The Alaska Affordable Energy Model (AAEM), an AEA-designed model built by the University of Alaska Fairbanks' (UAF) Geographic Information Network of Alaska (GINA), is used extensively in the Alaska Affordable Energy Strategy report to evaluate energy infrastructure opportunities in study-area communities. The AAEM uses the best data available for each community, including resource assessments, residential and non-residential building audits, energy consumption information, and generation infrastructure details. The AAEM integrates known information about communities with modeled data to gain a deeper understanding of the challenges faced and opportunities available to bring affordable energy to Alaska's communities.

The AAEM, a community-based energy model and project evaluation tool, uses the best available community and/or regional data to:

1. estimate and forecast heating and electricity consumption by sector,
2. compare the ability of energy infrastructure project types (efficiency, renewable energy, fuel switching) to reduce the cost of energy in communities, and
3. determine the capital investment needed and the resulting energy savings to communities.

The Affordable Energy Model fulfills some of the legislative requirements to "describe and recommend the means of generating, delivering, receiving, and storing energy in the most cost-efficient manner." Also in considering the state energy policy under AS 44.99.115 and sec. 1, ch. 82, SLA 2010, energy efficiency for residential and non-residential facilities is included as a way to "achieve a 15% increase in energy efficiency on a per capita basis between 2010 and 2020" and "institute a comprehensive and coordinated approach to supporting energy efficiency and conservation."

DATA SOURCES FOR MODEL

The model pulls data from databases, such as the Alaska Energy Data Gateway[498] (Gateway); thus, model results will be updated and expanded to remain current as new data is ingested.

Alaska has a number of existing sources of community-level energy data. The Gateway, a database maintained by the University of Alaska Anchorage's Institute for Social and Economic Research through contracts with AEA, has been the primary repository for Alaska's energy data. The scope of the Gateway has increased due to the requirements of the Affordable Energy Model and the data collected through AEA's regional planning effort.

The Gateway has electricity data from the state's Power Cost Equalization (PCE) and the federal Energy Information Authority (EIA). Data includes generation and sales at varying levels of granularity, depending on the data source and reporting requirements. The Gateway has residential electric rates reported for the PCE program and residential and non-residential rates calculated from EIA sales and income reports.

---

[498] Alaska Energy Data Gateway, developed by the Institute of Social and Economic Research, University of Alaska Anchorage, is supported by the U.S. Department of Energy (DOE), Office of Science, Basic Energy Sciences (BES), under EPSCoR Award # DE-SC0004903 (database and web application development), and by Alaska Energy Authority (Renewable Energy Fund data management and reporting). Database and web hosting is provided by the University of Alaska Fairbanks. https://akenergygateway.alaska.edu/

To date, there has been no systematic collection of non-residential rates in PCE communities nor any collection of other fees and/or demand charges.

The Gateway also maintains current and historical heating fuel prices (for heating oil, wood, and propane) at a local level for more than 200 communities; this data was acquired through surveys performed by the Alaska Housing Finance Corporation (AHFC) and the state's Division for Community and Regional Affairs (DCRA).

Another primary purpose of the Gateway is to store the data from the operational projects funded through the Renewable Energy Fund (REF). As the best source for renewable energy performance data in Alaska, the performance of several dozen renewable energy projects is available and will be updated as more projects are developed and further operational experience is gained.

The US Census, particularly the American Community Survey, is the main source for the model's socioeconomic data. The decennial population is supplemented by estimates from the Alaska Department of Labor and Workforce Development Research and Analysis section on a yearly basis. The Census also collected data on the number and status of houses: the number inhabited and vacant, rented and owned. The 5-year ongoing household survey from the American Community Survey (ACS) includes community and regional estimates for heating fuel usage in residences.[499] Because of the margin of error present in the ACS at the community level in Alaska outside of major population centers for all data sets, regional estimates are generally used. As one example, the Census Bureau's estimate for MHI in Lime Village was $145,313 with a margin of error of plus or minus $266,070 (183%).[500]

The Alaska Housing Finance Corporation's Alaska Retrofit Information System (ARIS) is the primary source of building information in the state, but the data is not publicly available. ARIS houses data for both residential and non-residential buildings and facilities. The residential data comes from AHFC's Home Energy Rebate (HER) program, Weatherization Assistance Program (Wx), and the Building Energy Efficiency Standard (BEES). The data is gathered on the household level by residential auditors that use the AkWarm program (AkWarm is a residential building modeling program specifically built for AHFC). Little actual residential building consumption data is included in ARIS.

ARIS also includes non-residential building and facility data. Data includes the square footage of buildings, the building use, some data on the building construction, and occasional data on electricity and/or heating consumption. Additional building data was gathered from audits performed by the Alaska Native Tribal Health Consortium energy program, AHFC building audit program, AEA's Village Energy Efficiency Program (VEEP), AEA-led regional planning[501], AEA's 2012 End Use Study[502], and various other sources.

---

[499] United States Census Bureau. "B25040: House Heating Fuel [10]". 2008-13 U.S. Census Bureau's American Community Survey Office, 2013. January 2015 <http://ftp2.census.gov/>.
[500] US Census Bureau. "American Community Survey 2009-2013 5-Year Estimates." Accessed from Division of Community and Regional Affairs Community Database Online.
https://www.commerce.alaska.gov/dcra/DCRAExternal/community/Details/5db73dd9-b52c-486a-acf4-a323b8d8f3cf
[501] http://www.akenergyauthority.org/Policy/RegionalPlanning
[502] http://www.akenergyauthority.org/Content/Efficiency/EndUse/Documents/AlaskaEndUseStudy2012.pdf

Other datasets are included in the description of each of the model's modules.

GLOBAL MODEL ASSUMPTIONS

The AAEM uses the California Energy Commission's Total Resource Cost Test, which is agnostic of where money comes from or where the benefits go.[503] It is assumed that when the AkAES legislative directive states that infrastructure projects should be cost-effective, it means that the present value of the benefits should outweigh the present value of cost of the project, independent of who is paying for the project or receiving the benefits. This TRC test does not quantify or include other societal benefits of renewable energy development.

The model is primarily based on the economic assumptions of the Round 9 Renewable Energy Fund (REF) project evaluation model, developed by ISER.[504] It uses the REF's discount rate (3%), real dollars, the assumed economic life of projects, O&M/R&R assumptions, fuel price forecasts, and technology performance (where applicable).

State energy policy established by sec. 1, ch. 82, SLA 2010 instructs that the "power project fund serve as the main source of state assistance of energy projects". As a result, the Alaska Affordable Energy model is built around the use of project financing (loans) and not grants. The loan terms are based on the expected life of the project with an initial interest rate set at 5%.

The heating oil price premium, a premium on top of the cost of the forecasted price per gallon for diesel to the utility, was calculated using an average of the regional differences between the yearly average cost of heating oil and utility diesel.

The model does not assume any price elasticity for electricity and heating fuels.

Regional cost multipliers were adapted from a 2013 Alaska Department of Education and Early Development cost estimating manual.[505] Insufficient data has been found through analyzing AEA projects to develop similar regional cost multipliers based on energy projects.

FORECASTS

ENERGY DEMAND FORECAST

Population projections at the community level were developed by a researcher at the University of Alaska Anchorage Institute of Social and Economic Research (ISER) (unpublished except as part of the AAEM).

The population projections are integral to forecasting future electricity and heating fuel demand. The future electricity demand, in kilowatt-hours per year (kWh/year), is forecasted by an equation developed from separate regressions for the residential and non-residential sectors of the actual consumption and population from 2003-2014 for each individual community. The population projections also impact the heating fuel forecast by estimating the future residences and consumption in the water/wastewater

[503] http://www.energy.ca.gov/pou_reporting/background/metrics.html and http://www.mwalliance.org/node/3032
[504] http://www.akenergyauthority.org/Programs/RenewableEnergyFund
[505] https://education.alaska.gov/facilities/pdf/cost_model_instructions.pdf

system. The population forecast does not currently affect the estimate of non-residential buildings in the community, and thus the consumption of heating fuels.

The energy demand forecast was tested by compiling the total heating oil and diesel fuel consumed by community. In 2016, AEA asked Crowley Maritime Corporation's Alaska Fuel Sales and Distribution division to provide feedback on the liquid fuels estimates for communities that they served. Of the communities that AEA received feedback on, approximately 70 communities, most appeared to be within a reasonable margin of error (10-20%). The process also allowed AEA to identify some programming and data bugs that helped to improve the estimates in a few communities.

GENERATION FORECAST

To forecast the generation needed to meet the expected demand, the future line loss (as a percentage of lost generation) and generation efficiency (in kWh/gallon) are assumed to be an average of the previous three years' line loss and generation efficiency, expected to remain constant in the future. For other generation sources, the future generation is based on an average of the previous three years of reported generation. This may cause some discrepancies for new renewable energy infrastructure.

In cases where excess hydro or wind capacity available in the community or intertie, the renewable energy absorbs any growth before diesel is used to supplement any forecasted increase in required generation. The renewable energy capacity is provided as a data input for each applicable community.

ENERGY COST FORECAST

One of the key aspects of estimating the benefits of projects is in forecasting the fuel prices, either for what is being displaced or the replacement fuel. Where it is possible, the model retains the fuel price forecasts from the REF. The utility diesel price forecast is based on the Energy information Authority mid-price forecast for Brent crude, in the current case, from 2016.[506] The community-specific conversion factors are based on work performed by the Alaska Center for Energy and Power (ACEP).[507] A carbon price has historically been included in the price projection.

A number of entities, including AEA and ISER, have unsuccessfully investigated the mechanisms that lead to the differences in heating oil costs between communities. Lacking this site-specific information, AEA used regional averages of the difference between the retail price of heating oil (both #1 and #2) and the diesel price reported to PCE to forecast the heating oil prices for the AAEM. The unit price of biomass is assumed to remain flat in real terms based on 2015 vendor prices gathered from the federal Low Income Heating Assistance Program (LIHEAP).

The retail electricity price forecast is developed by using the diesel price forecast, and assumes that the status quo operation expenses of the utility remains constant in real dollars, and that the operational cost

---

[506] Real Petroleum Prices Crude Oil Brent Spot (Case Reference case), http://www.eia.gov/forecasts/aeo/data/browser/#/?id=12-AEO2015

[507] Dominique Pride, Matthew Snodgrass, Antony Scott. "Correlating Community Specific Rural Diesel Fuel Prices with Published Indices of Crude Oil Prices, and Potential Price Projection Applications" June 2015. http://www.akenergyauthority.org/Content/Programs/RenewableEnergyFund/Documents/Round%209/RuralFuelModelReportFinalDraft.pdf

is captured in an average of the observed difference between the retail rate and the cost of power for the previous three years.

Future inflation is based on a 2.4% increase in the Consumer Price Index (CPI), which mirrors the REF Evaluation Model.

AAEM MODULES

These modules use forecasts for unit prices, population, generation, and consumption. Individual modules include other *key data inputs* and *key assumptions* to develop the *key outputs*.

Comparison is made primarily as existing grant-funded infrastructure to new debt-financed projects. The benefits are generally based on the savings in fuel costs.

EFFICIENCY MODULES

RESIDENTIAL ENERGY EFFICIENCY IMPROVEMENTS

This module estimates the potential improvements to heating efficiency of residential buildings (homes). Consumption and savings are based on the number of units that have not been retrofit, the performance improvements as a percentage of the pre-retrofit consumption, and the forecasted price of offset heating fuels. The cost to retrofit each home is also calculated.

KEY DATA INPUTS

1. ARIS AkWarm data for every community. Includes data from the Weatherization Assistance program, Home Energy Rebate Program, and Building Energy Efficiency Standard (BEES) compliant residences[508]
2. ACS residential heat source[509]
3. Community population and population forecast[510]

KEY OUTPUTS

1. Residential consumption of heating fuels
    a. Forecasted volume of heating fuels consumed
    b. Forecasted cost of heating fuels
2. Economic analysis of the potential cost effectiveness of residential efficiency to reduce heating costs

KEY ASSUMPTIONS

1. Economic life of efficiency retrofit: 15 years
2. Population and households—maintain number of people per household
3. Unknown residential buildings in a community are most similar to the average of pre-retrofit buildings

[508] ARIS is not a publicly available database
[509] United States Census Bureau. "B25040: House Heating Fuel [10]". 2008-13 U.S. Census Bureau's American Community Survey Office, 2013. January 2015 <http://ftp2.census.gov/>.
[510] Population forecasted by Mouhcine Guettabi of the Institute of Social and Economic Research for the AkAES in 2016.

4. Savings from weatherization based on average community savings, if it is statistically significant, or the regional average
5. Unit cost—$11,000 modified by a regional multiplier

NON-RESIDENTIAL ENERGY EFFICIENCY IMPROVEMENTS

This module estimates potential improvements in heating and electrical efficiency to non-residential buildings (commercial, education, health care, etc.). Consumption and savings are based on estimated square footage per building that may be retrofit and prices of fuels (electricity, biomass, diesel, etc.). The cost to retrofit each non-residential building is also calculated.

KEY DATA INPUTS

1. Non-residential building data (Sources: ARIS, ANTHC, End Use Study, regional plans, municipal and borough tax assessors, others)
    a. Available data was not consistent for all buildings, but could include the building use, square footage, electricity consumption, and/or heating fuels consumption
    b. Any building audits in the study area were included
2. Heating degree days for all communities

KEY OUTPUTS

1. Non-residential consumption of electricity and heating fuels
    a. Forecasted volume of heating fuels (used in other modules) for non-residential buildings
    b. Forecasted volume of electricity consumed for non-residential buildings
    c. Forecasted cost of heating fuels for non-residential buildings
    d. Forecasted cost of electricity for non-residential buildings
2. Economic analysis of module

KEY ASSUMPTIONS

1. Economic life of energy retrofit: 15 years
2. Population changes will not change the number or type of buildings or the consumption in non-residential buildings
3. Assume that heating oil is the only fuel used for heating except if natural gas is available in community
4. Savings in consumption
    a. Electricity—28%
    b. Heat—28%
5. Unit cost--$7/square foot, scaled by regional multiplier
6. If building size, electricity, and/or heating fuel consumption is not known, averages by building type and community size are assumed.
7. Heating consumption estimates are scaled by heating degree days in community relative to average that created dataset

WATER AND WASTEWATER EFFICIENCY IMPROVEMENTS

This module estimates potential improvements in heating and electrical efficiency to water and wastewater systems. Consumption and savings are calculated based on system type, population, and heating degree days per year for a community. Project costs are based on audits, or estimated by the community size.

Key data inputs

1. Reported consumption data from ARIS, Alaska Native Tribal Health Consortium (ANTHC), the Alaska Rural Utility Collaboration (ARUC), and the 2012 AEA-funded End Use Study
2. Approximately 60 audits of water/wastewater systems are included from ANTHC
3. The type of water/wastewater system is from the Division of Community and Regional Affairs Community Database Online.
4. Heating degree days for each community

Key outputs

1. Heating and electricity consumption for the water/wastewater system
2. Economic analysis of module

Key assumptions

1. Economic life of efficiency improvements: 15 years
2. If the electricity and heating fuels consumption is not known, the electricity and heating oil consumption is estimated based on the community size, the local heating degree days, and the type of water/wastewater system
3. Savings 25% for electricity and 35% for heating fuels
4. An estimated capital cost based on the number of people in the community ($400-650/person)

GENERATION MODULES

Diesel Efficiency Improvements

This module estimates the potential reduction in diesel fuel use from improvements to the efficiency of a community's diesel generation systems. Financial savings are from an assumed decrease in diesel oil used in generation. Costs of the improvements are based on the assumed capacity of the improved system.

Key inputs

1. Electric generation and consumption data in kWh
2. Generation efficiency and line loss

Key outputs

1. Economic analysis

Key assumptions

1. Economic life of improvements: 30 years
2. 10% savings in fuel over the economic life of the powerhouse
3. Generation capacity needed is based on a five times multiplier of the average community load
4. The estimated unit cost is based on the assumed generation capacity. The equation is derived from the costs of AEA- and Denali Commission-funded rural powerhouses

Wind Power Infrastructure

This module estimates potential reduction in diesel fuel use from the installation of wind power systems. Proposed wind generation is from existing projects or estimated from a proposed capacity. Financial savings result from decrease in diesel used in generation due to wind systems. The cost to build or improve wind infrastructure are also estimated.

Key data inputs

1. If available, data from Renewable Energy Fund projects (cost, generation, secondary loads) is used
   a. If no project-specific data is available, the highest wind class within one mile of community/intertie is used. Data is from the NREL wind map[511] or local anemometers

Key outputs

1. Generation in kWh per year
2. Economic analysis of module

Key assumptions

1. Economic life of infrastructure: 20 years
2. Generation capacity is 150% of the average community/intertie load
3. The capacity factor per wind class
4. 15% of the electricity generated is expected to be excess
5. If the existing powerhouse has heat recovery installed, the loss of waste heat from the diesel generator is included.
6. Capital cost is based on work performed by ACEP[512]
7. Operational cost is expected to be 1% of the capital cost

Solar Power Infrastructure

This module estimates the potential reduction in diesel fuel use from installation or improvement of photovoltaic (PV) solar generation systems. Proposed solar generation is based on an estimated capacity per community. Costs associated with the installation of panels and necessary power-house improvements are also estimated.

Key data inputs

1. Expected generation from a 10-kW solar panel PVWatts[513] was collected for 30 communities with solar data. Communities without data substituted data from the nearest community

Key outputs

1. Generation in kWh

---

[511] Available from Alaska Energy Data Inventory (http://www.akenergyinventory.org/)

[512] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

[513] http://pvwatts.nrel.gov/index.php

2. Economic analysis of module

Key assumptions

1. Economic life: 20 years
2. Performance degradation of 1% per year[514]
3. Generation size limited to 15% of the average load[515]
4. 15% of the electricity generated is expected to be excess
5. Capital cost is $6,000/kW, which is currently optimistic based on work performed by ACEP[516]
6. Operational cost is expected to be 1% of the capital cost

Hydropower Infrastructure

This module estimates the potential reduction in diesel fuel use from installation of hydropower projects. Proposed hydro generation is from proposed projects around the state. Financial savings result from decrease in diesel used in generation due to hydropower projects. Cost estimates for building hydropower infrastructure are also calculated.

Key data inputs

1. When available, Renewable Energy Fund pre-construction project data is included for cost and generation
2. Data collected for over 400 projects through US Army Corps of Engineers cataloging of hydropower studies
    a. Include some modeling based on regional output and costs

Key outputs

1. Generation in kWh
2. Economic analysis of module

Key assumptions

1. Economic life of hydropower infrastructure: 50 years
2. 15% of the electricity generated is expected to be excess
3. Operational cost is expected to be 1% of the capital cost

Transmission and Intertie Infrastructure

This module estimates the potential reduction in diesel fuel use from installation of transmission lines to another community with better generation infrastructure. Savings result from difference in generation

---

[514] Dirk Jordan and Sarah Kurtz. "Photovoltaic Degradation Rates — An Analytical Review." 2012. http://www.nrel.gov/docs/fy12osti/51664.pdf

[515] Based on: Mueller Stoffels M 2014 Adding PV Capacity – Initial Assessment And Recommendations For Galena Alaska, available at: http://acep.uaf.edu/media/127271/Mueller-Stoffels-M-2014-Adding-PV-Capacity-%E2%80%93-Initial-Assessment-and-Recommendations-for-Galena-Alaska.pdf

[516] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

costs between communities. The costs of new transmission lines are estimated based on distances between communities.

KEY DATA INPUTS

1. Distance to nearest community with lowest cost power

KEY OUTPUTS

1. Economic analysis of the module

KEY ASSUMPTIONS

1. Economic life of infrastructure: 30 years
2. Generation efficiency remains constant
3. Unit cost of transmission lines of $200,000 per mile with road access and $500,000/mile without a road.[517]

HEATING PROJECTS

Except for heat recovery projects, which uses data only from previous pre-construction studies, the heating projects share a common method for estimating the required capacity of the heating appliances. The estimated heating oil consumption for non-residential buildings is apportioned by binned weather data by month, assuming there is a direct relationship between the heating degree days and the amount of fuel consumed in the month. The required sizing of the heating appliance(s) (in MMBtu/hour) is estimated by converting the gallons of heating oil consumed in the coldest month into energy equivalent per hour (Btu/hour). This assumes that a secondary heat source, generally heating oil, is available to supply the peak load.

BIOMASS FOR HEAT (CORDWOOD) INFRASTRUCTURE

This module estimates the potential reduction in heating fuel use from installation cordwood boilers in non-residential buildings. Reduction in fuel used is based on estimated output of hypothetical boilers. Savings result from difference in fuel prices between diesel and cordwood. The costs of the biomass projects are estimated from number of installed boilers and their size. Fuel use from improvements to heat recovery systems is based on existing projects. Reduction of heating fuel used results from improved recovery of heat during electrical generation

KEY DATA INPUTS

1. A Boolean on if sufficient biomass available within a 5-mile radius
2. Data from non-residential model on heating oil consumption

KEY ASSUMPTIONS

1. General assumptions for heating projects, as explained above
2. Economic life of infrastructure: 20 years

---

[517] Alaska Center for Energy and Power. "Documentation of Alaska-Specific Technology Development Needs in support of the Alaska Affordable Energy Strategy." 2016. http://www.akenergyauthority.org/Portals/0/Policy/AKaES/Documents/Reports/TechnologyDevelopmentNeeds.pdf?ver=2016-08-08-152005-117

3. 30% of square footage of non-residential buildings are included
4. Unit cost is based on AEA analysis of REF-funded projects

Key outputs

1. Economic analysis of the module
2. Consumption of biomass

Biomass for Heat (Pellet) Infrastructure

This module estimates the potential reduction in heating fuel use from installation of pellet boilers in non-residential buildings. Reduction in fuel used is based on estimated output of hypothetical boiler. Savings result from difference in fuel prices between diesel and pellets. The costs of the biomass projects are estimated from number of installed boilers and their size. Communities must have access to road system.

Key data inputs

1. A Boolean on if the community is on the road system or marine highway system
2. Data from non-residential model on heating oil consumption

Key assumptions

1. General assumptions for heating projects, as explained above
2. Economic life of infrastructure: 20 years
3. 30% of square footage of non-residential buildings are included
4. Unit cost is based on AEA analysis of REF-funded projects

Key outputs

1. Economic analysis of the module
2. Consumption of biomass

Residential Air Source Heat Pump (ASHP) Infrastructure

This module estimate the potential reduction in heating fuel use from installation of Air Source Heat Pumps in residential buildings. Reduction in fuel used is based on coefficient of power in hypothetical ASHP system and heat energy produced per year. Savings result from differential heating fuel costs and ASHP operation costs. The costs of the ASHP infrastructure projects are based on the number of homes in the community and the cost of AHSP systems themselves.

Key data inputs

1. Input from Residential efficiency module
2. ACS residential heat source

Key assumptions

1. General assumptions for heating projects, as explained above
2. Economic life of infrastructure: 20 years
3. Coefficient of performance is dependent on the outdoor temperature

4. Output in Btu/hour is dependent on the outdoor temperature[518]
5. Electricity prices do not change with increased demand
6. No new generation is needed to power ASHPs
7. Unit cost based on national averages[519], modified by Alaska regional multipliers

Key outputs

1. Increase in electricity consumption
2. Excess generation capacity necessary to power ASHPs
3. Economic analysis of the module

Non-Residential Air Source Heat Pump (ASHP) Infrastructure

This model estimates the potential reduction in heating fuel use from installation of Air Source Heat Pumps in Non-residential buildings. Reduction in fuel used is based on coefficient of power in hypothetical ASHP system and heat energy produced per year. Savings result from differential heating fuel costs and ASHP operation costs. The cost of the ASHP infrastructure projects are based on the number of non-residential buildings in the community and the cost of AHSP systems themselves

Key data inputs

1. Input from Non-residential efficiency module

Key assumptions

1. General assumptions for heating projects, as explained above
2. Economic life of infrastructure: 20 years
3. Coefficient of performance is dependent on the outdoor temperature
4. Output in Btu/hour is dependent on the outdoor temperature[520]
5. Electricity prices do not change with increased demand
6. No new generation is needed to power ASHPs
7. Unit cost based on national averages[521], modified by Alaska regional multipliers

Key outputs

1. Increase in electricity consumption
2. Excess generation capacity necessary to power ASHPs
3. Economic analysis of the module

---

[518] Richard Faesy & Jim Grevatt, Energy Futures Group, Brian McCowan & Katie Champagne, Energy & Resource Solutions, Ductless Heat Pump Meta-Study: Final Report Presentation, November 13, 2014.
[519] Faesy & Grevatt, 2014.
[520] Richard Faesy & Jim Grevatt, Energy Futures Group, Brian McCowan & Katie Champagne, Energy & Resource Solutions, Ductless Heat Pump Meta-Study: Final Report Presentation, November 13, 2014.
[521] Energy Information Authority. "Residential & Commercial Building Technologies Appendix A." 2016. https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf

Heat Recovery Infrastructure

Insufficient data was available on a community-level to model the costs and benefits of heat recovery. Because of this, the module only includes analysis of projects that have pre-construction studies.

Key data inputs

1. Pre-construction project data from the Renewable Energy Fund and the Rural Power System Upgrade program

Key outputs

1. Economic analysis of module

AAEM DISTRIBUTION, INSTALLATION, AND RESULTS

AAEM is built in the Python programming language and is platform independent. The model is stored in a Git repository hosted at GitHub. As of January 2017, the AAEM is run from a command line interface (CLI), uses input data that is packaged with the model, and is installed locally. Users will need to use a Mac/Unix, Windows, or Linux terminal window and a familiarity with CLIs may be helpful.

Visualizations of the model output, and further documentation are available from http://www.akenergyinventory.org/energymodel.

Please contact AEA for the latest version of the model, accompanying input data, and model output.

Neil McMahon, Program Manager: Energy Planning
907-771-3981, nmcmahon@aidea.org