NUVISTA

YUKON-KUSKOKWIM DELTA
REGIONAL ENERGY PLAN

FINAL DRAFT November 2015

Yukon-Kuskokwim Delta Regional Energy Plan
November 2015

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ACRONYMS AND ABBREVIATIONS

ACEP	Alaska Center for Energy and Power
AEA	Alaska Energy Authority
AHFC	Alaska Housing Finance Corporation
AIDEA	Alaska Industrial Development and Export Authority
AMR systems	Automated meter reading systems
ANCSA	Alaska Native Claims Settlement Act
ANGDA	Alaska Natural Gas Development Authority
ANTHC	Alaska Native Tribal Health Consortium
ARDOR	Alaska Regional Development Organizations
ARECA	Alaska Rural Electric Cooperative Association
ARIS	Alaska Retrofit Information System
ARRA	American Recovery and Reinvestment Act
ARUC	Alaska Rural Utility Collaborative
ASRC	Arctic Slope Regional Corporation
AVCP	Association of Village Council Presidents
AVEC	Alaska Village Electric Cooperative
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BEES	Building Energy Efficiency Standards
CDR	Concept Design Report
CETF	Community Energy Task Force
CWG	Chaninik Wind Group
CIAP	Coastal Impact Assistance Program
CFL	Compact Fluorescent Light
EfW	Energy From Waste
DCCED	Department of Commerce, Community and Economic Development
DOE	U.S. Department of Energy
DOL	Alaska Department of Labor (and Workforce Development)
DOT&PF	Alaska Department of Transportation and Public Facilities
EEM	Energy Efficiency Measures
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ETF	Energy Technology Fund
EUI	Energy Use Index
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
HUD	U.S. Department of Housing and Urban Development
HVDC	High Voltage Direct Current
ICDBG	Indian Community Development Block Grant
IGA	Investment Grade Audit
IPP	Independent Power Producer
ISER	Institute for Social and Economic Research
kW	Kilowatt
kWh	Kilowatt hour
MMBTU	One thousand thousand British Thermal Units
Mcf	One thousand cubic feet
MWh	Megawatt hours

NAHASDA	Native American Housing and Self Determination Act
NIST	National Institute for Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NRECA	National Rural Electric Cooperative Association
NREL	National Renewable Energy Laboratory
ORC	Organic Rankine Cycle
PFD	Permanent Fund Dividend
PCE	Power Cost Equalization
PD&R	Policy Development and Research
PV	Photovoltaic
REAP	Renewable Energy Alaska Program
RUBA	Rural Utility Business Advisor
TED	The Energy Detective
UAF	University of Alaska Fairbanks
UCG	Underground Coal Gasification
USACE	United States Army Corps of Engineers
WtE	Waste to Energy
WTP	Water Treatment Plant
YK	Yukon-Kuskokwim
YKCC	Yukon-Kuskokwim Correctional Center
YKHC	Yukon Kuskokwim Health Corporation

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This section provides a condensed version of the Yukon-Kuskokwim Regional Energy Plan.

In November of 2014, Nuvista took a pro-active step to review and complete the YK Delta energy planning initiative and hired WHPacific, Inc. and Information Insights to help develop the *YK Delta Regional Energy Plan*.

With the guidance of Nuvista staff, whose mission is to "improve the energy economics in Rural Alaska by creating energy generation and transmission infrastructure to serve, connect and enable the region to attain affordable, long term energy sustainability and self-sufficiency", a draft plan was created. With help from the technical support staff at WHPacific, Inc. and Information Insights, oversight from the Alaska Energy Authority and support from local, regional and state stakeholders this planning effort will become a tool for current and future decision makers.

Due to logistic and Arctic climate design challenges for energy infrastructure, including maintenance and operation, this plan would provide a regional energy vision that would then provide the framework for future energy development in the YK Delta region. It was the vision created by current leaders in the region to become leaders pioneering a unified, creative approach to access abundant, affordable, efficient energy utilizing local resources.

This plan shows the current energy resources within the YK Delta region and presents options for reducing energy costs while maintaining or improving the current level of service provided. Analysis collected previously by federal, state and local energy specialists and relied heavily on the assistance of the Alaska Energy Authority and staff, as well as community leaders, was used to prepare a *final draft* energy plan. It is an expansion of previous studies and data collection and lays out issues, goals and prioritized energy projects obtained through a series of community meetings and document reviews. The goal is for this plan to become a living document that provides a tool for current and future generations on energy-related projects.

The energy planning efforts are based on a local, grassroots perspective. Sub-regional community meeting were held, in which issues, goals and prioritized projects are highlighted on individual community and energy profiles. These "snapshots" in time show the current energy-related conditions. Nuvista will continue to update and incorporate data as it becomes available.

The table below summarizes the issues, goals and potential projects. These projects are given more detail throughout the plan.

ENERGY ISSUES	ENERGY GOALS	POTENTIAL PROJECT(S)
Energy Efficiency & Conservation		
Lack of education in energy-efficiency and conservation, no tracking of energy costs, inefficient housing design for Arctic climate and no present best practices in place.	Provide adequate energy education in all levels and areas, calculate life-cycle costs for all energy systems, set standards and best practices for Arctic climate appropriate design and construction.	▪ Energy-wise educational visits to all residential homes ▪ Data metering and collection for all energy systems ▪ Design and build for Arctic climate and set standard for all construction in the YK Delta region ▪ Implement through an ESCO program all recommendations on energy audits
Maintenance and Operations		
Lack of trained workforce in energy-related systems at the local level, causing high maintenance and operations expenses.	Continue to train and develop a local workforce of operators and repair technicians for all energy systems. Train local workforce to do construction upgrades for efficiency.	▪ Institute a curriculum on energy-related jobs with local secondary and college educators to promote and design Arctic appropriate approach
Energy Financing		
Outside funding for energy projects is limited and highly competitive, SOA PCE rates are not always maximized, costs for energy systems continues to grow – stressing current budgets, high non-payment of utility bills, even with subsidies.	Seek Federal and State technical assistance for planning of future energy projects, collaborate funding efforts, develop comprehensive financial strategy for maximizing energy funding.	▪ Create a funding database for collaboration of federal, state, local and private funds for energy projects
Energy Infrastructure		
Inappropriate designed energy systems has led to very high M&O costs, failing systems (due to design flaws and climate change) continues to drive the costs up on all infrastructure – roads, water and sewer, housing stock, transmission lines, energy systems rely heavily on diesel and need upgrades to accept renewable systems.	Assess current infrastructure and develop an implementation plan for upgrades, assess housing stock conditions, upgrades systems to accept renewable energy, diversify energy sources through use of alternatives.	▪ Implementation plan for current needs ▪ Energy audits on all commercial/public buildings ▪ Assess current energy systems for upgrades to be more efficient
Planning		
Lack of effective planning efforts for implementation of recommendations for energy savings and projects, lack of accessibility to lands within federal parks, lack of regional collaboration.	Seek to create individual local energy plans that coincide with regional efforts, continue to update regional plan, educate legislators of current conditions and needs, and encourage investment in region through collaborated planning efforts.	▪ Create local energy plans ▪ Invite land management to meetings ▪ Invite legislators to region ▪ Collaborate efforts

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CHAPTER 1
INTRODUCTION

INTRODUCTION

This chapter introduces the plan, describes what it is and what it is not, outlines the methodology, presents the plan organization and summarizes the energy issues and goals.

Nuvista Light and Electric Cooperative Inc. (Nuvista) took the lead in preparing this regional energy plan for the Yukon-Kuskokwim (YK) Delta region.[1] The overall goal of the plan is to identify region-wide energy priorities that could reduce the long-term cost of energy and improve energy systems in the YK Delta. Throughout this planning process, the planning team sought to identify energy projects that provide stable, sustainable energy, help the region be more energy efficient, and reduce costs to consumers. To help prepare the plan, Nuvista contracted with WHPacific, Inc. and Information Insights, Inc.

The Energy Plan is intended to accomplish the following:

- Provide an energy profile for the region and each community within the region that clearly demonstrates existing energy issues, current energy usage, and potential opportunities for alternative energy and energy efficiency measures.
- Outline a process for educating residents, community leaders and business owners about energy efficiency and conservation measures.
- Assist in obtaining grants that reduce energy costs.
- Develop guidance for sound alternative resource development.
- Help to identify regional priorities for action.
- Save costs and increase comfort for residents resulting from energy efficiency improvements.
- Be a part of each community's overall comprehensive Plan.

NUVISTA'S MISSION

To improve the energy economics in Rural Alaska by creating energy generation and transmission infrastructure to serve, connect and enable the region to attain affordable, long term energy sustainability and self-sufficiency.

The Energy Plan is not intended to:

- Remain a static document. The plan should evolve as time passes to reflect current economic realities, political constraints and opportunities, and technology.
- Serve as a design document. The plan is not intended to capture a high level of detail surrounding energy projects, and most recommended projects will require standard pre-design and design documentation.

1.1 METHODOLOGY

The data collected for this report was gathered from existing data in published reports and databases including: the Alaska Energy Authority Energy Pathways and End Use Study, the Alaska Housing Finance Corporation (AHFC) Alaska Retrofit Information System (ARIS), Alaska Home Energy Rebate Program and Weatherization Program, Power Cost Equalization Reports, Institute of Social and Economic Research (ISER) information, Alaska Native Tribal Health Consortium information, energy audits and data collected by numerous stakeholders. Current energy data was derived from information provided by utility providers, the Association of Village Council Presidents (AVCP), Village Corporations, City and Tribal officials, and local power plant personnel.

Throughout the process, stakeholder input was solicited and the project team met to discuss progress.

Energy stakeholders in the Yukon-Kuskokwim Delta Region are diverse and interested in energy discussions. In early December 2014, a kick off meeting for the energy planning process was held in Bethel. Attendees included representatives from the Alaska Center for Energy and Power (ACEP), Alaska Energy Authority, Alaska Native Tribal Health Consortium (ANTHC), Alaska Village Electric Cooperative (AVEC), AVCP, Bethel Community Service Foundation, Calista Corporation, City of Bethel, Delta Western Fuel, University of Alaska Fairbanks Kuskokwim

[1] Note: Nuvista is a 501(c)12 non-profit utility cooperative and is guided and governed by a seven member Board of Directors made up of Yukon-Kuskokwim Delta business professionals and community leaders.

Campus, Wells Fargo and Yuut Elitnaurviat. This group was engaged and met to discuss progress throughout the planning process. A second SAG meeting was held in Bethel on April 13, 2015 to review and revise the Issues and Goals of the regional plan.

Other stakeholders key to the development of this energy plan include city, tribal, village corporations, federal and state agency staff and the general public. Near the beginning of the project, industry participants were interviewed to provide information and they provided input into a wide array of energy issues as they relate to their particular fields throughout the process.

In April of 2015, planners and stakeholders held the second Stakeholder Advisory Group meeting in Bethel and discussed and drafted a list of issue and goals.

1.2 VISION

As energy costs rise and new energy technology emerge, leaders have recognized the need to develop a new coordinated energy approach for the region to bring costs down while maintaining or improving the level of service. To meet this goal, an energy vision was created at the first Stakeholder Advisory Group meeting held in Bethel in December 2014. The vision, "Leaders pioneering a unified, creative approach to access abundant, affordable, efficient energy utilizing local resources," is intended to serve as a clear guide for future energy actions and to be an inspiration for strategic energy planning.

YK Delta Energy Vision

"Leaders pioneering a unified, creative approach to access abundant, affordable, efficient energy utilizing local resources."

December 10, 2014 YK Delta Energy Plan Stakeholder Advisory Group

1.3 ORGANIZATION

This plan contains the following chapters:

- Introduction – an overview of the regional energy issues and challenges, the goals of the plan, methodology, and stakeholders involved.
- Regional Background – summarizes physical, demographic, and energy use characteristics of the region.
- Regional Energy Analysis – a detailed look at the energy resources of the Yukon-Kuskokwim region. Outlines regional energy priorities.
- Community and Energy Profiles – an overview of the Yukon-Kuskokwim communities and their energy profiles.
- Implementation Plan – a summary of actions and strategy for completing the energy priorities.

1.4 ISSUES AND GOALS

The Stakeholder Advisory Group developed a list of issues that focused on six topic areas; energy efficiency and conservation, maintenance and operations, planning, energy infrastructure, and energy financing. These are presented below along with corresponding goals.

Table 1: Energy Issues and Goals

Energy Issues	Energy Goals
Energy Efficiency & Conservation	
■ Public purpose building energy efficiency upgrades are needed. Some audits are done but not implemented.	***Goal 1.*** *All public purpose buildings are audited and energy efficiency upgrades completed as part of a plan to implement energy and cost saving measures.*
■ There is a lack of education and practice in energy efficiency and conservation.	***Goal 2.*** *Residents in the YK Delta Region are well educated in and practice energy conservation, understand how their energy and heating systems operate, and know what energy resources are available to them.* ***Goal 3.*** *Use of energy efficient products is maximized throughout the YK Delta Region.*
■ Houses and associated infrastructure are not usually built with cold climate and environmentally appropriate design.	***Goal 4.*** *All new buildings are climate appropriate and energy efficient.*
■ There is no central location for energy information and resources.	***Goal 5.*** *There is a well maintained and updated clearinghouse that provides information about energy programs, resources, contacts, etc.*
■ Some state and federal energy and conservation programs are not being implemented due to excessive requirements (such as revolving loan program) or the structure of the programs do not fit the reality of rural energy needs.	***Goal 6.*** *State and Federal energy and conservation programs are restructured to maximize their use and benefits for rural residents*
Maintenance and Operations	
■ Many operators lack the proper training needed to maintain and operate new technology and energy equipment installed in the villages.	***Goal 7.*** *There is a well-trained workforce of operators and repair technicians throughout the YK Delta region that keep existing and new energy systems and buildings in operation.*
■ The cost for ongoing operations of energy systems continues to grow without corresponding increases to budget.	***Goal 8.*** *Budgeting practices reflect the need to maintain the existing energy system.*
■ Smaller utilities often do not have the administrative capacity to efficiently operate their utility.	***Goal 9.*** *Utility personnel are well trained and can effectively manage their energy programs and can react to the changing marketplace.*

Energy Issues	Energy Goals
Planning	
■ The energy vision is not well known nor is there a group that is trying to see that it is reached.	***Goal 10.*** *The YK Delta regional energy vision is generally known throughout the YK Delta Region and the stakeholder group is well established and lobbies for and monitors the progress of needed energy projects.*
■ There is a lack of effective planning efforts that showcase current energy demands, systems and costs that could help streamline future energy projects.	***Goal 11.*** *The energy plan for the region is updated regularly and it outlines a realistic, implementable path towards energy independence and sustainability based on stakeholder input.*
■ Land accessibility limits growth (i.e. federal regulation and red tape associated with Wildlife Refuge).	***Goal 12.*** *Land management agencies are part of the process and seek solutions that are acceptable to all.*
■ There is a lack of investment on a long term sustainable approach to energy.	***Goal 13.*** *Alaska legislators and federal agencies understand the benefit of long term energy investments and support them through the CIP process.* ***Goal 14.*** *Energy goals and priorities are incorporated into local, regional, state and federal planning and CIP processes.*
■ Actual costs of energy in the region are not tracked adequately.	***Goal 15.*** *Energy use and life-cycle energy costs for water and sewer systems, infrastructure, residential and non-residential heat and power generation are well documented, understood and updated on a regular basis.*
■ There is a lack of cultural knowledge by policy makers.	***Goal 16.*** *Cultural wisdom and knowledge are maximized and integrated into the solutions for reducing energy costs.*
■ The younger generation is generally not brought to the table in energy discussions and advocacy.	***Goal 17.*** *At least one student or youth is part of the energy stakeholder group.* ***Goal 18.*** *Youth develops several media messages regarding energy advocacy and energy issues.*
■ Lack of educational curriculum on energy	***Goal 19.*** *Integrate AKEnergySmart into regional classroom curricula.*

Energy Issues	Energy Goals
Energy Infrastructure	
■ Inadequate infrastructure remains a prevailing deficit throughout the region, including roads, transmission lines, sewer and water systems and inefficient building performance. ■ Failing systems result in high costs due to climate change and inadequate design.	***Goal 20.*** *All infrastructure in the region is built, upgraded, retrofitted, or redesigned for current environmental and climate settings.* ***Goal 21.*** *Integrated power systems exist throughout the region that effectively capture alternative energy*
■ Power plants are generally not designed to accept alternative energy sources. ■ Accepting large scale renewable energy into small power plants poses problems.	
Fuel	
■ Energy systems rely heavily on diesel, which is finite and constantly increasing in costs.	***Goal 22.*** *Fuel costs are stabilized due to diversified energy sources through implementation of appropriate energy alternatives.*
■ There is a lack of transparency of fuel costs. Surcharge fees are unknown.	
■ Consumers do not benefit from price decreases: fuel is bought in bulk, so price does not change even if market prices go down.	
Energy Financing	
■ Energy systems rely heavily on diesel, which is finite and constantly increasing in costs.	***Goal 23.*** *Fuel costs are stabilized due to diversified energy sources through implementation of practical energy alternatives.*
■ There is a lack of transparency of fuel costs. Surcharge fees are unknown.	
■ Consumers do not benefit from price decreases: fuel is bought in bulk, so price does not change even if market prices go down.	
■ Some communities do not realize the full benefits of PCE and other programs.	***Goal 24.*** *Communities fully understand the PCE and other energy programs and take actions to maximize their participation and benefits.*
■ There is a lack of investment on a long term sustainable approach.	***Goal 25.*** *Initiate a coordinated campaign to educate state legislators, as well as federal agencies, about the benefits of and need for long term energy investments with specific policy and program requests for those legislators/agencies to improve the level of investment in the YK Delta region.*

Energy Issues	Energy Goals
■ Our region is vast with disconnected communities, making projects expensive. Economy of scale is an in issue.	***Goal 26.*** *An YK Delta Energy Advisory Committee sees that projects are grouped, when practical, to reduce costs.*
■ Energy project financing from outside sources is limited and highly competitive.	***Goal 27.*** *Federal and State provide funding through a full range of project grants and technical assistance.*
■ Private partnerships in the field of energy is underutilized	***Goal 28.*** *Private sources of financing are used to help supplement public funding.*

CHAPTER 2

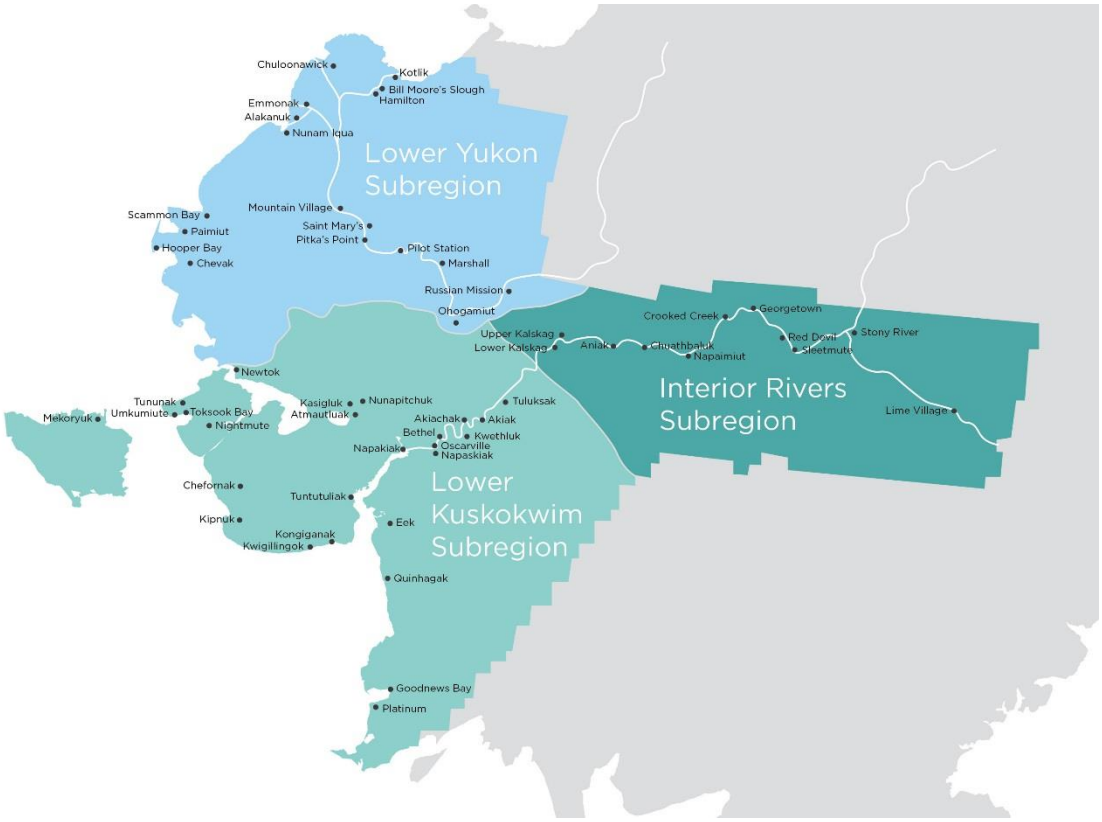
REGIONAL BACKGROUND

REGIONAL BACKGROUND

This chapter summarizes relevant physical, demographics and energy use characteristics of the Yukon-Kuskokwim region.

The Yukon-Kuskokwim Delta Region of Alaska encompasses an area over 100,500 square miles across western Alaska and includes 56 remote communities. The largest of these communities is Bethel, a major hub community with approximately 6,300 residents. The region can be divided into three Subregions with similar characteristics: the Lower Yukon, the Lower Kuskokwim and the Interior Rivers (see Figure 1). The majority of the residents in the YK Delta Region are Yup'ik.

Figure 1: YK Delta Regional and Subregional Map



Source: Nuvista 2015

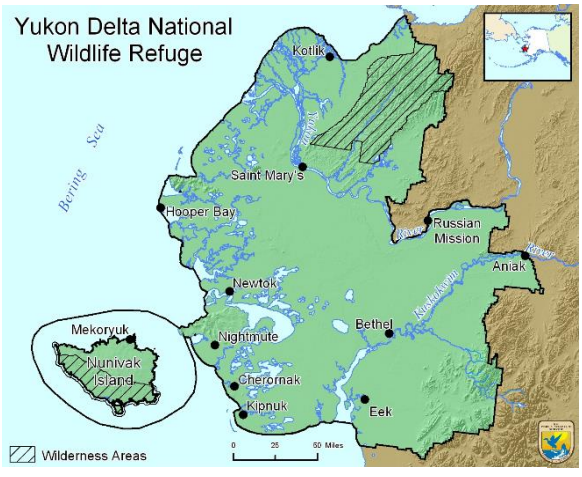
The following sections provide additional information about the physical conditions, demographics, economy, housing, sanitation systems, transportation, planning, regional contacts and energy background.

2.1 PHYSICAL CONDITIONS

LOCATION

The Yukon-Kuskokwim Delta region encompasses approximately 6.5 million acres of the Yukon Kuskokwim (YK) River Delta and the Kuskokwim Mountains regions of Southwestern Alaska. The region also includes two large islands - Nelson and Nunivak. The U.S. Fish and Wildlife Service manages lands within the region including the Yukon Delta and Togiak National Wildlife Refuges. Development within the refuges must be coordinated with the U.S. Fish and Wildlife Service. Figure 2 shows the federal land status of the Yukon Delta National Wildlife Refuge lands in the Kuskokwim region.

Figure 2: Yukon Delta National Wildlife Refuge Lands



Map Courtesy of U.S. Fish and Wildlife Service

VEGETATION

Most of the Yukon-Kuskokwim region is a vast, flat wetland/tundra complex interspersed by countless ponds, lakes, and meandering rivers. Vegetation is primarily subarctic tundra, underlain by permafrost, and includes a variety of scrub, peatland, heath meadow, marsh, and bog habitats. Only a small percentage of the region is forested. Narrow bands of riparian, black spruce-hardwood, mixed black spruce-balsam poplar, and balsam poplar woodlands extend onto the delta along the Yukon and Kuskokwim Rivers and their tributaries. None of the wooded areas contain commercially harvestable timber (U.S. Fish and Wildlife, 2014).

Photo 1: Typical Vegetation the YK Region
Photo Courtesy of US Fish and Wildlife

MINERALS

Photo 2: Donlin Creek Mine
Photo Courtesy of Barrick/NOVAGOLD

Mining has had a significant effect on the economy and social fabric of the region. At one time, the platinum mines at Goodnews Bay and the Red Devil mercury mine were leading North American mineral producers. Placer gold mining once supported several settlements, including Marshall and Nyac. Gold remains an important mineral in the region. The Donlin Gold project, located 12 miles from Crooked Creek, is estimated to contain 33 million ounces of gold. This mine, now in the predevelopment stage, is expected to have on-site power generation using natural gas from Cook Inlet transported to the mine in a 14-inch buried pipeline.

In addition to gold, the region also contains sand, gravel, and quarry rock mined for construction projects such as runways, roads, houses, sewer and water and other infrastructure.

OIL AND GAS

Exploration of oil and natural gas resources in the Region has been focused on three primary geographic areas – the Bethel Basin, the Yukon Delta/Norton Sound and the Holitna Basin. Geologic information collected to date indicates a low likelihood of the presence of conventional, economically recoverable oil resources. Analysis of sedimentary rocks from the basins indicate they contain organic material, which is not prone to generating oil, but some rocks do contain material associated with gas generation.

The Holitna Basin, located in a broad lowland area lying between the Kuskokwim Mountains and the Alaska Range, includes the communities of Sleetmute, Stony River, and Lime Village. The area was roughly outlined by a 3,200-square-mile, airborne magnetic survey, completed in 1998 by the Alaska Division of Geological and Geophysical Surveys (DGGS). Due to its proximity to the Donlin Gold project (about 45 air miles) and some geological similarities to Cook Inlet gas fields, the Holitna Basin is the most likely to be targeted for exploration activity in the future.

HYDROLOGY

The two major rivers located in the region include the Yukon and the Kuskokwim Rivers. The Yukon River is 1,980 miles long and begins in British Columbia, Canada, flows through the region, and empties into the Bering Sea at the Yukon-Kuskokwim Delta. Some of the most extensive flooding in Alaska has occurred along the Yukon River system. The relatively short summers concentrate the major portion of the annual runoff into less than five months. High flows occur from May through September; low flows from October through April (Selkregg, 1980s).

At 702 miles long, the Kuskokwim River is the ninth largest river in the United States by average discharge volume at its mouth and seventeenth largest by basin drainage area (Kammerer, 1990). The Kuskokwim flows southwest into Kuskokwim Bay on the Bering Sea. Except for its headwaters in the mountains, the river is broad and flat for its entire course, making it a useful transportation route for many types of watercrafts, as well as road vehicles during the winter when it is frozen over (Johnson, 2013). Nearly all the tributaries to the Kuskokwim River flow into the main stream from the south (Selkregg, 1980s).

Much of the terrain is low level with many lakes and ponds through which rivers snake their way, leaving oxbow lakes and isolated bends. Stream channels change from time to time because of frequent spring floods.

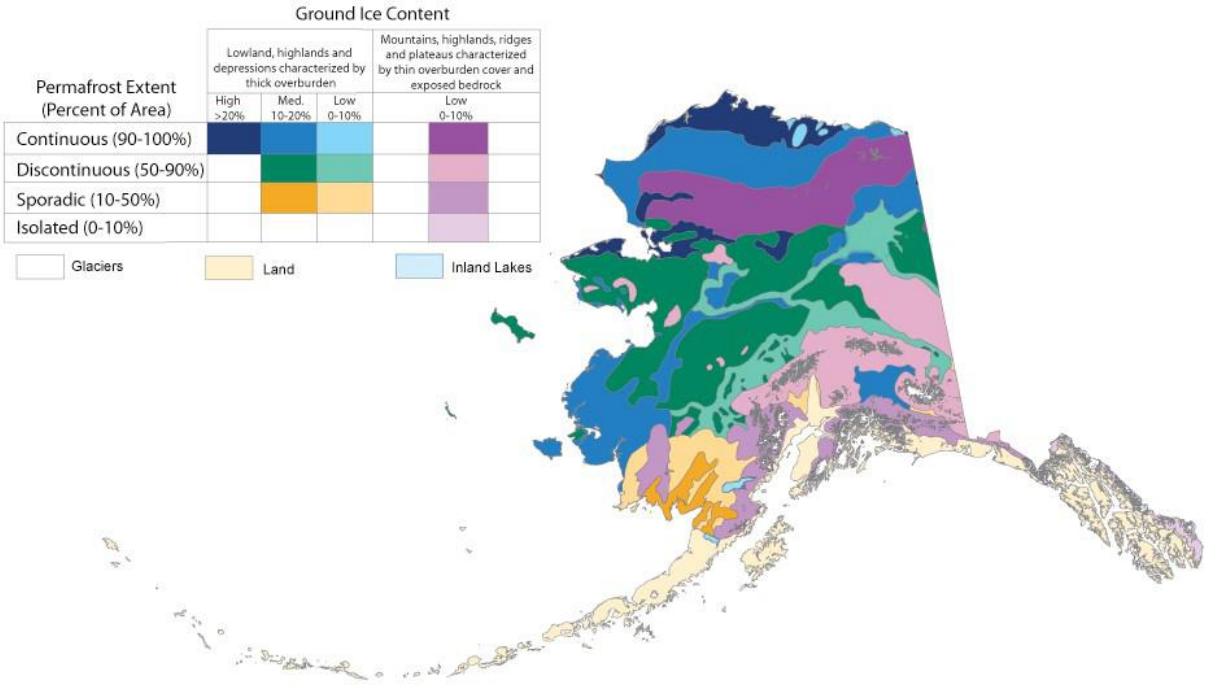
CLIMATE

The Subregional climates in the YK Delta Region vary, with a maritime climate in the coastal communities in the Lower Kuskokwim and Lower Yukon Subregions, a continental climate in the Interior Rivers Subregion and a transitional climate in communities that exhibit characteristics of both a maritime and continental climate. The maritime climate is typically wet and can include moisture year round with typical summer temperatures around 60 degrees F and average winter temperatures ranging from 0° to 20° F. The continental climate is generally drier and colder in the winter and warmer in the summers than a maritime climate. Temperatures range from highs in the summer near 80° F and lows in the winter well below zero. Precipitation and snowfall in the Interior Rivers Subregion is generally light.

PERMAFROST

The unique geology of the YK Delta Region contains discontinuous permafrost that is ice rich, thaw unstable and “warmer” than northern region permafrost. This creates a unique, sensitive situation where any disturbance to the ground could cause major changes in a short time, making it generally more difficult and expensive to build in this region. This, in turn, requires more funding for investment for infrastructure to be appropriately designed for this climate.

Figure 3: Permafrost Zones



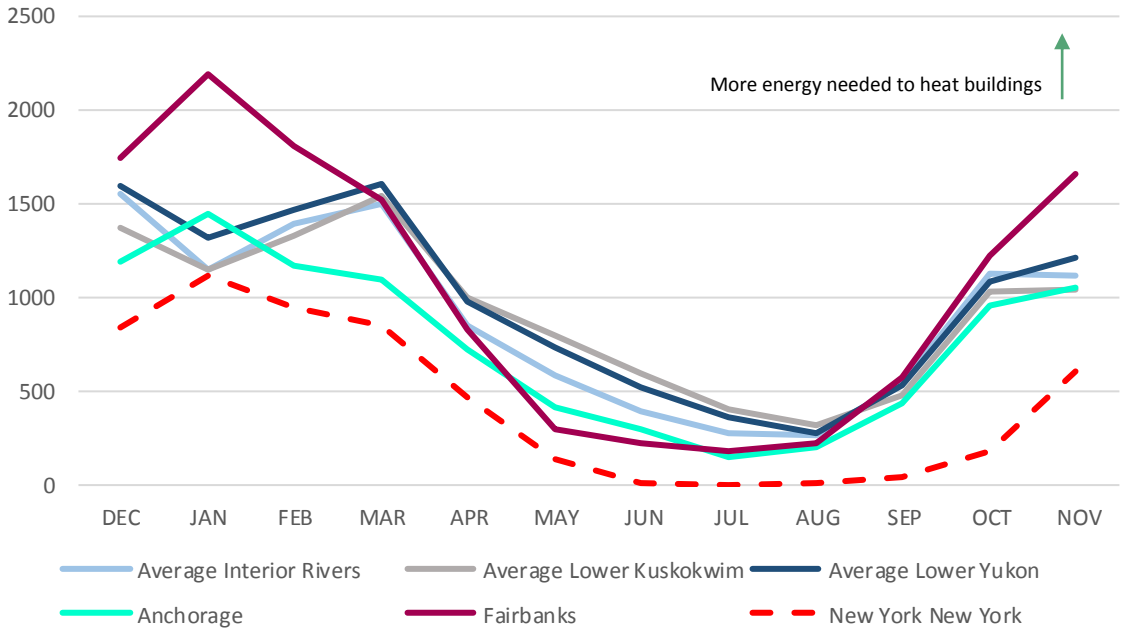
Source: USGS

HEATING DEGREE DAYS

The outside temperature plays a big role in how much energy it will take to keep a structure warm. Heating degree days are one way of expressing how cold a location is and can help determine how much fuel might be required at the village level. Heating degree days are a measure of how much (in degrees), and for how long (in days), the outside air temperature was below a certain level. They are commonly used in calculations relating to the energy consumption required to heat buildings. The higher the number, the more energy will be required.

The figures in the following exhibit indicate average heating degree days for each month by Subregion using data from communities in the Region where that data is collected. New York's heating degree days, shown for comparison, indicate a much warmer climate and therefore New York needs much less energy to heat its buildings. Only those communities with complete records are shown.

Exhibit 1: Heating Degree Days by Subregion Compared to New York, Anchorage and Fairbanks



Source: www.degreedays.net

WINDS

Some of the strongest winds in the state are located in the western and coastal portions of the YK Delta Region, generally the Lower Kuskokwim and Lower Yukon Subregions. The winds in these areas tend to be associated with strong high and low pressure systems and related storm tracks. In parts of this area, turbines may actually need to be sited away from some of the best winds to avoid extreme gusts and turbulence. In the Interior Rivers Subregion, average wind speeds tend to be much lower.

Meteorological towers (met towers) have been erected to measure the wind in several YK Delta Region communities. The wind speeds and directions were measured using anemometers for the wind speed, and wind vanes for the direction. Wind speeds are quantified in wind power classes ranging from class 1 (the lowest) to class 7 (the highest). Areas designated class 3 or greater are suitable for most wind turbine applications, whereas class 2 areas are marginal. Class 1 areas are generally not suitable. The analysis of data from met towers erected in the YK Delta Region validate the existence of strong winds in the coastal communities.

Table 2: Wind Classes in Selected YK Delta Communities

Community	Wind Class
Chevak	6
Emmonak	3
Mekoryuk	6
Mountain Village	5
Quinhagak	4
St. Michael	6

Source: V-3 Energy LLC, Website (http://www.v3energy.com/projects/yukon-kuskokwim/)

CLIMATE CHANGE

Climate change describes the variation in Earth's global and regional atmosphere over time. The impacts of climate warming in Alaska are already occurring. In the Yukon-Kuskokwim region, some of these impacts include coastal erosion, increased storm effects and permafrost melt.

The effects of climate change can potentially exacerbate natural phenomena. For example, melting permafrost contributes significantly to ground failure or destabilization of the ground in a seismic event and changing weather patterns can cause unusual and severe weather. Climate change also can cause structural failure in energy infrastructure, buildings, airports, and roads due to thawing permafrost. This leads to increased maintenance costs and disruption in services.

Adapting to the impacts of climate change before they become critical is important to the wellbeing of the people and infrastructure of the Yukon-Kuskokwim Delta region. Energy infrastructure will be vulnerable to more extreme weather events, rising sea levels, and thawing permafrost. This impact has already been seen in places like Newtok, where severe river erosion problems have prompted residents to begin to relocate the community. Strategies for adaptation to climate change will need to be developed and continually updated as new information becomes available.

Climate change and changing weather patterns will force adaptation at a rapid pace. The consequences could prove devastating for northern climates if planning efforts do not factor these effects into future design of infrastructure and energy systems.

2.2 DEMOGRAPHICS

Demographics shape current and future energy demands. Understanding current demand can help to pinpoint inadequacies and identify opportunities for efficiency improvements. Projections of future energy use can help leaders to tailor new or improved facilities to optimally meet community needs. While the region has been growing gradually, population trends for individual communities are more varied. This section provides an overview of current YK Delta Region demographics and projected trends.

CURRENT POPULATION

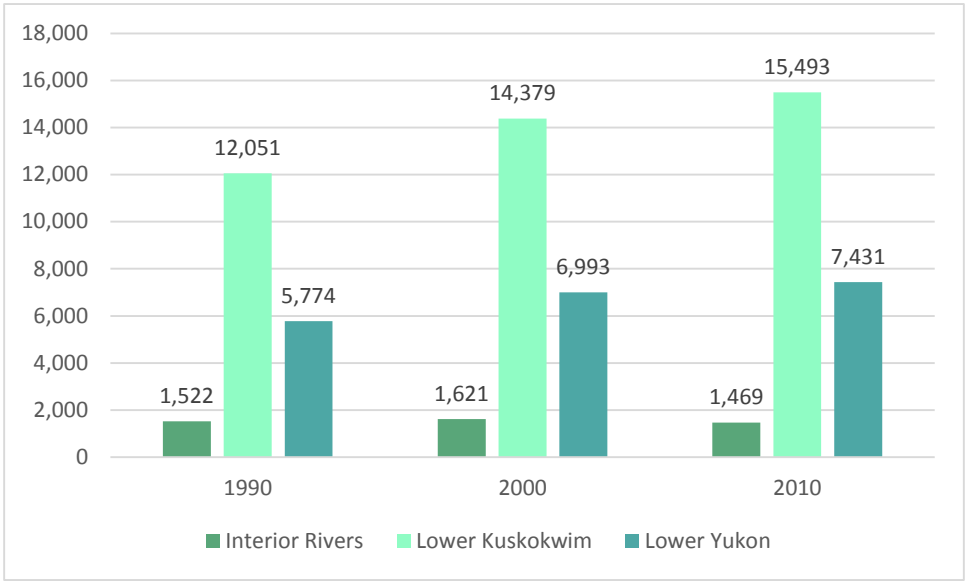
Most of the YK Delta Region residents live in small communities with fewer than 600 people. According to the U.S. Census, the 2010 population in the YK Delta Region was 24,393, or about 3.5 percent of the total state population. In addition to the regional center of Bethel, which had 6,080 residents, people in the region live in communities ranging in size from 23 residents in Red Devil to 1,093 in Hooper Bay (2010 U.S. Census).

The population in the YK Delta Region is significantly younger than residents of Alaska as a whole. At 26, the median age – or midpoint of the population – for the YK Delta Region is 10 years younger than the median age for the entire state. This young population will have an effect on future demand for services and this will likely extend to increased demands on the energy infrastructure within the YK Delta Region.

POPULATION TRENDS

According to the U.S. Census, the population of the entire YK Delta Region between 1990 and 2010 grew from about 19,347 to 24,393 or an increase of about 1.3% per year as shown in Exhibit 2. In that time period, the Lower Yukon and Lower Kuskokwim Subregions experienced population growth, while the Interior Rivers Subregion experienced a minor population decline.

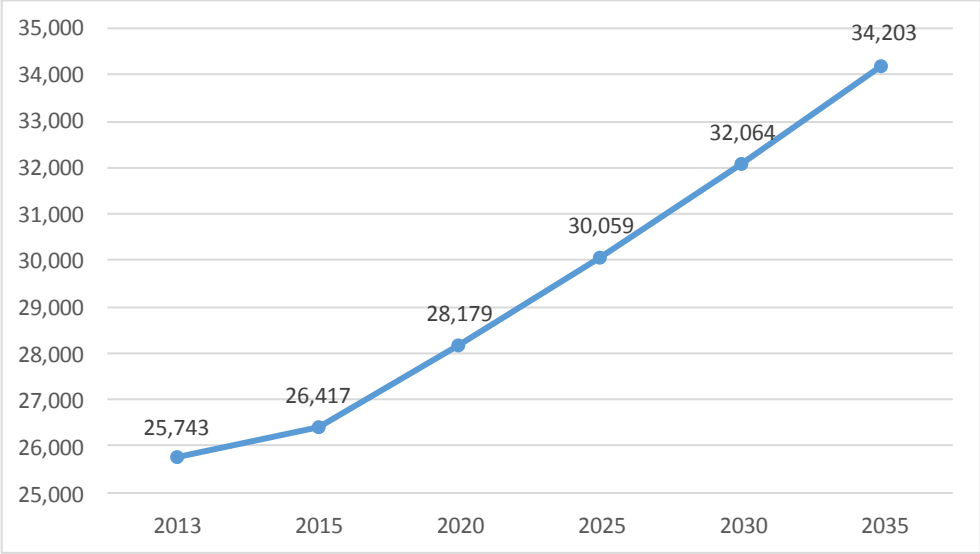
Exhibit 2: YK Delta Region Population Growth 1990-2010



Source: U.S Census data

Using the Alaska Department of Labor population estimate for 2013 (25,743) at an average 1.3% growth rate, the overall population would exceed 34,000 persons in 2035, as shown in Exhibit 3.

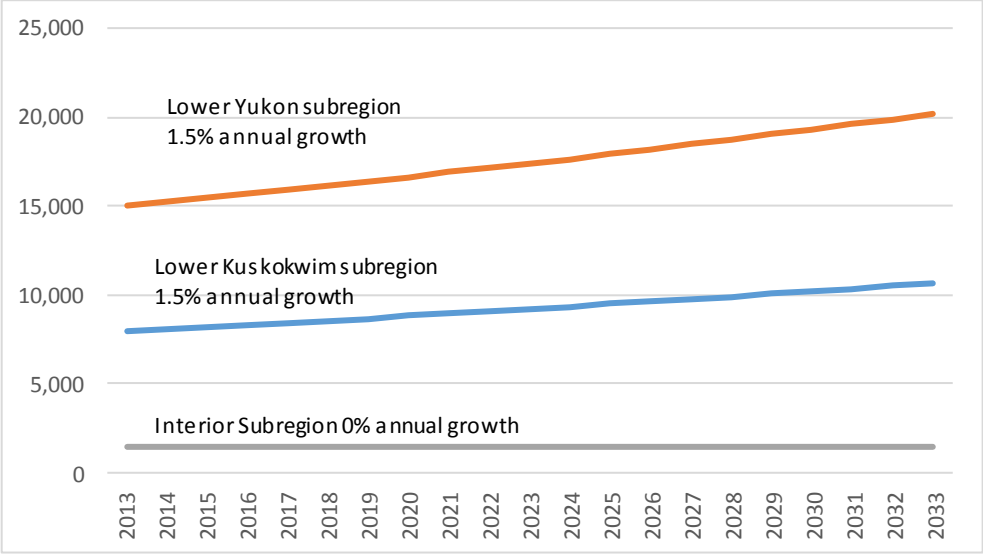
Exhibit 3: YK Delta Region Projected Population Growth 2013-2035



Source: U.S and DCRA Census data

Exhibit 4 shows the projected population growth by Subregion. Due to its population trend in the past 20 years, the Interior Rivers Subregion is shown as having a flat growth rate while the Lower Yukon and Lower Kuskokwim each have an annual 1.5% population growth rate.

Exhibit 4: YK Delta Subregional Projected Population Growth 2013-2035



Source: U.S and DCRA Census data

2.3 ECONOMY

The majority of the residents in the YK Delta Region supplement their cash economy with subsistence activities which is defined by state and federal laws as the "customary and traditional uses of wild resources for food, clothing, fuel, transportation, construction, art, crafts sharing and customary trade" (Alaska Department of Fish and Game, 2012). In the YK Delta Region approximately 400 pounds of annual wild food is produced on average per person a year, compared with 17 pounds annual wild food produced in the Anchorage area annually. Alaska Fish and Game estimates that this food, if replaced with non-wild foods, would be valued about $80,000,000.

Subsistence activities take place over a vast area as a result of the large-scale migration patterns of some subsistence resources. Residents also use offshore areas for subsistence hunting and fishing of a wide variety of marine mammals, birds and fish. They use onshore areas for hunting and fishing and gathering of eggs and plants. Subsistence use changes from year-to-year and throughout time, depending on the availability of a specific species.

In some ways, subsistence foods represent income. When opportunities for employment tighten, residents can adjust to smaller incomes by increasing their use of subsistence foods. For many residents, rather than replacing subsistence, the cash economy enables individuals to participate in subsistence by providing money for snow machines, boats, outboard motors, and other subsistence supplies (such as bullets, fuel, etc.). The combination of subsistence and employment contributes to the overall village economy. Other economic drivers in the region include health care, commercial fishing, government, retail and commercial services.

According to the Alaska Department of Labor, the December 2014 unemployment rate (not seasonally adjusted) was about 14 percent in the Lower Kuskokwim and over 20 percent in the Lower Yukon and Interior Rivers Subregions. The statewide unemployment rate for December 2014 was 6.3 percent. The average household income varies from about $16,000 in Platinum to $90,000 in Bethel.

Coastal villages in the Lower Kuskokwim Subregion participate in the Coastal Villages Region Fund (CVRF), one of the six Commercial Development Quota (CDQ) groups that participate in the Bering Sea fishing industry. Communities in the Lower Yukon Subregion participate in the Yukon Delta Fisheries Development Association (YDFDA) CDQ. The programs were designed to benefit communities adjacent or near the Bering Sea. Each CDQ

group manages its own fishing quota. CVRF receives royalty payments from catcher/processors and CVRF extended its involvement and purchased ownership shares, thereby receiving royalties and part of the business profits, which they use to benefit residents in the region. The funds were used to develop Community Service Centers in many communities that provide a space for community members to repair and maintain snow machines, four-wheelers, sleds, trailers and other equipment critical to maintaining the subsistence economy.

The Coastal Villages "People Propel™" program is another benefit created by the CVRF Board of Directors to meet the demand of the residents for safer, more fuel efficient and environmentally clean outboards and boats. By bulk-purchasing boats, motors and nets, CVRF is achieving economies of scale and bringing down prices for the region's residents.

2.4 HOUSING

REGIONAL HOUSING ASSESSMENT

The 2014 AHFC Alaska Housing Assessment used a variety of sources to analyze statewide and regional housing. Below is a summary of the assessment for houses in the YK Delta Region.

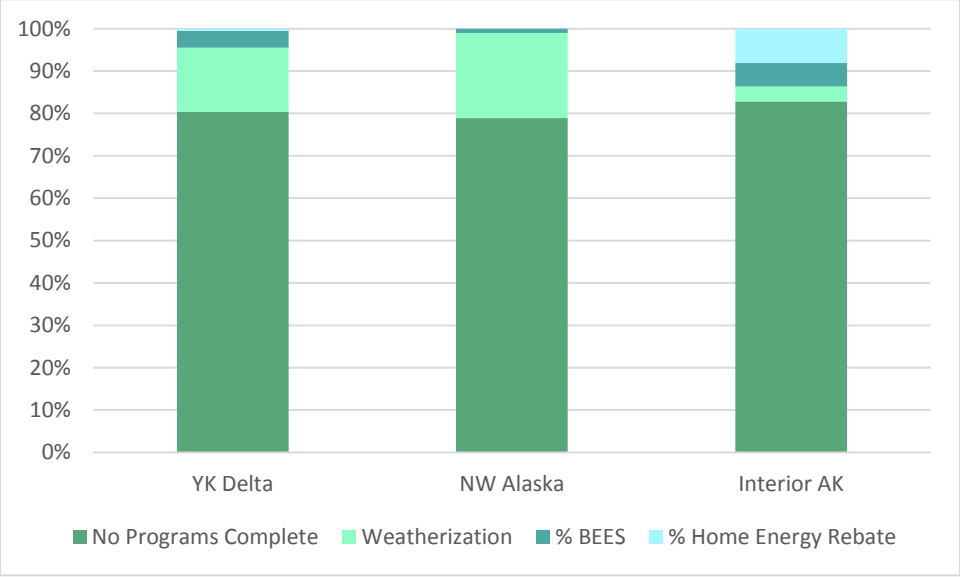
Housing Units. There are currently 8,042 housing units in the YK Delta Region. Of these, 6,009 are occupied, 375 vacant units are for sale or rent, and the remaining 1,658 are seasonal or otherwise vacant units.

Energy. The average home in the YK Delta Region is 875 square feet and uses 167,000 BTUs of energy per square foot annually for heating homes. This is 22% more than the statewide average of 137,000 BTUs per square foot per year. The YK Delta Region has the fourth highest energy use per square foot of any region in the state at approximately 168 kBTUs/ft^2.

Energy Costs. Using AHFC estimates prepared using AKWarm, an energy efficiency software program, average annual energy cost for a home in the YK Delta Region is $6,240, approximately 2.2 times more than the cost in Anchorage, and 2.9 times more than the national average.

Energy Program. Approximately 17% of the occupied housing in the YK Delta Region have completed either the Home Energy Rebate or Weatherization programs, or have received the state's Building Energy Efficiency Standard (BEES) certification since 2008, compared to 21% statewide.

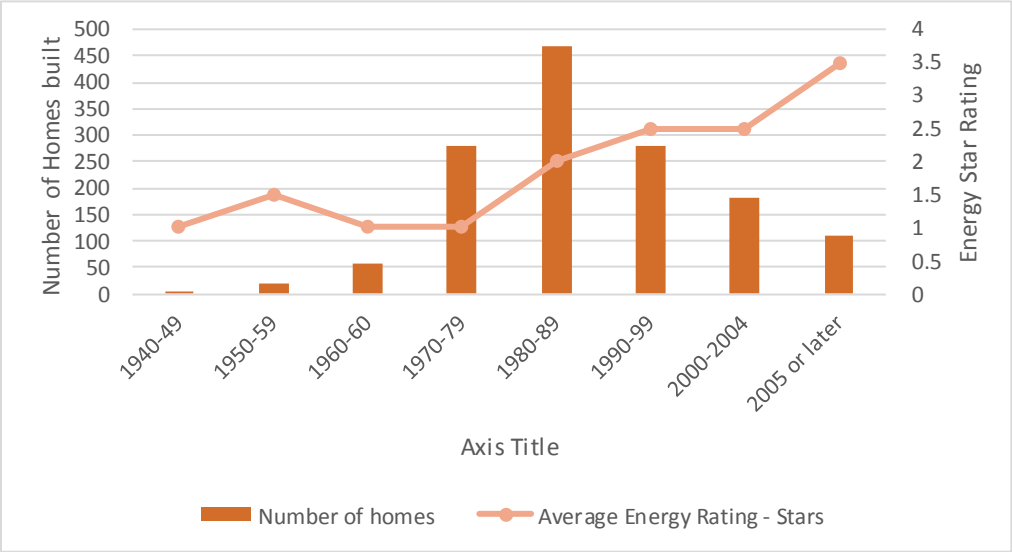
Exhibit 5: Comparison of Percent of Occupied Housing Completing Energy Programs



Source: 2014 AHFC Housing Assessment

Housing Quality. Within current housing stock, newer homes have better energy performance. Using the home energy rating system, which is the industry standard by which a home's energy efficiency is measured, where a higher number of 'stars' means a more energy efficient building, homes built in the 1940s generally received a one energy star rating, while homes built after 2000 received on average an energy star rating of nearly 3.5 as shown in Exhibit 6.

Exhibit 6: Homes and Energy Star Rating in YK Delta Region



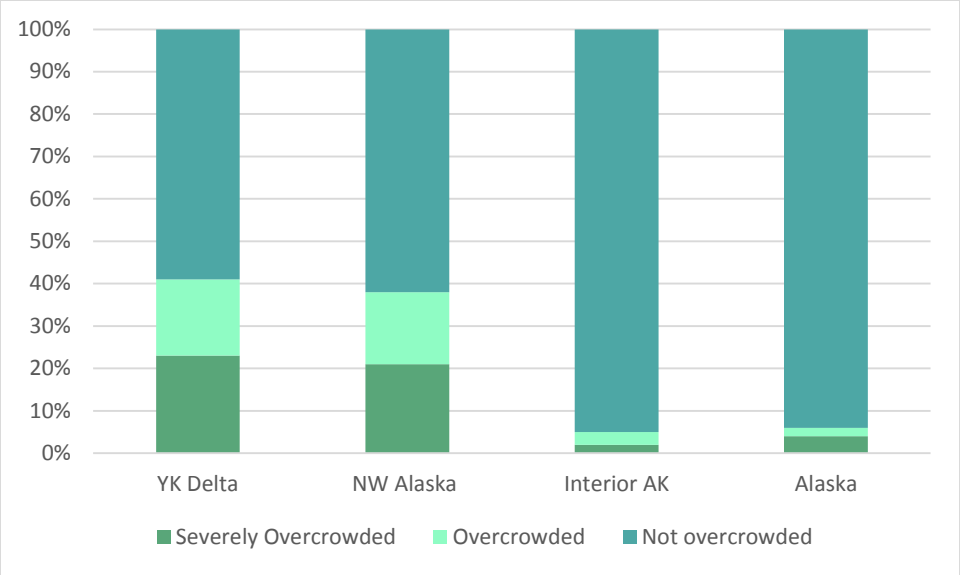
Source: 2014 Alaska Housing Assessment, AHFC

Air-tightness. Within current housing stock, newer homes are tighter. On average, homes built in the last decade very nearly meet the 2012 BEES standard of 4 air changes per hour at 50 Pascals (ACH50). In contrast, homes built in the 1960s are 2.5 times leakier than those built since 2000. Air change per hour is a measure of the air volume added to or removed from a space divided by the volume of the space for proper ventilation.

Ventilation. An estimated 1,481 occupied housing units (or 25%) in the YK Delta Region are relatively air-tight and lack a continuous ventilation system. These houses are at higher risk of moisture and indoor air quality-related issues such as fungus and mold.

Overcrowding. The YK Delta Region has the highest percentage (40%) of overcrowded housing units (more than one person per room) of any region in Alaska. This is roughly 13 times the national average. Overcrowding in the region varies widely by community from an estimated zero overcrowded households in Lime Village to 79% of housing units in Newtok.

Exhibit 7: Comparison of Overcrowded Housing



Source: 2014 AHFC Housing Assessment

Affordability. According to American Community Survey (ACS) data, approximately 19% of households in the YK Delta Region spend 30% or more of total income on housing costs, including rent, water and sewer utilities, and energy. Using AKWarm estimates, the average annual energy costs constitute approximately 13% of census median area income for occupied housing.

HOUSING ORGANIZATIONS

Association of Village Council Presidents Regional Housing Authority (AVCP-RHA) – AVCP Regional Housing Authority is a state-charted, regional housing authority formed to address housing needs in Southwest Alaska. They work with 50 Tribal councils in the Region that have named AVCP RHA as the Tribal Designated Housing Entity and are funded with Native American Housing Assistance and Self Determination Act of 1996 (NAHASDA) funds. AVCP-RHA was organized on October 17, 1974 and is located in Bethel.

The housing authority provides affordable housing services to program-eligible individuals and families. The largest program it offers is the "Mutual Help Homeownership Program". The agency also provides low rent housing as well as rental housing for elderly or handicapped persons. AVCP-RHA has constructed over 1,500 homes in 48 villages.

The AVCP-RHA Tribal Operations Department works with tribal councils, future and current homebuyers and rental tenants, as well as individuals and families who are seeking affordable housing opportunities (AVCP-RHA).

Cold Climate Housing Research Center (CCHRC) – The Cold Climate Housing Research Center is an industry-based nonprofit corporation created to facilitate the development, use, and testing of energy-efficient, durable, healthy, and cost-effective building technologies for people living in cold climates. CCHRC offers services in Building Science Research, Sustainable Northern Communities, and Policy Research.

CCHRC, in collaboration with local and regional entities, has worked on several projects in the YK Delta Region. Energy-efficient prototypes were constructed in Quinhagak, Bethel, Crooked Creek and Atmautluak. Additional work in design, planning and building analysis was done in Newtok/Mertarvik, Hooper Bay, and Kongiganak (www.cchrc.org).

2.5 SANITATION

SEWER AND WATER

Compared to the rest of the state, the YK Delta Region (outside of Bethel) has the most "unserved" communities in terms of water and sewer services. Unserved is defined as 55% or less of homes in the region are served by piped water/sewer or haul systems, with the remaining residents relying on "honey buckets" (use of plastic buckets for toilets). With honey bucket systems, human waste can spill, exposing residents to raw sewage. Those exposed are more likely to contract diseases including hepatitis A, bronchitis, and impetigo. Observations indicate that water and sewer systems in this region are in worse shape than any other region in the state.

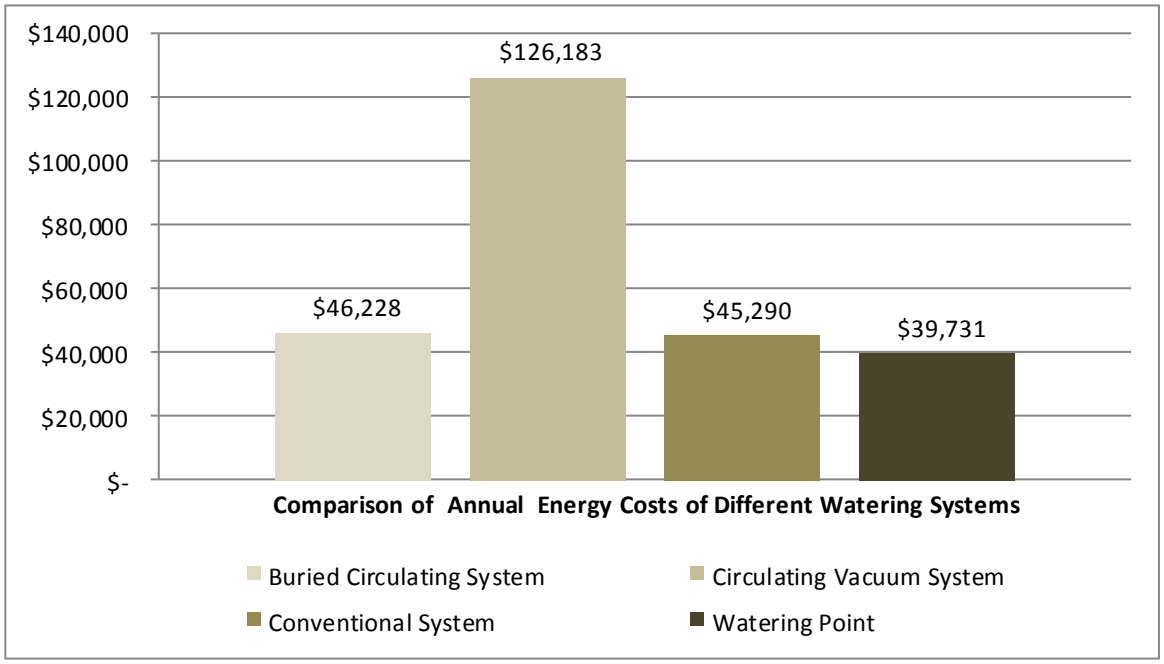
There are many reasons for the lack of conventional sewer and water systems in this region, including the lack of suitable soils and gravel, discontinuous permafrost, drainage, climate and environmental factors, technical constraints, operation and maintenance challenges, and low per capita income.

One of the issues preventing the installation of the more desirable piped water and sewer systems in the YK Delta Region is finances, both in terms of construction and maintenance costs. Due to the isolation of the communities and lack of access, construction costs are extremely high, often making a project out of reach. The YK Delta Region also has one of the highest unemployment and poverty rates in the state. This limits the ability of the area's residents to pay the monthly fee required to maintain a piped water and sewer systems. Energy costs make up, on average, 40% of the operating cost of a water and sewer utility in Arctic and Sub-arctic Alaska according to the Alaska Rural Utility Collaborative at ANTHC (ARUC). Keeping energy costs down can improve the likelihood that residents can afford piped sanitation facilities.

There are several types of water and sewer systems including buried or unburied circulating systems, circulating vacuum system, conventional system and a watering point. Energy costs for each system vary, with the circulating vacuum system being the most expensive. ANTHC recently conducted energy audits on the water and sewer systems in 28 of the 56 communities in the YK Delta Region. Exhibit 8 illustrates the annual costs for the water systems in the communities in the YK Delta Region that were audited by ANTHC.

The Yukon Kuskokwim Health Corporation (YKHC) is raising funds to develop a "Dump the Bucket" campaign. They plan to test a couple off-the-shelf systems for recycling gray water. They hope that by using water twice people will spend less money to deliver water to their homes (Eurich, 2015).

Exhibit 8: Average Annual Water System Energy Costs for 28 Audited Communities in the YK Region



Source: ANTHC

LANDFILLS

Alaska Department of Environmental Conservation manages the solid waste permit process required by state law. Landfills in the region are generally unpermitted, Class III facilities. Exceptions are the larger communities, such as Bethel, which has a permitted Class II landfill. In 2013, thirty-two landfills in the region were inspected by Alaska Department of Environmental Conservation as part of a Waste, Erosion Assessment and Review program funded by the Coastal Impact Assistance Program. They found some communities had burn barrels that were used at least part of the year, but none of the facilities had waste to heat recovery.

2.6 TRANSPORTATION

ACCESS

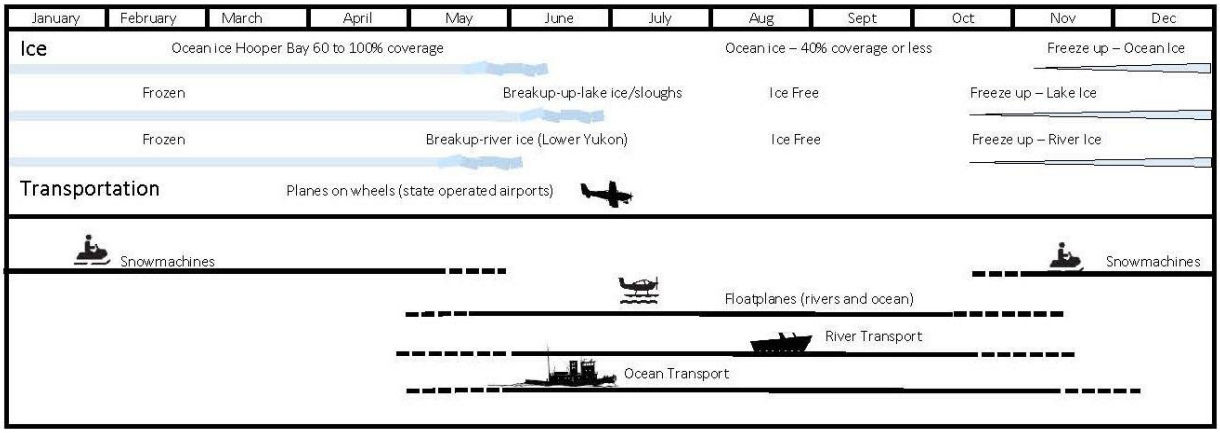
YK Delta residents rely on a system of airports, rivers, ports, barge landings, and trails for transportation to, from and within the region. Communities are not connected to the state's highway system. This lack of connection contributes to the high cost of fuel and goods. While air travel is the only year-round mode of transportation, a patchwork of surface transportation modes – varying depending on the time of year – support the movement of passengers and cargo (including fuel delivery) within the YK Delta. Alaska Airlines provides passenger service and freight delivery between Anchorage and Bethel. Grant Aviation provides air service to 15 villages; Ravn Alaska and Yute Air serve 26 villages; and Pen Air provides air service to 2 villages. Northern Air Cargo, Alaska Central Express (ACE), Arctic Transportation Services and Everts Air Cargo offer large cargo and fuel shipment.

There are numerous marked winter trails throughout the region. The trail markings consist mostly of wooden tripods. The AVCP Transportation Department received a grant to install trail marking on nearly 3,000 miles of trails and to construct safety shelters along the routes. [2]

[2] Email with Clarence Daniel, AVCP, January, 2015.

When the rivers are frozen they become highways used by motorized vehicles, such as snowmachines and cars, and in the summer they are used by boats. Exhibit 9 shows the general time for breakup and freeze up of the rivers and when the modes of transportation can operate.

Exhibit 9: Annual Transportation Modes



Source: Alaska Department of Transportation and Public Facilities, YK Transportation Plan, March 2002

In addition to the more traditional modes of transportation, the US Postal Service contracts mail delivery by hovercraft to villages near Bethel year round. When the ice is thick and can handle the weight, the hovercraft also hauls freight.

Snowcats have been used to haul fuel from Bethel to Tuntutuliak and Kongiganak. A snowcat is an enclosed-cab, truck-sized, fully-tracked vehicle, designed to move on snow that can travel on snowmachine trails on both land and frozen rivers. It can haul extensive loads, two to three times the amount of a pickup truck. Snowcats were used to haul many components of the wind turbines installed in Kongiganak, Kwigillingok and Tuntutuliak. Transportation of large loads with a snowcat has proven to be far cheaper than transporting large loads by air.

Photo 3: Snowcat tracked vehicle

Barges deliver freight (including fuel) during the summer months to most of the villages in the region. Currently, navigation difficulties on the upper Kuskokwim River make barge operations from Bethel difficult, unpredictable, and consequently expensive. Due to year-round low water levels, Lime Village must fly in fuel from nearby Stony River. At times, the upper Kuskokwim River water levels are also too low for barges; and freight and fuel must be flown into those communities (such as Crooked Creek, Red Devil, Sleetmute and Stony River).

The Department of Transportation and Public Facilities (DOT&PF) established an Energy Office in 2010. They serve as a resource to state agencies with energy efficiency efforts. They also can assist other governmental agencies, school districts, municipalities, and villages. At the Yukon-Kuskokwim Correctional Center (YKCC) in Bethel, DOT&PF performed lighting, lighting control, and water conservation upgrades, installed premium efficiency motors, completed building automation system upgrades, installed Vending Misers (efficiency tools for vending machines), heat recovery equipment and valve insulation. In 2012, the improvements allowed the YKCC to save $86,589.

2.7 PLANNING

Several efforts have been made in the region to take steps to improve energy efficiency and develop energy infrastructure. However, many of these approaches have been conducted on the community level and were not part of a larger, coordinated effort that could benefit multiple communities.

Thirteen of 56 communities in the YK Delta Region have completed Comprehensive Plans. These plans are listed in the State of Alaska Community Plans Library. This regional energy plan is intended to be a component of these plans.

In November of 2014, Nuvista was funded by the Alaska State Legislature, which re-appropriated funds to assess and restart this regional energy planning process. This plan is the result of those efforts.

2.8 REGIONAL CONTACTS

Table 3 provides contact information for entities serving the YK Delta Region as a whole.

Table 3: Regional or Subregional Entities Serving the YK Delta Region

Community Development Quota Organization	Coastal Villages Region Fund 711 H Street, Suite 200 Anchorage, AK 99501 Phone: (907) 278-5151 Website http://www.coastalvillages.org/
	Yukon Delta Fisheries Development Association 2909 Arctic Blvd. Anchorage, AK 99503 Phone: (907) 644-0327 Website: http://www.ydfda.org/
Health Corporation	Yukon Kuskokwim Health Corporation 900 Chief Eddie Hoffman Highway Bethel, AK 99559 Phone: (907) 543-6000 Website: http://www.ykhc.org
Non-Profit Regional Electric Cooperative	Nuvista Light and Electric Cooperative, Inc. 1205 E. International Airport Road, Suite 202 Anchorage, AK 99518 Phone: (907) 562-3103 Website: http://www.Nuvistacoop.org
	Alaska Village Electric Cooperative 4831 Eagle St. Anchorage AK 99503 Phone: (907) 561-1818 Website: http://www.avec.org
	Middle Kuksokwim Electric Cooperative P.O. Box 206 McGrath, AK 99627 Phone: (907) 524-3360
Native Corporation	Calista 301 Calista Court # A Anchorage, AK 99518-3000 Phone: (907) 279-5516 Website http://www.Calistacorp.com
Native Association	Association of Village Council Presidents P.O. Box 219 Bethel, AK 99559

	Phone: (907) 543-3596 Website: http://www.avcp.org
Regional Housing Authority	AVCP Regional Housing Authority P.O. Box 767 Bethel, AK 99559 Phone: (907) 543-3121 Website: http://www.avcphousing.org
School Districts	Lower Kuskokwim School District 1004 Ron Edwards Way, Bethel, AK 99559 P.O. Box 305 Bethel, AK 99559-0305 Phone: (907) 543-4800 Website: http://www.lksd.org/lksd/
	Lower Yukon School District PO Box 32089 Mountain Village, AK 99632 Phone: (907) 591-2411 Website: http://www.loweryukon.org/
	Yupiit School District 1 Main St Akiachak, AK 99551 Phone: (877) 825-3600 Website:: http://www.yupiit.org
	Kashunamiut School District (Chevak) PO Box 345 Chevak AK 99563 Phone: (907) 858-7712 Website: http://www.chevakschool.org
	Kuspuk School District PO Box 49 Aniak, AK 99557 Phone: (907) 675-4250 Website: http://www.kuspuk.org
	Saint Mary's City School District PO Box 9 Saint Mary's, AK 99658 Phone: (907) 438-2735 Website: http://www.smcsd.us/
Workforce Development	Yuut Elitnaurviat PO Box 869 Bethel, AK 99559 Phone: (907) 543-0999 Website: http://www.yuut.org

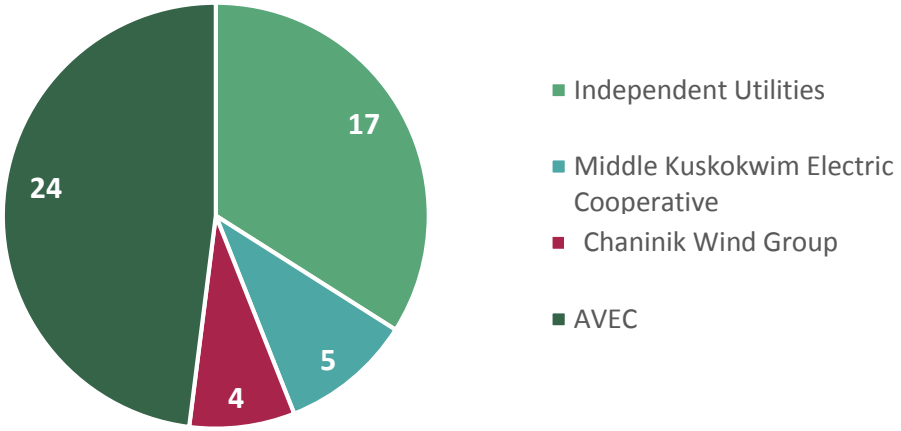
2.9 ENERGY BACKGROUND

ELECTRICITY

AVEC is an electric utility serving 24 of the communities within the region. With the exception of the Bethel-Napakiak-Oscarville intertie, all the interties in place in the region connect AVEC communities with each other. Other electric utility providers include Middle Kuskokwim Electric Company that serves Chuathbaluk, Crooked Creek, Red Devil, Sleetmute and Stony River. There are also several independent electric utilities operating in the YK Delta Region.

Exhibit 10 illustrates the number of communities served by the various electrical power producers.

Exhibit 10: Number of Communities Served by each Electrical Power Producer in the YK Delta Region



Source: 2013 PCE Report

Most utilities use diesel generators. CWG has integrated wind and heat to offset the high cost of diesel. AVEC has wind diesel systems in the communities of Kasigluk, Toksook Bay, Hooper Bay, Mekoryuk, Quinhagak, Emmonak and Alakanuk.

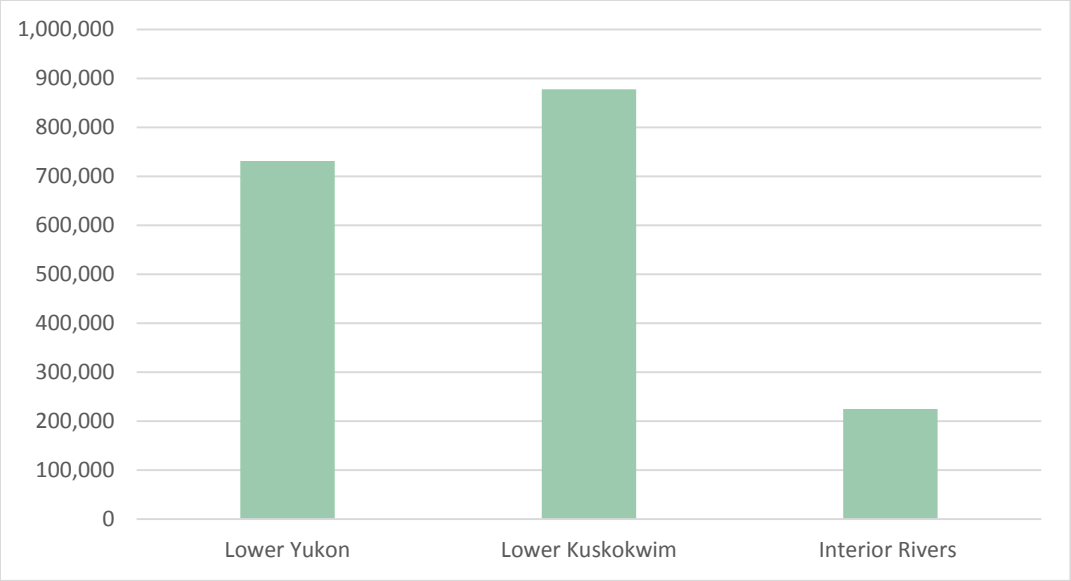
Between 2010 and 2013, CWG implemented a multi-village wind heat smart grid in the villages of Kongiganak, Kwigillingok, and Tuntutuliak. Each of these wind-diesel systems produces wind capacity in excess of 200% of the peak load and uses an on-site wind-diesel smart grid control system to maximize efficiency. Heat recovery boilers help manage system energy balance, and diesel generators provide energy support. Light winds displace diesel fuel used to generate electricity at the diesel power plant. Modest-to-high winds produce excess wind energy that is captured in electric thermal storage units to heat tribal resident homes at 50% of their previous heating fuel cost. In Kipnuk, a larger version of these systems is under development; the metering system is in place and construction is scheduled for completion in 2016.

> The Chaninik Wind Group Multi-Village Wind Heat Smart Grid Project has helped our communities of Tuntutuliak, Kongiganak, and Kwigillingok by reducing fossil fuel use at the power generation plant and homes where home heaters were installed.
>
> *William Igurak, President and Founder, Chaninik Wind Group*

Electrical Usage

Measurements of the average community-wide residential kWh usage shows that the Subregion with the highest household use occurs in the Lower Kuskokwim Subregion with residents using a total of 877,744 kWh per year, and residents in the Interior Rivers Subregion using a total of 224,661 kWh per year as shown in Exhibit 11. This is a reflection of their large and small populations.

Exhibit 11: Average Annual Residential kWh Electricity Used per Subregion



Source: 2014 AEA PCE Report

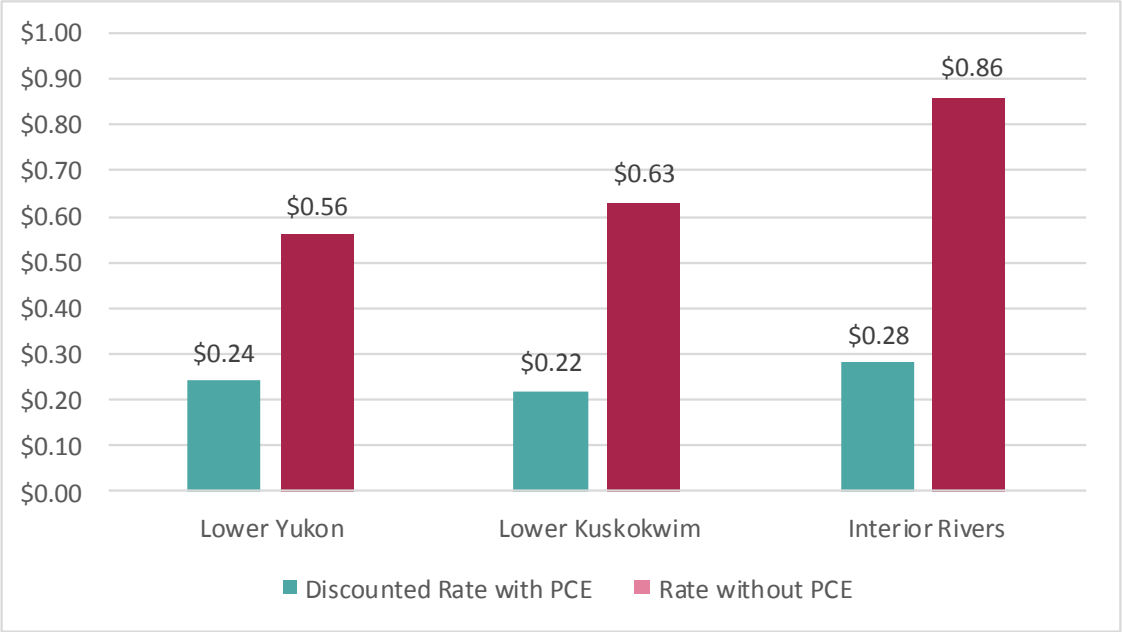
In analyzing the actual electrical use per household, we can see that some communities have higher household use than others. Residents in the Lower Yukon Subregion tend to use more electricity than the other Subregions, and residents in the Interior Rivers use the least. The average residential electrical use per customer in the Lower Yukon is an estimated 5,004 kWh annual average household use. This is followed by the Lower Kuskokwim Subregion with 4,312 kWh a year. In the Interior Rivers Subregion, the average annual residential use per customer is 3,471 kWh.

Electric Rates

The YK Delta consumer's electric rate is generally well above the state average electrical rate of $0.20 per kWh. This high rate is due to the fact that the communities in the region tend to be isolated and fuel rates to operate the generators are high. Residential rates (without the PCE subsidy) for residents within the region vary from 56 cents to 86 cents per kWh with the highest electrical rates occurring in the Interior Rivers Subregion as shown inExhibit 12.

Below is a chart that shows the average electrical rates with and without the PCE subsidy by each YK Delta Subregion.

Exhibit 12: YK Delta Electrical Rates by Subregion With and Without Power Cost Equalization Subsidy



Source: 2014 PCE report

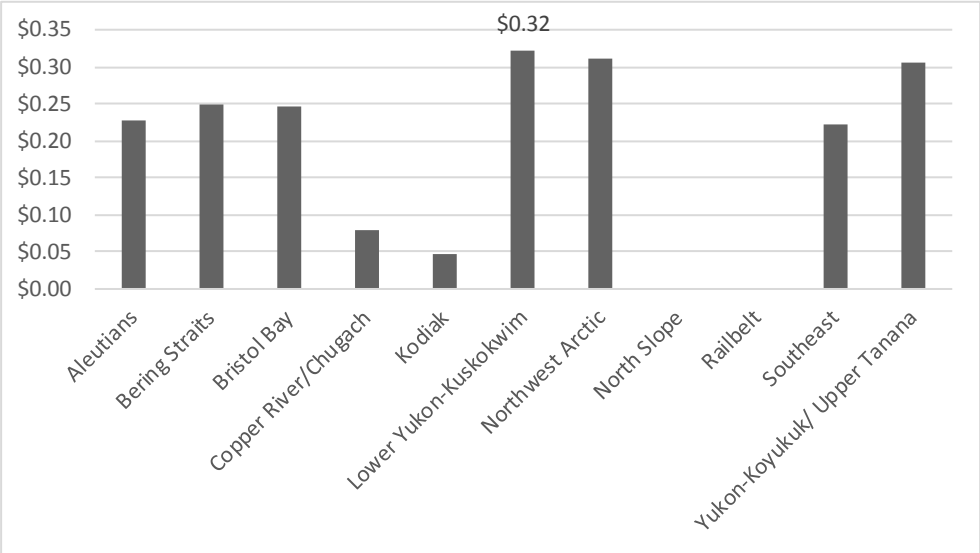
Power Cost Equalization

The Power Cost Equalization (PCE) program was created in 1985 as part of a statewide energy program to benefit rural consumers who did not reap the benefit of large state-subsidized energy infrastructure projects such as SE hydroelectric projects or improvements to the interties that serve the Railbelt (communities on road system). The PCE program provides rate relief to rural communities off the road system who often pay three to five times the rate of urban consumers (Alaska Energy Authority, 2013).

The AEA and the Regulatory Commission of Alaska (RCA) both receive reports from utilities that detail electrical statistical data by community. AEA reports are provided monthly and utilities deliver an annual report to RCA. RCA uses the annual reports to calculate the PCE rate using both fuel and non-fuel rates, and RCA then provides the rate to the AEA.

The PCE program subsidizes an average of about 32 cents per kWh up to 500 kWh per month for residents in the YK Delta villages (excluding Bethel). This is very high in comparison to most rural communities which average a PCE subsidy of about .20 cents per kWh, as shown in Table 12.

Exhibit 13: Average Power Cost Equalization Rates throughout Alaska



Source: 2014 PCE Report

PROPANE

Propane may have been the most cost effective choice for household use for cooking in the past. In the early 1980s when electricity costs were high, more residents used propane for cooking. Over time, propane-fired appliances were replaced and by the early 2000s, that number of propane-fired appliances were replaced by electrical appliances. This is evident in all rural communities, where old propane tanks have complied from disposal over time and no current option available for removal of these tanks from the communities. Lately, interest has renewed in propane as a power source for household appliances such as stoves, refrigerators and dryers. Although, propane is more energy-efficient than diesel, the cost of propane shipped into the YK Delta region remains too high to be an affordable option. It is anticipated that by 2015 the costs of propane in Anchorage could be reduced by as much as 30%, which may make propane more economical than electricity for some applications in households with electrical usage over 500 kWh/month.

Comparison of propane vs. diesel can be computed as such: 1 Gallon of Propane = 27 kWh (Kilowatt Hours) of electricity - This means that one gallon of propane contains the same amount of usable energy as 27 Kilowatt Hours, or 27 kWh equals approximately 91,500 BTU.

The cost of propane shipped into the YK Delta communities remains high. The costs range from about $150 to $465 per 100 pounds for residents. Comparatively, the cost in Anchorage is $106 per 100 pounds.

Table 4: Propane Costs per 100 Pounds by Subregion

Subregion	Lowest Price	Highest Price	Average Price
Interior Rivers	$261.19	$363.10	$292.01
Lower Kuskokwim	$148.81	$463.81	$279.54
Lower Yukon	$166.19	$415.24	$280.46

Source: AHFC Fuel price survey, 2014

FUEL

Transportation and storage contribute to the high cost of fuel in the YK Delta Region. Rising fuel cost impacts are magnified if the additional costs associated with the limited logistical options for bulk fuel shipping, the poor economies of scale in fuel transportation, power generation and distribution are considered. In addition to fuel costs, electrical utilities spend a significant amount on regulatory compliance and oil spill response preparedness annually. This includes the following compliance programs (Dellabona, 2009):

- *U.S. Environmental Protection Agency* – Spill Prevention Control and Countermeasure Plans – SPCC Plan
- *U.S. Coast Guard Operations Manual* – Coast Guard Operations Manual Site Inspections and Exercises
- *Alaska Department of Environmental Conservation* (ADEC) – Oil Discharge Prevention and Contingency Plan-C Plan, API 653 Internal and External Tank Inspections, API 570 Tank Farm Piping Inspections, Cathodic Protection Surveys, Site Inspections and Exercises Power Plant Air Pollutant Fees

Since 2000, fuel rates have more than doubled. Fuel rates from 2014 are shown in the following table:

Table 5: 2014 #2 Diesel Fuel Rates per Gallon in the Yukon-Kuskokwim by Subregion

Subregion	Lowest Price	Highest Price	Average Price
Interior Rivers	$6.25	$11.00	$6.75
Lower Kuskokwim	$4.62	$8.67	$4.78
Lower Yukon	$5.40	$7.17	$6.65

Most households use diesel to heat homes, with some supplementing their heat with wood.

Consolidation of fuel purchase can reduce costs by allowing the purchasers to pay a lower wholesale price for larger quantities of fuel purchased (Crowley Maritime). Alaska Village Electric Cooperative (AVEC) consolidates fuel purchases to reduce fuel costs in Alaska. They purchase about five million gallons annually for the 52 communities in the interior and western Alaska that they serve. Northstar Gas purchases about 5 million gallons and serves villages in the Lower Kuskokwim. Western Alaska Fuel Group, which serves communities in Bristol Bay, Seward Peninsula and Kotzebue Sound, purchases about six to seven million gallons a year.

Fuel Storage. Fuel storage – awaiting AEA fuel storage report.

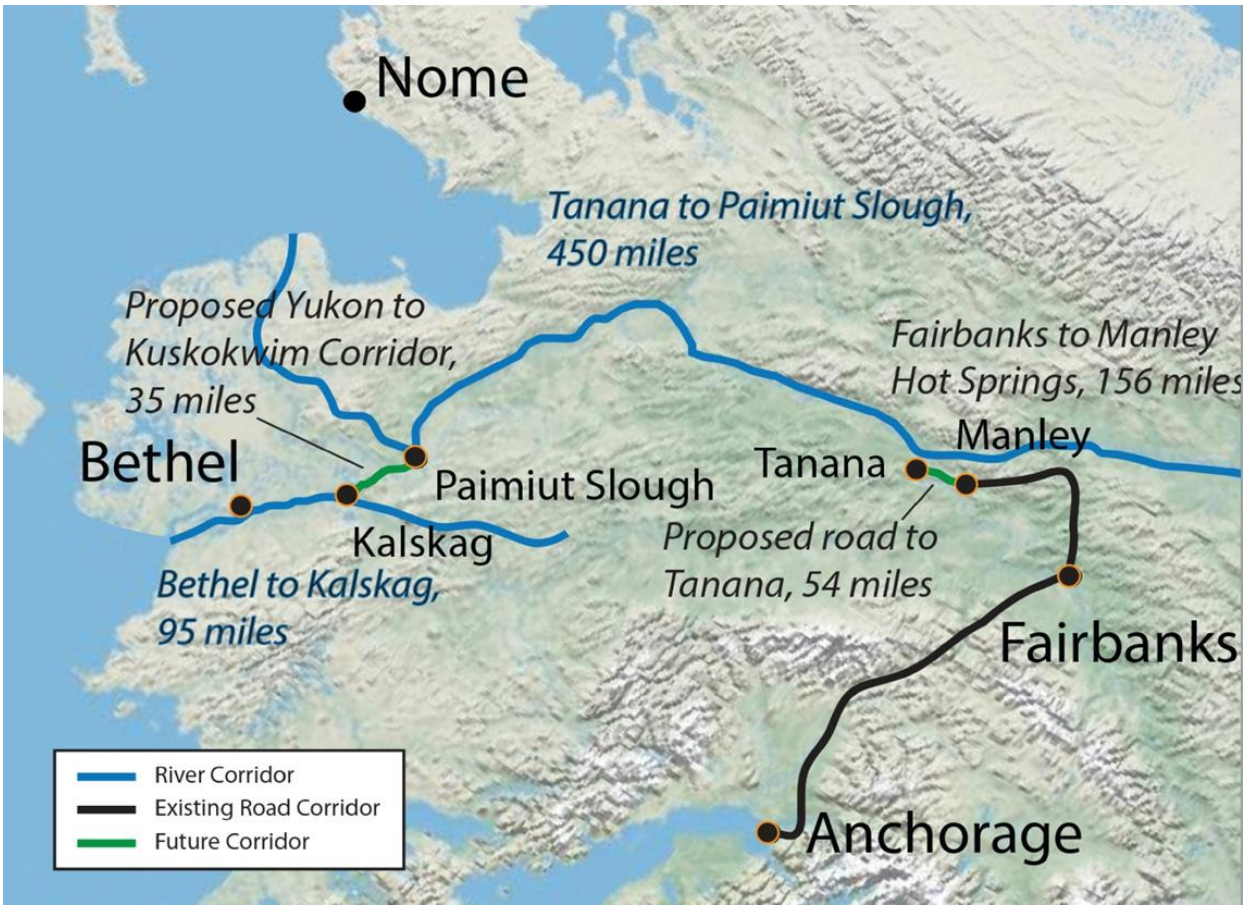
2.10 POTENTIAL GAME CHANGERS

YUKON-KUSKOKWIM ENERGY AND FREIGHT CORRIDOR PROJECT

A corridor between the Yukon River and communities in the upper Kuskokwim River region has been discussed and studied. Such a route may allow potential growth in the Fairbanks-based fuel and freight market an opportunity to deliver products to communities in western Alaska. In 2013, villages within the YK Delta region initiated a project called the Yukon-Kuskokwim Energy and Freight Corridor, requesting AVCP serve as the project sponsor.

In the first phase, AVCP conducted a feasibility study to determine the possibility of developing a corridor in this area. Initial findings indicate that such a corridor is possible. The current planning activities will define the location, type of corridor that can provide the greatest benefit to the region, and continue evaluation of potential economic impacts. Although design is expected to be completed in 2018, preliminary planning has proposed a 40-45 mile corridor that is roughly 2,000 feet wide. (AVCP)

Figure 4: River Transport Systems and Potential Road Connections



Source: Yukon-Kuskokwim Energy and Freight Corridor, Association of Village Council Presidents

DONLIN GOLD MINE & NATURAL GAS PIPELINE

An undeveloped gold resource in the Yukon-Kuskokwim region has been found ten miles north of the village of Crooked Creek. Based on exploration results, proven and probable reserves are estimated at 33.6 million ounces of gold. Donlin Gold, an exploratory mining company, is proposing the development of a socially and environmentally responsible open pit gold mine. Approximately 59,000 tons (118 million pounds) of ore would be processed daily during the mine's 27-plus years life. Donlin Gold would operate an open pit mine, approximately 2 miles long by 1 mile wide. In order to extract this resource, Donlin Gold estimates the mine would require an average power load of 157 MW. To meet this demand, project managers are considering construction of a 14-inch, 312-mile-long buried pipeline to provide natural gas from Cook Inlet to the mine site in western Alaska. Donlin Gold has stated natural gas from this pipeline would only be 50 percent subscribed, allowing residents in the area to consider tapping into the pipeline as an alternative energy option. (Donlin Gold)

Figure 5: Donlin Gold Project Location

Map of the proposed Donlin Gold mine in relation to the Kuskokwim River.

Source: Donlin Gold – Project Summary

CHIKUMINUK LAKE HYDROELECTRIC PROJECT

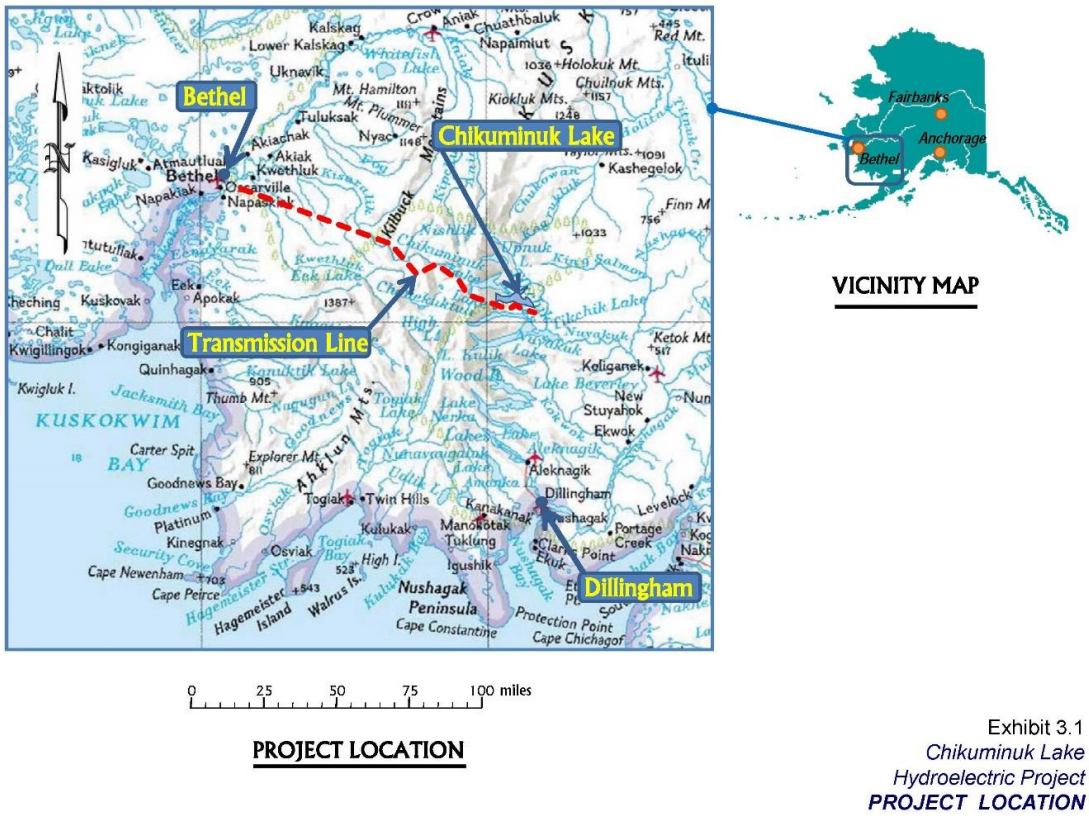
Because the cost of energy in western Alaska remains high, in 2010, several regional entities in the Yukon-Kuskokwim Delta region began pursuing alternative energy solutions. Previous studies indicated hydroelectric potential in the Allen River, which could provide enough electricity to power both Dillingham and Bethel regions with less expensive, renewable, clean energy.

As a result, policymakers and non-profit entities allocated resources to further study hydroelectric generation at Chikuminuk Lake. Nuvista Light & Electric Cooperative, Inc. (Nuvista) served as the project lead. Following a series of community meetings, it was determined Chikuminuk Lake offered several advantages over other potential sites in the watershed, including: records indicated it received limited recreation or subsistence activity, preliminary studies showed it does not support a salmon run, and it can generate year-round water flows capable of meeting the electricity demand among communities throughout the Yukon-Kuskokwim and Bristol Bay regions.

Initial findings estimated Chikuminuk Lake could produce roughly 22 MW of power to the region, potentially displacing 5 million gallons of diesel per year. Initial studies of the site included: geology of the lake basin, water use and quality, aquatic resources, terrestrial resources, cultural and subsistence resources, recreation and visual resources, socioeconomic resources, electric generation capability of the site, and potential costs to construct and

operate. As a result of concerns over State capital project funding, the need for greater regional support, and challenges of accessing the site for greater subsistence studies, Nuvista opted to end its work on the project. Providing first-ever study of this location, the organization submitted its findings to the Alaska Energy Authority as a baseline for any future review of hydroelectric potential at Chikuminuk Lake. (Nuvista)

Figure 6: Chikuminuk Lake Hydroelectric Project Location



Source: Nuvista

CHAPTER 3

REGIONAL ENERGY ANALYSIS

REGIONAL ENERGY ANALYSIS

This chapter provides details about energy resources and potential opportunities in the Yukon-Kuskokwim region and outlines regional priorities.

The following sections describe the potential energy resources and energy efficiency opportunities in the region, along with descriptions of regional priority energy projects proposed or already underway.

As concerns about rising fossil fuel prices, energy security, and climate change increase, renewable resources play a key role in providing local, clean, and inexhaustible energy to supply Alaska's growing demand for electricity, heat, and transportation fuel. Because there are limited fuel costs associated with generating electricity and heat from renewable sources, more Alaskans are looking to resources like hydropower, wind, biomass, geothermal, solar, tides, and waves. Alaskans are also increasingly saving heat and electricity through energy efficiency and conservation measures, keeping dollars in the state's economy, creating more stable and resilient communities, and helping to achieve the state goal of 50% renewable energy by 2025 (REAP).

3.1 ENERGY RESOURCES

OIL AND GAS

Exploration for oil and natural gas resources in the YK Delta Region has been focused on three primary geographic areas – the Bethel Basin, the Yukon Delta/Norton Sound, and the Holitna Basin.

In the 1950s, after the U.S. Navy discovered oil and gas in the cretaceous rock on the North Slope, attention turned to the YK Delta Region. There was hope that the cretaceous strata in this region might have similar oil and gas potential. Between 1954 and 1961, large parts of the region were reconnoitered by oil company surface parties and a small amount of geophysical work was carried out near Bethel including a 1,500 foot well drilled at Napatuk Creek, 35 miles southwest of Bethel. The exploration did not reveal oil or favorable reservoir rocks so exploration and leasing activity in the region declined sharply thereafter.

With the exception of the exploration near Bethel and the Norton Sound, which had eight deep wells drilled in the 1980s, none of the remainder of the region was the focus of subsurface exploration efforts. However, all of the geologic information collected to date reveals a very low probability for the occurrence of conventional, economically recoverable oil resources. Analysis of rocks from the basins indicate they are not prone to generating oil, but some rocks do contain material associated with gas generation.

In 1998, the Alaska Division of Geological and Geophysical Surveys (DGGS) conducted an airborne magnetic survey in the Holitna Basin which is located in a broad lowland area between the Kuskokwim Mountains and the Alaska Range. Villages in the area include Sleetmute, Stony River and Lime Village. Due to its proximity to the Donlin Gold project (about 45 air miles) and some geological similarities to Cook Inlet gas fields, the Holitna Basin is most likely to be targeted for oil and gas exploration activity in the near future (D. L. LePain, 2012).[3]

COAL

There are limited coal resources in the YK Delta Region. The exceptions worth noting are the Cheeneetnuk River and Nelson Island. Neither occurrences is well understood.

The Cheeneetnuk River has a narrow belt of coal-bearing sedimentary rocks that is discontinuously exposed. In 2000, geologists visited the area and found mudstone along the north bank of the river that included some coal float (small fragments), but were unable to locate exposures of coal. The presence of coal in this area is well

[3] Swenson, Robert E., David LePain, Marwan Wartes, and James Clough. *Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska: Summary of Available Information*. Fairbanks, Alaska: Alaska Division of Geological & Geophysical Surveys, 2012. Print.

established, but the number of seams, seam thickness, and extent are unknown. Available information suggests that coal seams are of limited lateral extent and thickness, and thus likely do not represent a significant energy resource (LePain., 2012).

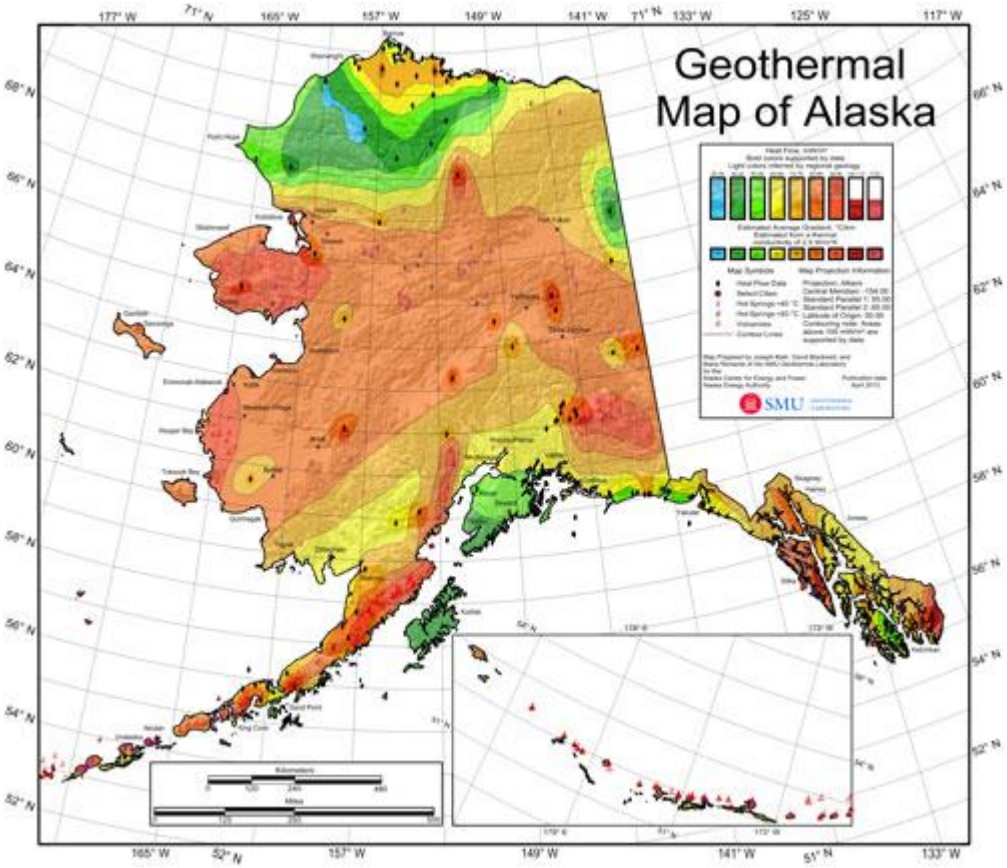
On Nelson Island, geologists also found minor coal-bearing sections. The thickest seam encountered was 19 inches, located east of the village of Toksook Bay and another narrow band was noted on the north shore of the island at Hazen Bay, east of the village of Tununak. Reportedly, a few tons of coal were mined from this locality but the years when the coal was mined are not known. Available data suggest coal from these seams represents a resource suitable for use by individuals to heat cabins. The lack of thick coal seams and uncertainty of the subsurface volume and extent of any coal suggests that coal has little potential for providing an energy source for local communities in the YK Delta Region (LePain., 2012).

Potential for the extraction of this resource as an energy source would require further feasibility and environmental studies.

GEOTHERMAL

Geothermal energy uses the heat of the earth to provide direct heat or electricity production. Direct heat geothermal uses low to moderate temperature water to heat structures, grow plants in greenhouses, and in industrial processes such as drying food or fish farming. These systems pump hot water directly into the structures they are warming. Producing electricity from geothermal uses high temperature resources to convert heat into power, though new technologies are emerging that allow lower temperature resources to be utilized in electricity generation. (REAP Geothermal)

Figure 7: Geothermal Map of Alaska



Source: ACEP

The Alaska Energy Authority Geothermal Program consider a geothermal resource to be capable of economically-viable power production if it attributes these four factors: 1) a heat source, 2) a reservoir with sufficient permeability and porosity, 3) sufficient heat conduction within the formation and 4) high enough fluid flow. This program support projects for geothermal development for power generation, direct use, and heat pumps and assists in identifying potential resources. Most geothermal projects are funded through AEA's Renewable Energy Fund (REF). (AEA)

There are three known hot springs in the region including Ophir, Chuilnuk, and an unnamed hot spring near the Tuluksak River, located approximately five miles west of Ophir hot springs. The Ophir and the unnamed hot springs are both approximately 25 miles southeast of Kalskag, and Chuilnuk Hot Springs is approximately 40 miles southwest of Sleetmute.

Table 6: Hot Springs in the Yukon-Kuskokwim Region

Hot Spring Location	Measured water temperature	Flow rate
Ophir	142 degrees F	71 gallons/minute
Chuilnuk	124 degrees F	145 gallons/minute
Unnamed	Unavailable	Unavailable

Source: Fossil Fuel and Geothermal Energy Sources for Local Use in Alaska, Alaska DNR Division of Geological and Geophysical Surveys, 2012

Given the distance from these hot springs to nearby communities and the low-grade nature of these hot springs, it is unlikely that they are viable geothermal energy resources (LePain., 2012).

The U.S. Department of Energy (DOE) Geothermal Technologies Office (GTO) is committed to developing and deploying a portfolio of innovative technologies for clean, domestic power generation.
The Geothermal Technologies Office researches, develops, and validates innovative and cost-competitive technologies and tools to locate, access, and develop geothermal resources in the United States.
DOE works in partnership with industry, academia, and DOE's national laboratories on research and development activities focused on these areas:

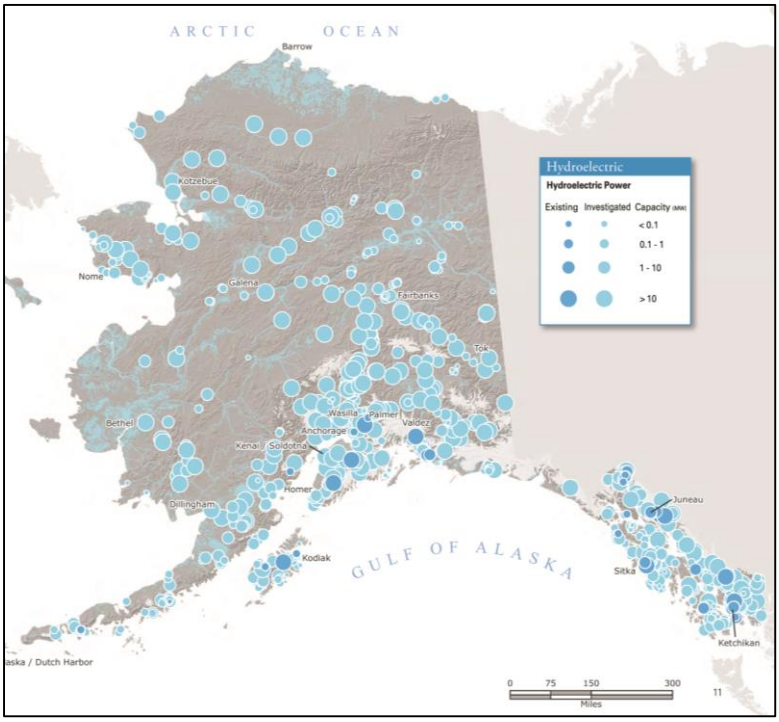
- Enhanced Geothermal Systems
- Hydrothermal and Resource Confirmation
- Low-Temperature Resources
- Systems Analysis

Geothermal energy, a virtually untapped energy resource derived from the earth's heat, is more vital today than ever—it supplies clean, renewable power around the clock, emits little or no greenhouse gases, and takes a very small environmental footprint to develop. By developing, demonstrating, and deploying innovative technologies, GTO's efforts are helping stimulate the growth of the geothermal industry within the renewable energy sector and encouraging quick adoption of technologies by the public and private sectors. (DOE GTO website)

HYDROELECTRIC

According to AEA, hydroelectric power is Alaska's largest source of renewable energy, supplying 20% of the state's electricity in an average water year. Most of these projects are located in Southcentral, the Alaska Peninsula, and Southeast – mountainous regions with moderate to high precipitation (AEA Hydroelectric Program).

Figure 8: Hydroelectric Map of Alaska



Source: AEA Hydroelectric Program

In 2010, Nuvista began to work with communities in the YK Delta Region to investigate possible solutions to the region's energy challenges. This led to investigating hydroelectric generation at Chikuminuk Lake, which sits at the upper reaches of the Nuyakuk-Nushagak drainage in northern Wood Tikchik State Park. Following the Federal Energy Regulatory Commission (FERC) guidelines, Nuvista completed an interim feasibility assessment on the Chikuminuk project. The Nuvista Board of Directors concluded that there remain unanswered questions about the environmental impacts as well as economic questions and political issues that may prevent this particular hydroelectric project from being a practical solution to Western Alaska's energy programs at this time. As a result, Nuvista ended efforts to pursue the potential project.

A feasibility study of Ekashlusk Creek and a reconnaissance study of Kisargalik River were completed by AEA, but no further studies have been done. With emerging technologies in "run-of-river" hydroelectric systems, potential remains an unknown, but the potential is available. Small "run-of-river" projects use more modest structures to divert a portion of the natural river flow through penstocks to turbines making power.

According to the AEA Hydroelectric program, hydroelectric power projects are complex and can be lengthy and expensive to construct. Hydropower projects usually have high initial costs, low operating costs and project lives of 50 years or more. Even with excellent hydro resources, engineering must be thorough to insure a positive return on investment. This consists of an involved process with many things to consider. Project development phases include reconnaissance, feasibility, licensing and design, and finally construction. (Hydroelectric Process, 2015)

Alaska's primary biomass fuels are wood, sawmill wastes, fish byproducts, and municipal waste. A majority of the coastal communities in the Lower Yukon and Lower Kuskokwim Subregions expressed their current use of biomass for heat. Driftwood and willows were stated to provide a biomass resource for woodstoves throughout the region. The Interior Rivers Subregion has the most potential for larger wood biomass due to the presence of wood resources such as white and black spruce and areas of birch trees. With sawmills in Napaimute, Chuathbaluk and Red Devil, the opportunity for distribution of biomass exists. Feasibility studies would need to be conducted to identify which communities have a viable resource that would sustain either a local or utility scale project.

Photo 4. Lime Village

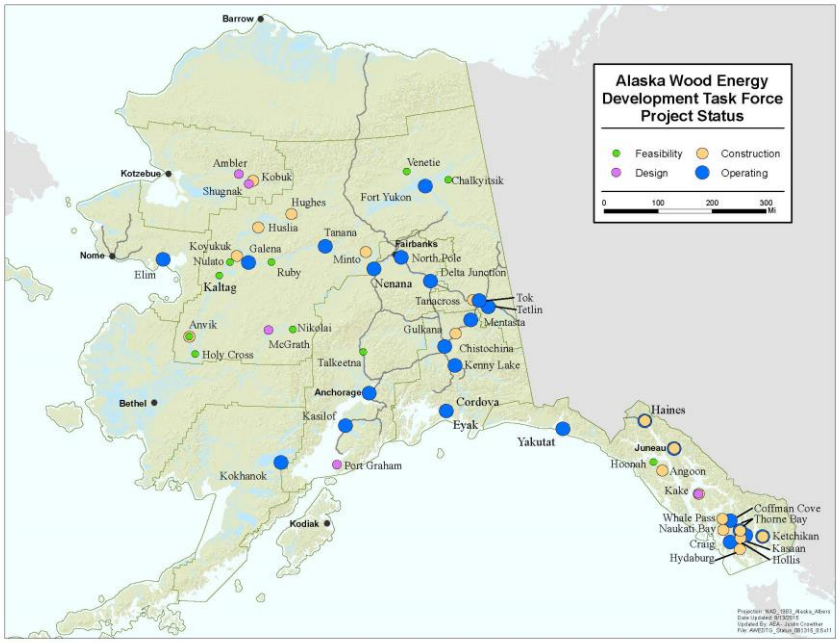
The Alaska Wood Energy Development Task Group (AWEDTG) consists of a coalition of federal and state agencies and not-for-profit organizations that have signed a Memorandum of Understanding (MOU) to explore opportunities to increase the utilization of wood for energy and biofuels production in Alaska. AWEDTG continually seeks parties that would like to explore the feasibility of community heating projects of individual facility, community, and/or district heating projects with high-efficiency, low-emission, wood-fired systems. AWEDTG have conducted pre-feasibility studies in six YK Delta region communities, as shown in Figure 9. These studies did not meet the criteria to implement projects, as shown in Figure 10.

During the community outreach meetings conducted in 11 sub-regional communities, residents commented that most still used wood as a source for heating their homes, due to the high cost of diesel fuel. Further investigation of biomass resources and proven new technologies is a priority for this region. The potential for energy-efficiency measures on current woodstoves is one potential to explore.

Figure 9: Locations of Prefeasibility Reports for Wood Energy

Source: AEA Biomass Program

Figure 10: Project Status for Wood Energy Development



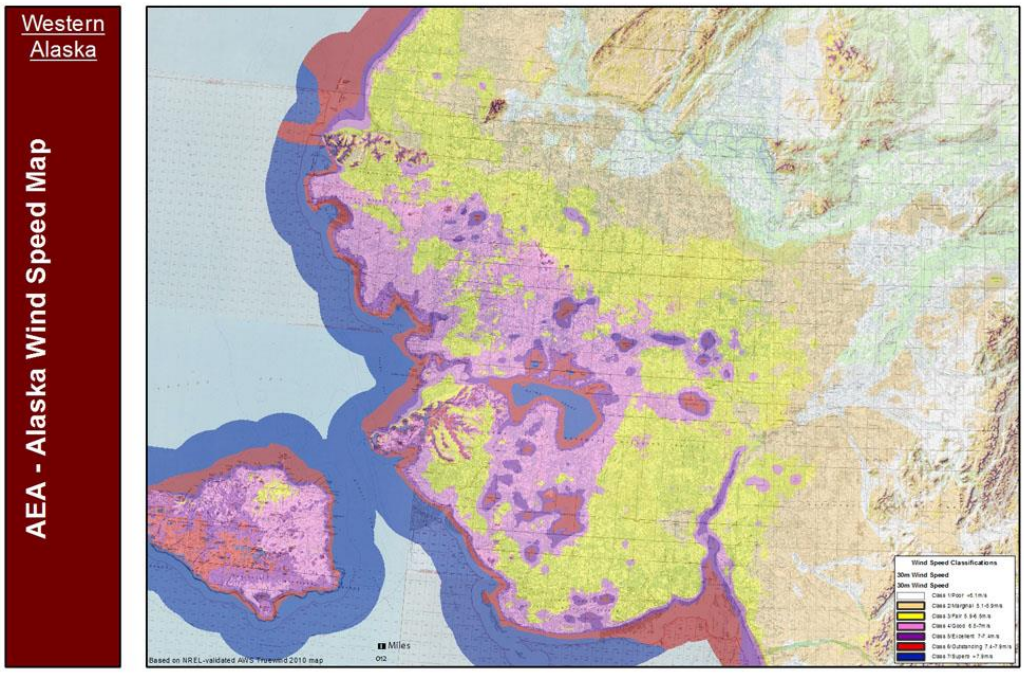
Source: AEA Biomass Program

WIND

AEA strives to make Alaska a leader in designing, planning, constructing and operating integrated wind-energy systems, providing the maximum benefit for utilities and ratepayers to offset electrical and heating needs. Our staff works to: 1) Identify economic wind resources for potential development 2) Support research and development efforts for rural and Arctic applications 3) Establish best practices in the design, construction, operation and maintenance of integrated wind energy systems 4) Educate Alaskans about wind energy. The uncertainties and inconsistency of wind causes challenges in rural Alaska as an intermittent power source. Small diesel systems require upgrades to accept wind/diesel systems. Accessing the current infrastructure and its capabilities to accept wind renewable power systems is vital to the success of a wind project. Proven Arctic climate designs are becoming more readily available, making this resource more widely used.

Using wind as an energy resource has a higher potential in the coastal communities in the Lower Yukon and Lower Kuskokwim Subregions where winds are stronger than the interior communities. The first phase for determining if a community has an adequate wind resources is to install a meteorological (met) tower to measure the wind over the course of at least 12 months. If the wind appears to be adequate, a feasibility report that examines the viability of installing a wind turbine in the community, location, how it is to be integrated into the electrical grid, etc. is completed. If the feasibility report indicates that the community would benefit from a wind turbine, a concept development report, final design, and permitting are conducted and, finally, the system is put into operation. The following table shows the status of the various phases of wind energy projects in the YK Delta shown by Subregion. Figure 11indicates the low, medium, or high potential likely for a wind resource based on the strength of the wind.

Figure 11: AEA Alaska Wind Speed Map



Source: AEA Wind Program

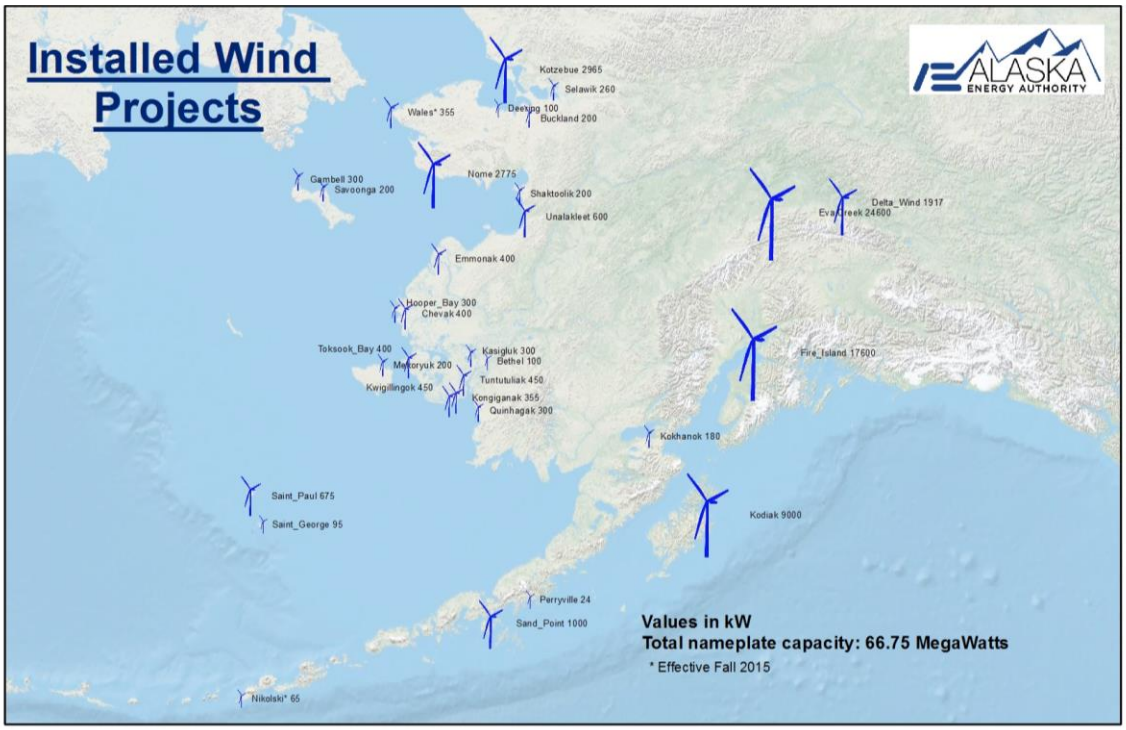
Table 7: YK Wind Energy Project Status by Subregion

	Current Phase					Potential		
Subregion	**None**	**Met Tower Installed**	**Feasibility Report**	**Conceptual/ Final Design**	**Operation system**	**L**	**M**	**H**
Lower Kuskokwim Sub Region	16	12	9	4	10	15	14	18
Lower Yukon Sub Region	3	3	3	3	4	1	8	4
Interior Sub Region	9					7	2	

Source: Concept Design Reports, Rural Power System Upgrade Reports, Chaninik Wind Group Report, V3E Report

Figure 12 shows wind project implementation the YK Delta region in the communities of Emmonak, Hooper Bay, Chevak, Toksook Bay, Mekoryuk, Kwigillingok, Kasigluk, Bethel, Tuntutuliak, Kongiganak and Quinhagak.

Figure 12: AEA Installed Wind Projects



Source: AEA Wind Program

Diesel fuel is the primary source of electrical power in the region. However, it is worth noting that 11 communities increased the percentage of electricity generated through wind power in recent years. Table 8 shows the amount of power generated from diesel fuel and from wind resources in kilowatt hours for each communities in the region with wind systems.

Table 8: Power Generation Comparison, FY 2013/2014*

Community	FY2013 Diesel (kWh)	FY2014 Diesel (kWh)	FY2013 Wind (kWh)	FY2013 % Wind	FY2014 Wind (kWh)	FY2014 % Wind	FY2013 Total Generation	FY2014 Total Generation
Bethel	44,326,400	42,460,800	*	*	*	*	44,326,400	42,460,800
Chevak	1,709,307	1,695,162	908,019	53%	852,280	50%	2,617,326	2,547,442
Emmonak	3,046,790	3,418,936	611,365	20%	441,230	13%	3,658,155	3,860,166
Hooper Bay	2,675,469	2,756,103	713,768	27%	428,928	16%	3,389,237	3,185,031
Kasigluk	2,548,852	2,557,735	603,586	24%	487,894	19%	3,152,438	3,045,629
Kongiganak	861,659	944,780	318,848	37%	326,681	35%	1,306,761	1,436,531
Kwigillingok	1,125,730	1,038,264	59,295	5%	280,518	27%	1,185,025	1,318,782
Mekoryuk	825,971	765,238	186,660	23%	209,553	20%	1,012,631	974,791
Quinhagak	1,415,362	1,532,913	628,961	44%	529,245	35%	2,044,323	2,062,158
Toksook Bay	2,609,319	2,641,489	726,450	28%	612,278	23%	3,335,769	3,253,767
Tuntutuliak	859,558	833,480	196,349	23%	219,108	26%	1,055,907	1,100,266

Source: AEA, 2013 and 2014 PCE report

SOLAR

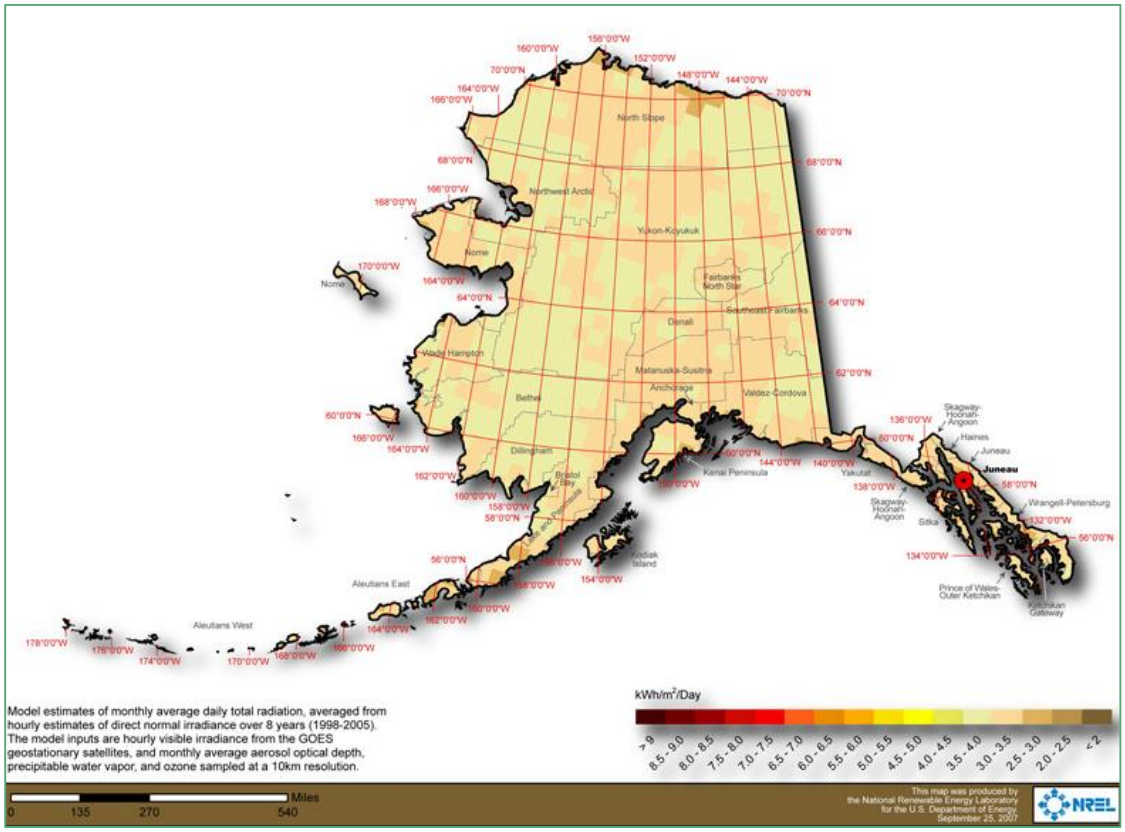
The world's northern latitudes offer a unique opportunity to take advantage of solar power. In Alaska, even in the YK Delta Region where there are great fluctuations in sunlight throughout the year, solar power is a viable source of energy. Recent installations throughout the northern latitudes indicate that despite limited daylight hours in the winters, solar power can still offset energy costs, particularly in the spring when the sun reflects off the snow. This plays an important role in small, off-grid power generation and low-power applications such as remote communications sites, fish camps, and seasonal fisheries. Recent worldwide demand and larger scale production of panel components has cut the solar panel costs by 80%. (REAP, 2015)

Solar energy is electromagnetic radiation transmitted from the sun. There are two types of solar projects: solar thermal and solar electric. Solar thermal projects involve the use of solar energy for heating purposes. Typically, pipes are arranged such that a cluster of piping passes through a solar panel. Radiant energy from the sun increases the temperature within that section of pipes and that heat spreads throughout the piped loop. Solar electric projects convert the energy from the sun's rays into electricity to feed the building unit or the grid to which it is connected. Solar panels are used to collect the radiant wavelength energy of the sun. A converter is then used to change the energy into electricity that can be transferred into a grid. This is often used in off-grid battery systems when connection to an overall grid is not available. (AEA, 2015)

The National Renewable Energy Lab (NREL) provides an interactive map called PVWatts, which provides access to multiple data sets which link directly to their corresponding PVWatts Calculators, allowing the user to determine energy production and cost savings of grid-connected solar photovoltaic (PV) systems. This viewer provides easy access two datasets, Site Specific Data (Version 1), which offers individual data for specific locations, depicted as a black cross with a yellow center and Grid Data (Version 2), which allow users to create estimated performance data for any location in the United States and surrounding territories by selecting any point within one of the 40km grid cells.. This application, built on ESRI Flex Viewer, utilizes an interactive web mapping interface that allows you to query both data sets simultaneously for any specified location. (NREL, 2015)

The interest in solar applications in Alaska is on an upward trend as the cost for solar continues to go down and technology continues to produce more efficient and sturdier solar equipment. Since maintenance and operation of solar applications tends to be less expensive than other renewable technologies, such as wind, this resource needs to be further explored and implemented. According to AEA, it should be noted that "most interest in solar in the state has been in small-scale (building-level) installations. Whether or not these are net-metered, projects like this in rural communities need to consider many different factors to determine both technical and economic viability, including the condition of the existing electrical system serving the building, PCE eligibility, and the requirements of available funding sources". (Drolet, 2015) The potential for solar in the YK Delta region is shown inFigure 13.

Figure 13: Global Solar Radiation at Latitude Tilt – Annual



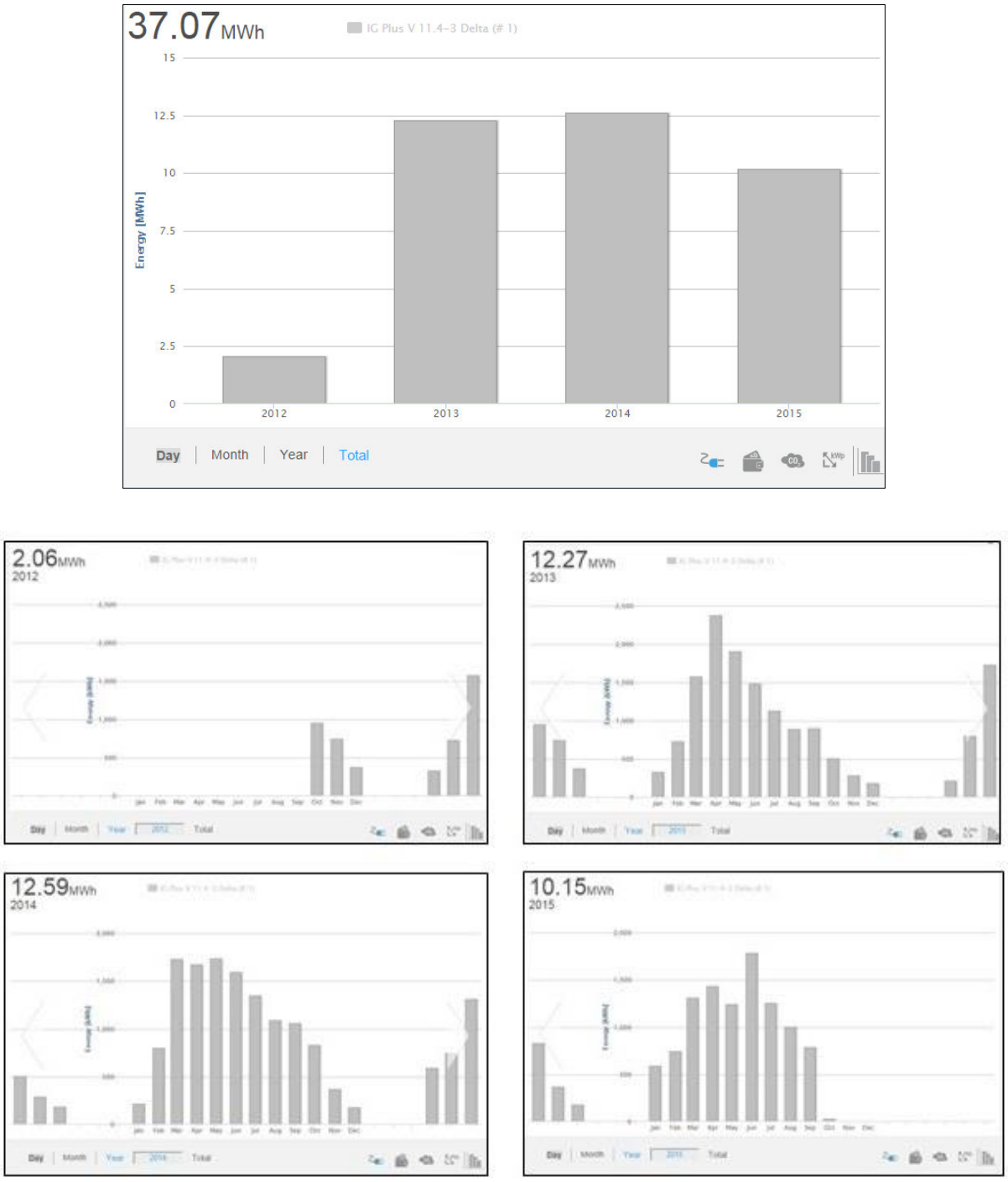
Source: NREL

Solar applications are currently implemented in the YK Delta on a very limited scale. The Yuut Elitnaurviat Learning Center in Bethel integrated a wind/solar combination unit to help offset the high cost of electricity. Some of the challenges faced in building the wind/solar system were the ones very often encountered in rural Alaska: 1) lack of local trained professionals, 2) high shipping costs for materials manufactured in the contiguous United States, and 3) removing permafrost where the turbines and solar array were being installed. Engineers and installers came from Anchorage and Nome, as well as engineers and designers from Fairbanks' Cold Climate Housing and Research Center to work on the project. Funding was provided through a capital projects grant from the U.S. Department of Education. (Osborne, 2015)

These challenges are faced throughout rural Alaska and each project is unique to its environment, size, technological aspect, local support (or buy-in) and funding availability from feasibility stage to construction and maintenance and operation of the renewable system.

Exhibit 14 shows the annual savings for the solar component for 2012-2015.

Exhibit 14: Yuut Elitnaurviat Learning Center Solar Data



Source: Yute Elitnaurviat Learning Center

In the community of Mountain Village a solar photo voltaic system with 64 micro inverters has produced 787.5 megawatt hours of electricity since its installation in 2013. (Enlighten, 2015) This offset to the high cost of diesel ($6.25/gallon 9/2015) is a viable solution to integrated renewable energy for this region.

In 1997, Lime Village built a 4kw photovoltaic (PV) solar system with battery storage and inverter in conjunction with 77kw of diesel generation in a hybrid diesel-PV battery system. No operational data is available from this time period. The system was upgraded to 12kW in 2003 and the battery system was replaced. The solar part of this

system ran for one month and has not operated since. The population and electric loads in Lime Village have dropped significantly since that time. The Lime Village solar project is an example of the challenges of testing high-penetration renewable energy pilot projects in remote Alaskan locations. (AEA, 2015)

Some challenges with solar applications are shading (when trees are present), logistics, interconnection agreements with local utilities, cost to install, return-on-investment, and maintenance and operations. (CCHRC, 2015) State and federal agencies, such as the Department of Energy Office of Indian Energy and their National Renewable Energy Lab (NREL) have tools to help local entities calculate some of these costs and barriers. Net metering allows the user to track savings, which helps communities justify integration of renewable systems. Net metering can be a challenge in small communities with single-site electric utilities. (Drolet, 2015)

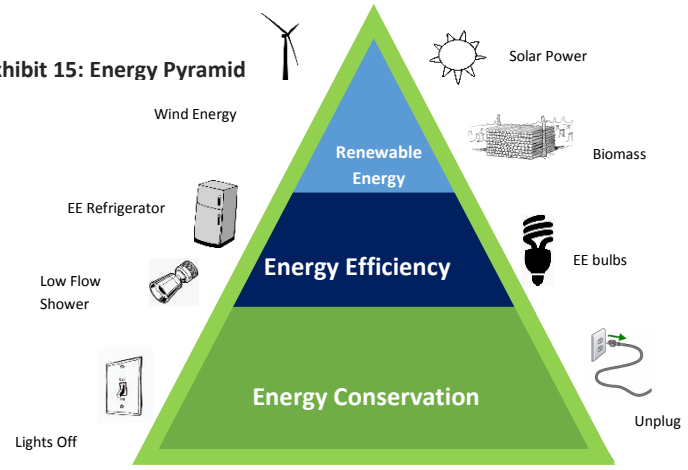
ENERGY EFFICIENCY AND CONSERVATION

Energy efficiency and conservation (EE&C) measures can result in significant savings on heating and electricity costs for both residential and non-residential buildings. "Energy conservation" and "energy efficiency" are often used interchangeably, but there are some differences. Energy conservation means using less energy and is a behavioral change, such as turning your lights off or unplugging your coffee maker when not in use. Energy efficiency means using energy more effectively, and is often a technological change, such as replacing light bulbs with more energy efficient light bulbs or replacing old refrigerators with more energy efficient refrigerators. Using renewable energy is another way to reduce dependence on non-renewable energy. These concepts are illustrated in Exhibit 18.

Since space and hot water heating typically account for over 80% of home energy budgets (and around 50% of energy used in public and commercial buildings), EE&C improvements provide one of the best ways to address total energy costs.

Reducing energy demand through EE&C provides both current savings through avoided fuel purchase, transportation and storage costs, and future savings by reducing or postponing the need for new capital investments in energy production.

Exhibit 15: Energy Pyramid



Source: WHPacific, Inc.

Energy efficiency measures also act as an economic driver in Alaskan communities, while providing a quick payback on investment for building owners. Energy efficiency projects create more jobs in the economy than investments in some other energy projects. There are approximately 7.8 jobs created for every $1 million spent on EE&C compared with only 2.6 jobs from the same investment in electrical power and 1.3 jobs from natural gas projects (Ord, 2014). Payback periods for EE&C investments can be as short as 4 months, while typical paybacks on new renewable energy generation are rarely shorter than 5 years (Pelunis-Messier, 2013).

In the YK Delta Region, weatherization programs have been a significant economic resource in the past seven years, producing work for 1,324 people and paying wages of over $12.5 million, as shown in Table 9.

Table 9: 2008-2014 Economic Impact of Weatherization Projects in YK Delta Region

Program Year	Number of Villages	Units	Wages	Employed
2008	5	140	$495,485	60
2009	4	95	$1,515,803	160
2010	9	152	$1,154,505	165
2011	9	100	$2,536,156	294
2012	16	158	$2,536,156	262
2013	17	201	$2,870,231	242
2014	4	100	$1,474,151	141
TOTAL	***64***	***946***	***$12,582,487***	***1324***

Source: AVCP Regional Housing's Weatherization Program

RESIDENTIAL BUILDINGS

The 2014 Alaska Housing Assessment contains housing and energy data primarily collected through the AHFC Home Energy Rebate (HER) and Weatherization (Wx) programs. Some of the data quality is poor (based on minimal energy audits) and there are data gaps, particularly with home heating, but there are still several conclusions that can be drawn.

Within the YK Delta Region, there are approximately 6,009 occupied housing units. Among them, participation in EE&C programs varies, with 40% participation in the Interior region and 20-30% participation in the Lower Kuskokwim and Lower Yukon Subregions. The housing assessment's energy-related findings for the region include:

Energy Use: The average home in the YK Delta Region is 875 square feet and uses 167,000 BTUs of energy per square foot annually. This is 22% more than the statewide average of 137,000 BTUs per square foot per year.

Energy Cost: The average annual energy cost for homes in the YK Delta Region is $6,240, approximately 2.2 times more than the cost in Anchorage, and 2.9 times more than the national average. Using AKWarm estimates, average annual energy costs constitute approximately 13% of census median area income for occupied housing (Cold Climate Housing Research Center, 2014).

Residential Energy Efficiency Savings Completed. A common home energy efficiency and weatherization measures typically save YK Delta Region households 23% to 52% on energy consumption, which translates into 250 to 600 gallons of fuel oil per home per year. Most of the energy savings is in home heating, although lighting efficiency upgrades also result in electrical savings.

The Home Energy Rebate (HER) program requires homeowners to pay for an audit and recommended upgrades up front. The homeowner is then reimbursed up to a certain amount once work is done and a "post" audit is completed. HER reimbursable costs are limited to direct labor and materials. The average out-of-pocket expense to homeowners is around $4,800 statewide (Ord, 2015). This amount does not include the "rebate" or state funds that are invested into the upgrades. With annual cost savings averaging $1,464 statewide, the payback period for homeowners is 3.3 years (Lister, 2013).

In rural communities across the state, the HER program has been underutilized. In the YK Delta Region, only residents in Bethel and Aniak have taken advantage of the program. There are many reasons for the lack of participation in the program, such as inability to pay the up-front costs, lack of energy raters, cost of transportation for materials and lack of certified general contractors in rural communities.

To address one of the barriers to rural participation in the HER program, AHFC will now send a rater to a community if there are three to five customers signed up, depending on the size of the community (generally three for small communities or five for rural hub communities). Customers can always choose their own rater, but their costs will be lower if they use the AHFC sponsored rater.

The Weatherization program provides similar services to the HER program. AHFC administers the program but AVCP Regional Housing Authority is the weatherization service provider in the region. The Weatherization program differs from HER in that it is free of charge and requires an application from which an applicant's eligibility is determined based on age, disability, dependents, and income level. AVCP RHA has applications online at http://www.avcphousing.org/wp-content/uploads/WeatherEligibilityApplication.pdf.

Approximately 30% of the occupied homes in the YK Delta Region have completed either the Home Energy Rebate or Weatherization programs, or have received BEES certification since 2008 as shown in Table 10.

Table 10: Estimate of Homes Participating in Energy Efficient Housing Programs in the YK Delta Region, 2008-2014

Subregion	Occupied Homes	BEES-certified Homes[1]	Home Energy Rebates[2]	Weatherization[2]	Total EE Housing Stock	% EE Housing
Interior Rivers	467	5	4	183	192	41%
Lower Kuskokwim	3,827	183	64	827	1,074	28%
Lower Yukon	1,714	53	0	502	555	32%
Total	**6,008**	**241**	**68**	**1,512**	**1,821**	**30%**

Sources: (Ord, 2015) (Wiltse, 2014) 1/ 2014 Alaska Housing Assessment. 2/ AHFC, January 2015. Other sources: U.S. Census.

The AVCP Regional Housing Authority Weatherization program compiled statistics for four communities in the YK Delta Region (Table 11). They concluded that the projects saved between 20 and 34% from the energy bill and between 41 to 54% savings in annual heating costs.

Table 11: 2014 Weatherization Project Statistics

Subregion	Village	Projected Annual Energy Cost - Before	Projected Annual Energy Cost - After	Heating System Loss Cost - Before	Heating System Loss Cost - After	Value of Overall Project Savings	Value of Annual Heating Savings
Lower Kuskokwim	Akiachak	$201,924	$131,217	$48,469	$17,380	$70,707	$31,089
Interior Rivers	Upper Kalskag	$111,716	$91,183	$25,088	$14,610	$13,713	$7,633
Lower Yukon	Russian Mission	$165,922	$128,469	$33,002	$15,725	$37,453	$17,277
Lower Yukon	Saint Mary's	$151,309	$106,991	$37,245	$13,638	$44,318	$23,607

Source: AHFC, Association of Alaska Housing Authorities, 2014

Remaining Residential EE&C Savings Opportunities. Residential weatherization measures already completed account for over 124,913 MMBTU (One thousand thousand British Thermal Units) annually in energy savings, nearly 900,000 gallons of heating fuel oil per year, and $6.1 million in avoided fuel costs for the region (Table 12). If the remaining energy inefficient housing stock is upgraded or rebuilt in some cases, the savings from residential EE&C could save another 235,000 MMBTU per year. This would save an additional 1.7 million gallons of heating oil and over $11 million annually in avoided fuel costs. This does not include savings from lighting or appliance upgrades or other measures that reduce electrical use (or diesel used to generate electricity).

Table 12: Estimated Energy Savings and Potential Energy Savings from Residential EE&C

	EE&C Savings Achieved				EE&C Savings Opportunity			
Subregion	**Occupied Housing Units (2010)**	**Annual Energy Savings (MMBTU)**	**Annual Diesel Savings (Gallons)**	**Annual Fuel Cost Savings ($ millions)**	**Remaining Residential EE&C Opportunity**	**Annual Energy Savings (MMBTU)**	**Annual Diesel Savings (Gallons)**	**Annual Fuel Cost Savings ($ millions)**
Interior Rivers	467	14,967	107,460	$0.74 mil	59%	13,851	99,451	$0.7 mil
Lower Kuskokwim	3827	69,285	497,463	$3.4 mil	72%	149,228	1,071,454	$7.4 mil
Lower Yukon	1714	40,662	291,953	$2.0 mil	68%	72,885	523,312	$3.4 mil
Total	**6008**	**124,913**	**896,877**	**$6.1 mil**	**70%**	**235,963**	**1,694,217**	**$11.6 mil**

Sources: (Ord, 2015) (Wiltse, 2014). Model assumptions: All non-BEES-certified, income-eligible homes are weatherized. Remaining owner-occupied homes participate in Home Energy Rebate program. Assumes average energy savings for region based on 2008-14 ARIS data. Assumes retail heating fuel costs for communities as of August 2014.

NON-RESIDENTIAL BUILDINGS AND PUBLIC FACILITIES

Inventories of non-residential buildings and other public facilities in rural Alaska tend to be nonexistent or incomplete. Filling in the following data gaps would allow a regional EE&C strategy to be designed that targets public investment and educational messaging to maximize energy savings.

- NON-RESIDENTIAL BUILDING INVENTORY. While there is limited data on non-residential building stock in rural Alaska, there is data on how different types of non-residential buildings behave in different climate zones that could be used to model non-residential energy consumption in the YK Delta Region. A small inventory project to collect information on the number, type and size of public and commercial buildings in each community could be used to identify and prioritize public and commercial EE&C opportunities and strategies. An initial list based on secondary data sources is presented in each community's energy profile.
- STREET LIGHTING INVENTORY. It would be useful for regional planning to know the type and approximate number of street lights and other public outdoor lighting in each community. An initial inventory of retrofits based on secondary data sources is presented in each community's energy profile.
- WATER AND SEWER ENERGY USE AND HEAT RECOVERY STATUS. In order to identify the highest priorities on a regional basis for efficiency upgrades to community sanitation systems, it is necessary to understand current energy use and know which communities already have heat recovery systems that serve sanitation facilities or have the potential to do so. With the audits completed by ANTHC in the region, this process has been started, but more needs to be done.
- SATURATION RATES FOR SPECIFIC EE&C MEASURES. Knowing which consumer energy efficiency investments (programmable thermostats, efficient water heaters, other appliances and lighting) and energy conservation behaviors (setting back thermostats, turning off lights, powering off electronics), etc. have already been widely adopted and which still provide significant opportunity allows for strategically targeted investments.

Savings from efficiency improvements to non-residential public buildings average 20% per building statewide. Though there is variation based on building type, the potential statewide annual savings with over 5,000 publicly owned buildings would exceed $125,000,000 (Waterman, 2015).

Non-residential Buildings Audits. Both AHFC and AEA completed commercial energy audits in the region. AHFC funded 327 audits statewide in 2011 and 2012 through the Retrofit Energy Assessment for Loan Program (REAL), including audits of 27 public buildings in the YK Delta Region. Since the public funds cover the cost of the audits

only — not the cost of retrofits — it is not known how many recommended measures have been implemented by building owners. Statewide, AHFC estimates that few retrofits have been implemented to date (Waterman, 2014).

AEA's Commercial Building Energy Audit program funds audits for commercial buildings; over half of the audits funded in 2013 were in non-railbelt communities (Alaska Energy Authority, 2014). Only 13 businesses in the YK Delta Region received Commercial Energy Audits. As with other non-residential EE&C programs, the program only covers the cost of the audit (it does not reimburse owners for building improvements). It is not known how many of the recommended improvements are made. Loan programs for commercial building energy efficiency improvements are currently available through DCCED and AIDEA.

Table 13: Non-residential Facility and Infrastructure Energy Efficiency Upgrades

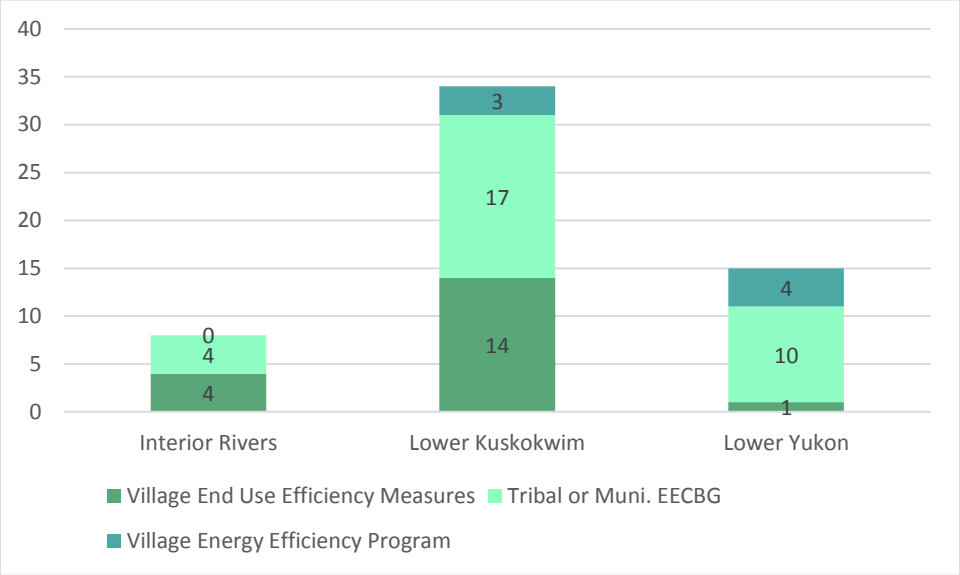
Subregion	AHFC Community Facility Audits	AEA Commercial Building Energy Audits
Interior Rivers	6	1
Lower Kuskokwim	15	7
Lower Yukon	6	5
Total	**27**	**13**

Source: (Alaska Energy Authority, 2013) (Alaska Energy Authority, 2014)

Non-Residential EE&C Programs. Several programs have been funded EE&C energy improvements for non-residential units. AEA's Village Energy Efficiency Program (VEEP), which began as the Village End Use Efficiency Measures (VEUEM) Program in 2005 with funding from the Denali Commission, offers a resource to small communities wishing to make significant progress on energy efficiency with real, recurring annual savings. Measures implemented under VEUEM were primarily lighting upgrades and some weatherization. Between 2005 and 2009, 19 communities in the YK Delta Region and 49 communities statewide participated.

Between 2010 and 2012, the American Recovery and Reinvestment Act (ARRA) funded energy efficiency improvement projects in an additional 118 Alaska communities through the Small Cities Energy Efficiency Community Block grant (EECBG) and VEEP programs. In 2013, AEA codified regulations for VEEP. During open application periods, communities with a population less than 8,000 could apply for the competitive grants. The last round of VEEP funding was for FY14 and was very competitive (Alaska Energy Authority, 2014). Funding for the next round of VEEP is not yet certain, as this program is funded yearly by the Alaska legislature.

Exhibit 16: Participating Communities in Village Energy Efficiency Upgrade Programs



Sources: (Alaska Energy Authority, 2013); (Alaska Native Tribal Health Consortium, 2014); (Alaska Energy Authority, 2014)

Estimating Remaining Non-residential EE&C Savings Opportunity. The lack of data on public and commercial buildings (including number, type, and square footage) in the region makes it difficult to estimate non-residential energy savings potential. In addition, most local governments operate multiple facilities and purchase fuel for a variety of buildings and vehicles. They do not usually account for individual building energy use, and fuel metering is rare. This makes it difficult to understand current energy use in public buildings and limits the accuracy of the community-reported data used in many audits. Though data are often unavailable on public and commercial buildings, an estimate for the savings potential is shown in the table below. This is based on behavioral changes (such as setting back thermostats) by building managers and occupants as well as efficiency and conservation retrofits identified in building energy audits.

Table 14: Savings Potential for Public and Commercial Facilities

Make All Behavioral Changes	Make the Most Cost-Effective Changes	Do All EE&C Recommendations
10-15% Savings	15-25% Savings	25-35% Savings

Source: (Waterman, 2014)

Energy Efficient Lighting

Indoor Lighting Retrofits - Electrical efficiency measures such as lighting retrofits generally have shorter payback periods than other building efficiency measures. The five communities in the YK Delta Region that included interior or exterior energy efficient lighting upgrades as part of VEEP and EECBG-funded projects are saving nearly $10,000 per year (Alaska Energy Authority, 2013).

Table 15: Savings from Energy Efficient Lighting Upgrades in Small Communities

Type of facility	One-time Investment	Annual Savings	Annual Electricity Saved (kWh)	Average Simple Payback Period
Average per Community	$53,579	$9,584	20,480	5.6 years
Average per Building	$5,898	$1,138	2,395	
Total	**$267,896**	**$47,921**	**102,400**	

Source: (Alaska Energy Authority, 2013). Based on lighting upgrades completed with VEEP and EECGB grants through 2013.

Street Lighting - At least four communities in the region funded street lighting upgrades through their VEEP or EECBG grants (Goodnews Bay, Kotlik, Newtok and Pilot Station). The communities are saving an average of nearly $4,000 annually for an investment of just over $40,000. If not grant-funded, the projects would have had a 10- to 11-year simple payback. Collectively, they are saving the region 55,000 kWh in electricity (Alaska Energy Authority, 2013).

WATER AND SEWER ENERGY EFFICIENCY

Sanitation systems are one of the single largest energy users in rural communities, accounting for 10% to 35% of a community's energy use. ANTHC performed energy audits of public facilities in small communities as part of its study of energy use in rural Alaska sanitation systems. Table 16 shows average cost and savings by Subregion based on audits of water systems in a total of 19 communities in the YK Delta Region.

Table 16: Estimated Average Savings Potential from Water and Sewer EE

Subregion	Systems Audited	One Time Investment	Annual Average Savings Opportunity			Average Simple Payback (years)
			Electricity Savings (kWhs)	Diesel Savings (Gallons)	Cost Savings ($)	
Interior Rivers	2	$82,025	7,281	1,681	$21,968	6.4
Lower Kuskokwim	11*	$37,492	8,803	1,778	$11,679	2.9
Lower Yukon	6*	$50,716	35,164	2,071	$30,565	1.9
Region Average		**$46,355**	**16,967**	**1,860**	**$18,726**	**2.9**
* Four audits removed from analysis because waters system not treated separately from additional buildings or EE upgrade not economically viable.						

Source: (Dixon, 2014)

According to ANTHC officials, the state does not currently have a good mechanism for funding energy efficiency projects in sanitation facilities. To date, no water and sewer utilities have been successful in using the AHFC Energy Efficiency Revolving Loan Fund to help alleviate this issue. Communities that have completed retrofits have largely done so with nontraditional funding sources (Dixon et al., 2013).

Tracking Energy Efficiency

Energy efficiency technology is advancing at a rapid pace, with the government teaming with universities, national laboratories and industry to advance research, development, and commercialization of energy efficient and cost-effective building technologies. One way to promote energy efficiency is through better tracking of energy use. Below are several means of tracking energy use.

Individual meter units. Single outlet kilowatt monitors connect to appliances and assess efficiency of energy consumption by the kilowatt-hour. These units can monitor electricity consumption and expenses by the day, week, month, or year. By gaining awareness of consumption, the user can implement energy efficiency measures.

TED meters. "The Energy Detective" meter (TED) teaches energy efficiency and awareness through providing feedback on electrical energy usage. Studies have shown that an average of 20% can be saved on electric bills with the TED device. A "smart" energy meter placed within households allows homeowners to monitor energy usage and predict monthly electric cost. The TED meter shows energy use in real time and also warns when the power cost equalization (PCE) limit has been reached (500 kWh), the point at which the cost dramatically increases. The average TED user decreases their electricity bill by 5 to 30% when using these meters.

SmartGrid. "Smart grid" generally refers to a class of technology that uses computer-based remote control and automation to reduce electrical costs. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. Similar to the concept of a 'smart' phone containing a computer, a" smart grid "means "computerizing" the electric utility grid. It includes adding two-way digital communication technology to devices associated with the grid (DOE). These smart grid upgrades add four features to the existing grid:

1. Upgrade power meters with smart meters, which have two-way communication capability – allowing the utility to retrieve data remotely, as well as disconnect or limit customers' electrical consumption for non-payment.
2. Install IHD (In Home Display) units that allow in-home displays of current electricity usage – kWh/day, kWh/week, kWh/month – bringing customer awareness of electric consumption.
3. Install smart distribution switches throughout the power grid to enable the utility to shut down small portions of the grid for repairs or upgrades instead of shutting down the entire grid.
4. Control usage by household and billing.

Benchmarking. Benchmarking serves as a valuable baseline tool to help owners understand if energy upgrades are effective. Baseline energy data for homes and public and commercial buildings are limited and not centrally available or analyzed. For individual homes, participation in the Home Energy Rebate or Weatherization program yields a significant amount of information on how energy is used and how energy use may be reduced. Energy audits by certified energy auditors contains detailed physical information about the structure and identifies low- or no-cost efficiency projects that can be undertaken in the short term to jump start conservation efforts.

- At the community or regional level, a public building inventory can be used to identify and prioritize public facility EE&C opportunities and develop an "EE&C Roadmap" for the community or region. Data can be collected using local labor and a standard input form. It should include, at a minimum, building type, age, square footage, fuel type, owner, occupancy, hours of operation and EE&C audit/renovation status. Additional data fields may include bulk fuel tank capacity and annual community fuel order by type, and the number and type of street lights or other public outdoor lighting. Data can be used to help verify statewide energy end use models and be used to develop a grant proposal for community or regional public facility EE&C upgrade projects.

- "Benchmarking" public and commercial buildings also benefits individual facility owners and managers by giving them the ability to see trends in a building's energy use and compare use and operating costs to other buildings. Owners can benchmark their facility by completing the REAL Benchmark Form at: http://www.ahfc.us/efficiency/research-information-center/energy-efficiency-public-facilities/.

Energy Efficiency Technology

There are ways that utilities can use technology to improve energy efficiency such as the following:

***Microgrid*.** Microgrid power systems are small-scale power generation solutions consisting of local power generating facilities and individual homes and buildings equipped with wind and solar power systems. This type of distributed power generation is a low-cost alternative to large-scale systems.

Microturbines. Microturbines generate both electric and thermal energy. Using both maximizes efficiency and minimizes a facility's energy bills. Using both energy outputs is called cogeneration or combined heat and power (CHP). Onsite CHP is far more fuel efficient and environmentally beneficial than utility power and traditional boiler methods. The system lowers a facility's demand on utility power and dramatically cuts monthly power bills.

In addition to burning liquid fuels such as diesel, kerosene, jet fuel, and liquid bio fuels, microturbines can burn almost any carbon-based gaseous fuel: natural gas, propane, methane, and other waste gases to create renewable power and heat. Waste material buried in landfills biodegrades over time to produce methane, carbon dioxide, and other gases. Treatment of domestic wastewater, agricultural waste and food processing waste using anaerobic digestion also produces methane and other gases. Many sites flare these waste gases; or worse yet, vent them directly into the atmosphere. Methane has a greenhouse gas impact on the atmosphere that is 21 times that of carbon dioxide, and burning methane in a flare completely wastes its energy value (Capstone Microturbines). Microturbines provide a means to capture and reuse these waste products.

***Fuel Additives*.** Fuel additive products can help maximize vehicle fuel efficiency and help to avoid problems such as rough idling, weak acceleration, stumbling and stalling. Fuel additives have lower emissions and therefore reduce toxic pollutants including nitrogen oxide, improving air quality. Prudhoe Bay Service Area 10 (SA-10) has reduced vehicle fuel consumption by 10-15% efficiency by using fuel additives in their vehicles.

Heat Recovery. Even when electrical generators operate at maximum efficiency, 60% of all energy in the diesel fuel will be released as heat. The waste jacket heat can be run through a heat exchanger that transfers the heat to a heat loop that can warm nearby buildings. This process can recover 10 to 20% of the energy in the fuel. The heat can be measured and, if a heat sales contract is developed, sold to consumers, providing another revenue source for the utility.

The heat expelled in the exhaust is more difficult to capture — cooling the exhaust causes sulfuric acid to develop and can cause other operational issues with the engine. Low sulfur diesel and other technologies may help limit these issues (YourCleanEnergy, November 2013).

While excess or waste heat is primarily a byproduct of diesel generation, heat can be harnessed from hydro plants or wind farms in situations where there is excess power (e.g. water going over the spillway) that can be used as a dump load to power an electric heater.

In the YK Delta Region, 51% of the communities have active heat recovery systems and another 5 communities have heat recovery systems under construction. The vast majority of these heat recovery systems are waste heat collected from diesel generators serving the power plant or nearby water system, clinic, community store, or school. Though over half of the communities have heat recovery, there is no question that additional opportunities exist both in terms of installing new or additional heat recovery systems in diesel generator powerhouses and expanding the number of buildings and facilities accessing the recovered heat. A full listing of the heat recovery systems and heat recovery potential is found in each community's energy profile.

Interties. One means of reducing the cost of energy production is to share expenses and resources across a cluster of communities. In the YK Delta Region, long distances and difficult terrain often separate communities. Currently, there are interties connecting six groups of communities all of which, with one exception, are part of AVEC.

Table 17 Interties in the YK Delta Region

Communities connected via intertie	Utility
Bethel - Oscarville - Napakiak	AVEC , Napakiak Inricaq Power
Emmonak - Alakanuk	AVEC,
Kasigluk - Nunapitchuk	AVEC
St. Mary's - Pitka's Point	AVEC
Toksook Bay - Nightmute - Tununak	AVEC
Lower Kalskag - Upper Kalskag	AVEC

Source: (AVEC, 2014)

The Alaska Center for Energy and Power (ACEP) is engaged in a High Voltage Direct Current (HVDC) transmission project to "assess and demonstrate the technical and financial feasibility of low-cost small-scale HVDC interties for rural Alaska." The objective is to demonstrate that small-scale HVDC interties are technically viable and can achieve significant cost savings compared to the three-phase AC interties proposed between Alaskan villages. Because these AC interties are very costly to construct and maintain, very few have been built in Alaska. As a result, most villages remain electrically isolated from one another, which duplicates energy infrastructure and contributes to the very high cost of electricity. HVDC technology has the potential to significantly reduce the cost of remote Alaskan interties, reducing the costs to interconnect remote villages and/or develop local energy resources (ACEP, 2014).

3.2 REGIONAL ENERGY PRIORITIES

The following table contains regional energy priorities. The regional projects were identified through research of existing documents, interviews and discussions with officials and stakeholders. They are broken down into the following time tables:

- Immediate projects which are currently underway or expected to begin in the next 12 months;
- Short range, expected to start within 1-5 years;
- Medium range projects expected to take place between 5-10 years; and
- Long range projects which are expected to occur beyond 10 years and can be more speculative in nature.

The YK Delta Energy Advisory Committee, established to champion energy efforts in the region, will be a crucial means of monitoring progress on implementation of these priorities. The committee should establish performance measures for individual projects, and perform consistent monitoring and evaluation to assess the success of each effort.

Table 18: Regional Energy Priorities

Timeframe	Project Name
Energy Efficiency and Conservation	
Immediate 0-1 year	■ *Conduct community outreach and educational energy fairs.*
	■ *Collaborate with AVCP, CCHRC and other sustainable building specialists to identify energy-efficient, climate appropriate structures.*
	■ *Encourage bidders on all new facilities to research and present at least one demonstration energy conservation feature, system or material application.*
	■ *Identify energy conservation strategies for public and private structures and vehicles.*
	■ *Educate energy users on how their actions impact energy consumption.*
Short 1-5 years	■ *Assess current infrastructure and develop a plan to build, upgrade, retrofit, or redesign systems for current environmental and climate settings.*

Timeframe	Project Name
	■ *Conduct energy audits and complete recommendations on residential and public buildings.*
	■ *Implement RurAL CAP Energywise Program in each village.*
	■ *Integrate AkSmart Energy curriculum in schools.*
	■ *Install metering systems, such as TED and smart meter grids, to track and collect energy production, consumption and cost.*
	■ *Develop and maintain matrix showing current cost of energy.*
	■ *Conduct study to determine actual space heating costs.*
	■ *Lobby for a statewide building code that emphasizes sound energy efficient construction.*
	■ *Design and construct energy-efficient, climate appropriate structures.*
	■ *Complete energy audits on public buildings and implement recommendations.*
Medium 5-10 years	■ *Establish additional interties where practical.*
Maintenance and Operations	
Immediate 0-1 year	■ *Train employees for new systems, including water and sewer, housing and power generation.*
Short 1-5 years	■ *Demolish, remove, and clean up out of service fuel tanks.*
	■ *Install system to electronically manage fuel tanks most efficiently.*
	■ *Upgrade fuel tanks for safety and capacity.*
Planning	
Short 1-5 years	■ *Adopt an energy element into local and regional comprehensive plans that agrees with the local and regional energy plans.*
	■ *Maintain an ongoing YK Delta energy committee to monitor energy projects and support funding requests.*
	■ *Incorporate energy into local, regional, state and federal planning and CIP processes.*
	■ *Coordinate with Land Management agencies early in the process and seek solutions that are acceptable to all.*
Medium 5-10 years	■ *Update the Yukon-Kuskokwim Delta Regional Energy Plan on a regular basis.*

Energy Financing	
Immediate 0-1 year	■ *Develop a strategy for educating legislators about the region and challenges with energy in the YK Delta Region.* ■ *Invite legislators to the region to learn first-hand about the energy needs in the region.*
Short 1-5 years	■ *Analyze current electrical costs and rates and consider ways to increase PCE subsidy rates to reflect electrical usage.*
	■ *Provide incentives for bill payment through education and energy efficiency measures that reduce monthly bills.*
	■ *Seek funding to implement recommendations from existing energy audits and for additional energy audits and improvements.*
	■ *Calculate life-cycle energy costs for water and sewer systems, infrastructure, housing and power generation.*
	■ *Develop and implement a comprehensive financial strategy for maximizing energy funding.*
	■ *Seek funding for long term solutions and lobby legislators about the benefit of long term investments.*
	■ *Seek Federal and State agency assistance for energy planning, project implementation and management efforts, including a full range of grants and technical assistance with collaborative funding.*
Energy Infrastructure	
Short 1-5 years	■ *Reassess current failing systems (such as water and sewer), and redesign for environmental and energy efficiency as needed.*
	■ *Upgrade electric metering.*
Medium 5-10 years	■ *Upgrade to more efficient street lighting across the YK Delta Region.*
	■ *Redesign and upgrade power plants to capture renewable energy.*
	■ *Upgrade village power distribution grids.*
Long >10 years	■ *Construct Portage Mountain Corridor.*
	■ *Bring natural gas to the YK Delta Region.*

The timing of these projects reflects an aggressive move toward improved energy efficiency in the region in the near term. While it is an ambitious list, responsibility for completion will be spread out among numerous local governmental agencies, state agencies and utilities. Longer term, the focus of the YK Delta Energy Advisory Committee should be on consistent monitoring to ensure that these projects are funded and completed.

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CHAPTER 4
COMMUNITY AND ENERGY PROFILES

COMMUNITY AND ENERGY PROFILES

This chapter provides an overview of each community, their energy use, and available energy resources.

The following section contains a community and energy profile for each of the communities in the YK Delta Region.

The community profiles contain general information about the location, economy, historical and cultural resources, planning, demographics, contacts and infrastructure. It is intended to provide an overview of the community and to give context to the energy profile.

The energy profiles for each community provide an overview of energy production and distribution. It is intended to provide a snapshot of local energy conditions. In addition, the energy profiles include information about AEA and DOE's Energy Efficiency Community Block Grants and Village Energy Efficiency Program (VEEP) program that funded energy efficiency improvements. Also included is information about the 2010 AHFC audits. These energy grade audits detail improvements that could be made to make buildings more energy efficient.

The Subregional areas are broken down as follows:

Lower Kuskokwim Subregion

Akiachak, Akiak, Atmautluak, Bethel, Chefornak, Eek, Goodnews Bay, Kasigluk, Kipnuk, Kongiganak, Kwethluk, Kwigillingok, Mekoryuk, Napakiak, Napaskiak, Newtok, Nightmute, Nunapitchuk, Oscarville, Platinum, Quinhagak, Toksook Bay, Tuluksak, Tuntutuliak, Tununak

Lower Yukon Subregion

Alakanuk, Chevak, Emmonak, Hooper Bay, Kotlik, Marshall, Mountain Village, Nunam Iqua, Pilot Station, Pitkas Point, Russian Mission, Saint Mary's, Scammon Bay

Interior Rivers Subregion

Aniak, Chuathbaluk, Crooked Creek, Lime Village, Lower Kalskag, Red Devil, Sleetmute, Stony River, Upper Kalskag

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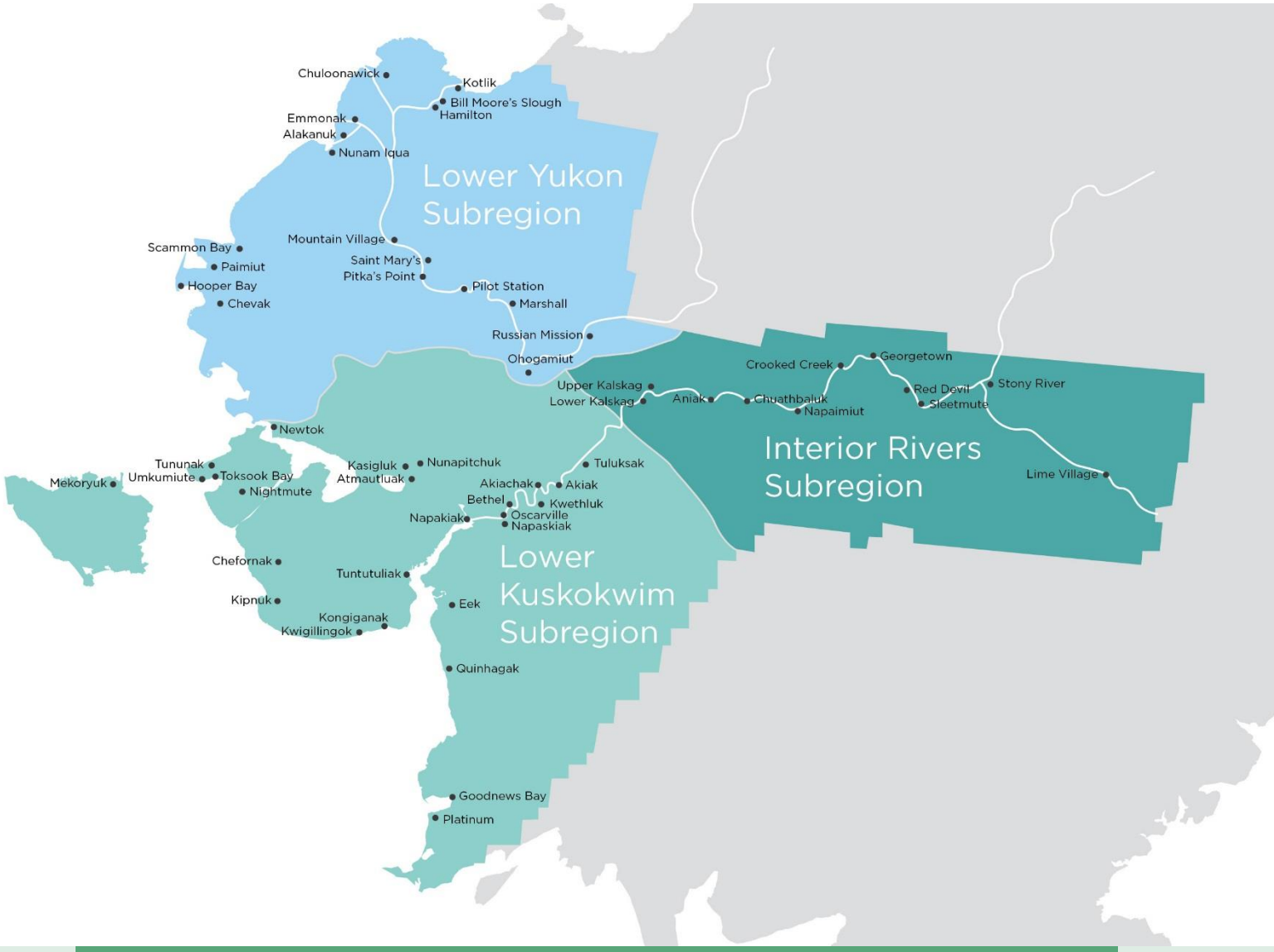

4.1 LOWER KUSKOKWIM SUBREGION

Akiachak, Akiak, Atmautluak, Bethel, Chefornak, Eek, Goodnews Bay, Kasigluk, Kipnuk, Kongiganak, Kwethluk, Kwigillingok, Mekoryuk, Napakiak, Napaskiak, Newtok, Nightmute, Nunapitchuk, Oscarville, Platinum, Quinhagak, Toksook Bay, Tuluksak, Tuntutuliak, Tununak

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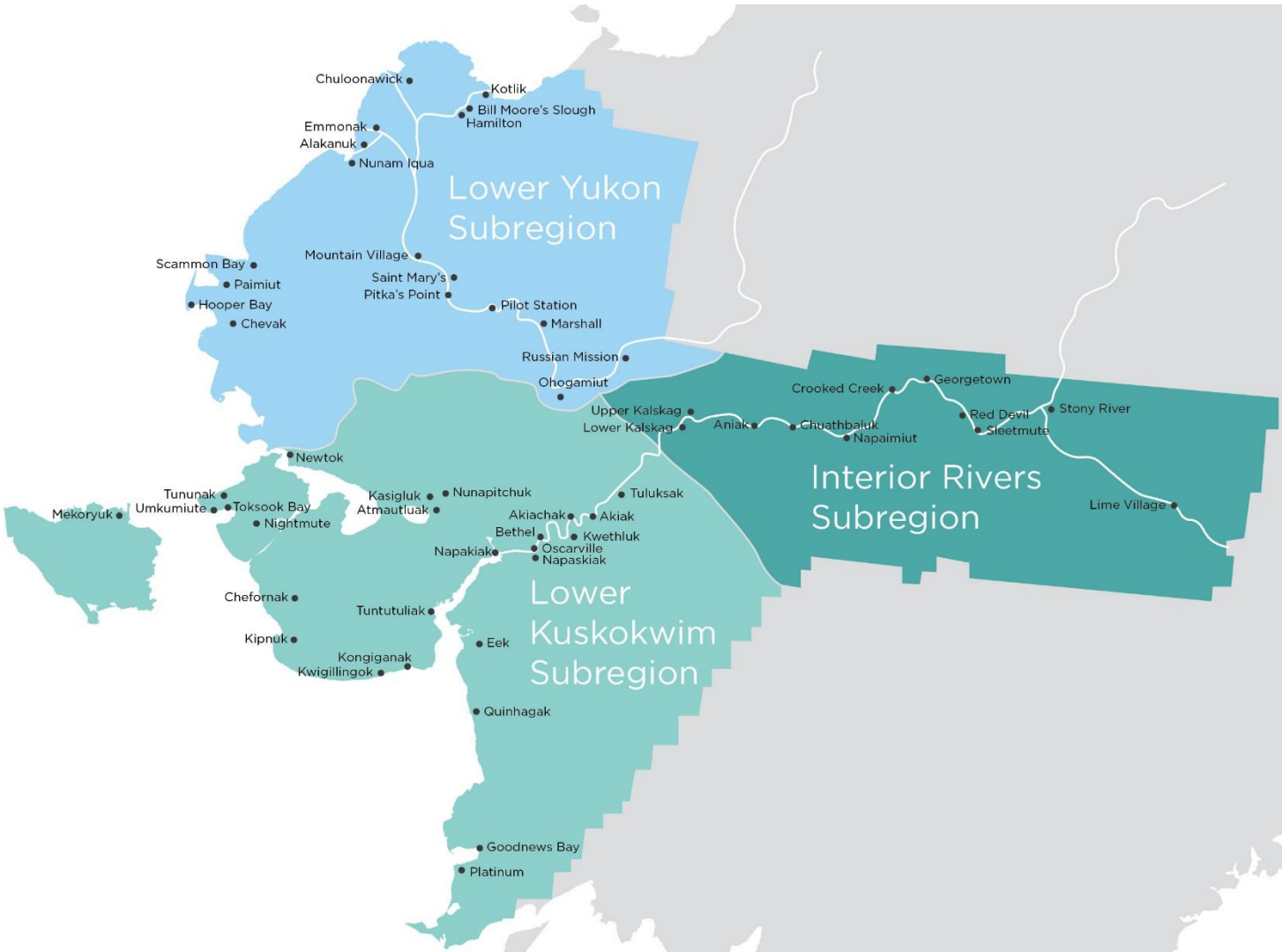

4.2 LOWER YUKON SUBREGION

Alakanuk, Chevak, Emmonak, Hooper Bay, Kotlik, Marshall, Mountain Village, Nunam Iqua, Pilot Station, Pitkas Point, Russian Mission, Saint Mary's, Scammon Bay

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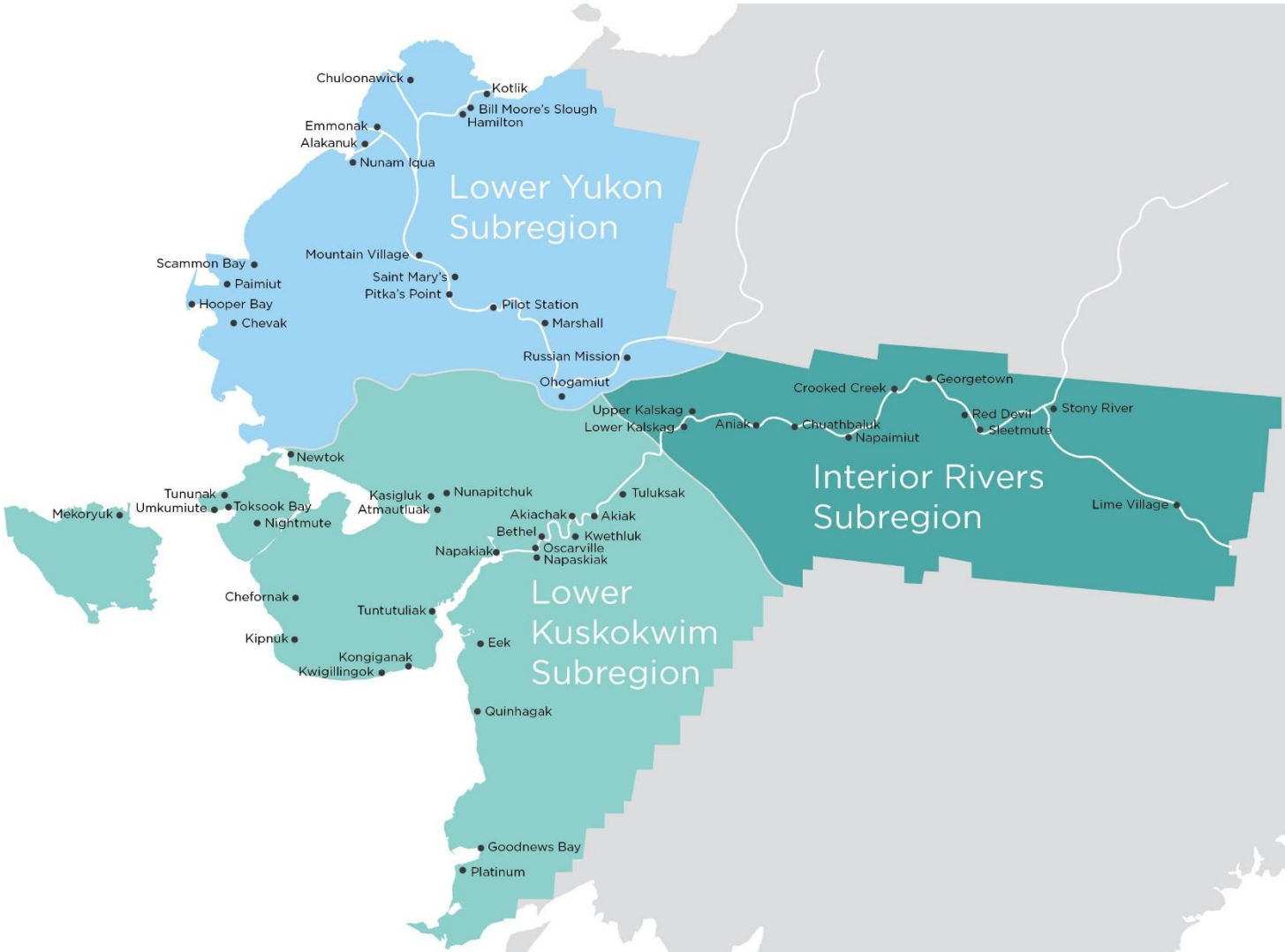

4.3 INTERIOR RIVERS SUBREGION

Aniak, Chuathbaluk, Crooked Creek, Lime Village, Lower Kalskag, Red Devil, Sleetmute, Stony River, Upper Kalskag

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CHAPTER 5

COMMUNITY OUTREACH

COMMUNITY OUTREACH

This chapter provides feedback obtained from sub-regional outreach meetings.

5 COMMUNITY OUTREACH

5.1 COMMUNITY OUTREACH

Community meetings were held in 12 sub-regional communities in the YK Delta region to engage local leadership and community members in the planning process. This allowed for guidance in the grassroots approach to the energy planning process. The chart below shows the dates of the Community Outreach meetings, as well as engaged agencies and entities which participated in this process, and issues brought up by residents of each community.

Residents and other stakeholders were given opportunity to voice their opinions both orally in the meetings and in writing via comment forms. Comments spanned a broad range of topics related to energy and planners used the feedback to be sure that each area of concern was addressed in the plan. The comments on the following page provide a representative sample of the feedback received from across the study area.

Table 19: Community Meetings and Participants

COMMUNITY	ORGANIZATIONS ATTENDED	COMMUNITY ISSUES
Quinhagak **8/3/2015**	City of Quinhagak, Native Village of Quinhagak, AVCP Headstart, Qanirtuuq, Inc., ANTHC, Nuvista, AEA, WHPacific, Moravian Church, AVEC,	2010 study on water source showed lower limits – based off tide schedule – lower water Dock issues being assessed for improvement Landfill and sewage lagoon being tracked – these both need to be fully assessed Climate change issues include lack of winter snow fall – causing less run off affects commercial fishing costs Brownouts happen often – need power upgrades Cost of transportation is too high Identify a “local energy champion”: education and awareness, data collection, work with community and councils to become more “energy wise” Want longer runway with new surface More Energy Efficiency education: energy fairs, school presentation, council meetings 55 old homes that need to be demolished – cannot be weatherized, expensive to heat Would like to see actual savings (and understand) cost savings and how they are passed down to consumers Nuvista notes: Willard Church: Cultural impacts due to high cost of energy. Too expensive to gather and hunt. Folks are resorting to store bought foods. Transportation costs keeps the cost of groceries high, having a direct impact to the people. Erosion is causing issues for the landfill and sewage lagoon – which are getting too close due to tide water levels. More transparency in operations costs. Have technology to incorporate efficiency measures for projects. How can structures be “self-sustaining”? Warren Jones: Funding for implementation of energy audit recommendations. Would share energy audits with Nuvista. Grace Hill: Expense for lighting the grocery store too high.

		Tracy Pleasant: Energy audit funding is not there for implementation of recommendations. Anna Sattler: AVEC will send updates for energy profile and renewable energy info. Need to raise PCE to 700 kWh per month, instead of the current 500 kWh.
Aniak **8/19/2015**	WHPacific, AEA, Nuvista, AVEC, Aniak Light and Power, Aniak Traditional Council, City Council, City of Aniak, Aniak Tribe, OCS	High reconnect fee for light and power - $500.00 each time Bad power – people don't want to pay because of outages, fluctuations, etc. Lack of housing – fix issue at AVCP RHA. Credit keeps people from getting homes. Food Bank needed - several people in between $ for food stamps, not enough for whole family, elders, and children Sewer Costs too high – Elders and large families cannot afford running water. Elementary School is too old. Smells bad, like fuel. Kids get asthma. Light & Power needs help – never able to help with community, too fast to cut off, hard to work with.
Bethel **8/27/2015**	Calista, WHPacific, Inc., AEA, OWC, YKHC, City of Bethel, Delta Discovery, BCSF, Alaska Dispatch News, AVCP	Inadequate and too expensive, lack of E/E education and measures, AHFC HERP helps but is too expensive to participate in because of upfront costs. Would like to know more about housing programs available. AVCP/CCHRC homes are great (Brent Latham from AVCP shared information about costs and construction. Low hanging fruit is E/E – needs more information and integration. 40% overcrowding. 3,000-4,000 homes need to be replaced. Encouraged more partnerships like AVCP/CCHRC. Water and Sewer issues: Piped, Honey Bucket, Haul System (City) (metered water). Needs new sewage lagoon – lots of work. ANTHC/City have applied for USDA-RD grant for lagoon. Would like to learn more about Scandinavian designs – filters differently. Fuel Cost issues: Crowley has monopoly – would like lower costs $7.00/gal diesel $6.00/gal for gasoline What about a bulk fuel programs for the whole region? Or the state? Wind helps with pool costs – solar seems too expensive, alternative energy costs too high. Hydro (run of the river system?) Check if study was done Natural Gas – is this an option? Needs more upgrades on E/E – both systems and housing Biomass – 25-30% use wood stoves in town. Want new boilers in old homes – toyo stoves? Home heating costs range from 400-500 gallons of diesel per month Folks have to choose between food or fuel – poor folks hit the worse
Hooper Bay **9/2/2015**	WHPacific, Nuvista, AEA, UAF/KUC, NVHPB	Bulk fuel tank farm study (AEA?) Have purchased fuel off foreign ships to get better price CVRF heating subsidy $200/year Housing: Drafty homes, electric heaters used when no money for fuel. Would like

		different houses. Blueberry Subdivision house uses 6 gallons of stove oil in 3 days. Overcrowding – tribe states over 200 more folks who live in Anchorage want to move back. 2-3 bedroom homes house 8-10 people. Old boilers in homes. Poor lighting. Want more E/E homes. People try to fix them up and cause mold and air quality issues. Multiple generations living together. Some homes could not be worked on due to current condition of structure. Major ventilation issues. Needs more housing education. 30% believe they have clean water – 70% get water from different watering points – lakes, rainwater, etc. Water issues: $85/month is hard for folks. Fuel Storage issues: would like to consolidate to save money 95% use wood stoves for heat. Lack of wood. No biomass or forestry studies/inventory done. Climate Change: used to get NW winds, now they are SW (less wood) Price of fuel is too high – never goes down even when Anchorage does. Some use electric cook stoves. $6.52/gallon diesel, $6.36/gallon gasoline
Lower Kalskag **8/19/2015**	WHPacific, Nuvista, AEA, Village of Lower Kalskag, Kalskag Bulk Fuel, Village of Kalskag, City of Upper Kalskag	Lower Kalskag has no street lights, but would like some. Energy education and awareness Housing issues: heat loss is very high (drafty), ventilation is poor in over 50% of all houses and they have old furnaces that need replacing Water & Sewer issues: too expensive, poor quality of water (maybe need new water source), climate change has affected snow melt off. Lower Kalskag is working with ANTHC on water and sewer. Climate Change issues: foundations are shifting due to permafrost melting, this causes housing issues Fuel prices: $6.25 gas diesel Biomass: residential use is around 50% on wood stoves. Cord of wood costs $300.00 Weatherization concerns: folks not happy with the current weatherization. Lower quality materials does not improve the home, but makes homes draftier on the outlets entrances, windows and doors. Would like to see better energy efficiency and better lighting (old fluorescent).
Upper Kalskag **8/19/2015**	WHPacific, Nuvista, AEA, Village of Lower Kalskag, Kalskag Bulk Fuel, Village of Kalskag, City of Upper Kalskag	(Upper) Kalskag has LED street lights but does not receive PCE for them and some of the buildings. Energy education and awareness Housing issues: heat loss is very high (drafty), ventilation is poor in over 50% of all houses and they have old furnaces that need replacing Water & Sewer issues: too expensive, poor quality of water (maybe need new water source), climate change has affected snow melt off. (Upper) Kalskag has 50% on honey buckets. Climate Change issues: foundations are shifting due to permafrost melting, this causes housing issues Fuel prices: $6.25 gas diesel Biomass: residential use is around 50% on wood stoves. Cord of wood costs $300.00 Weatherization concerns: folks not happy with the current weatherization. Lower

		quality materials does not improve the home, but makes homes draftier on the outlets entrances, windows and doors. Would like to see better energy efficiency and better lighting (old fluorescent).
Saint Mary's **9/15/2015**	WHPacific, Nuvista, AEA, AVEC, Kwethluk IRA, AVCP, Kwethluk, Inc., City of Kwethluk,	Needs vocational training lacking on Lower Yukon Water and Sewer issues: Heat trace uses lots of electricity Wx issues: AVCP-RHA doesn't come often and old housing stock lacks energy efficiency, homes are drafty when wind blows 90% use Biomass – but wood stoves are cheap quality – most wood used is driftwood. No inventory or study done Some use solar at fish camp – why not in town? AVEC has wind at Pitkas Point – can it power Mt. Village and Saint Mary's? Water Plant issues: 50% of City's utility bill – way too high to sustain a budget Would like Energy Efficiency classes for all community members Fuel costs too high: $7.90/gallon for diesel and $7.01/gallon for gasoline. City has purchase agreement with Ruby Marine. Would like to see State of Alaska do a bulk fuel purchase for ALL rural communities to lower fuel costs. Would like more energy audits and retrofits on ALL buildings (both residential and commercial) Water and Sewer costs $124/mo. – 12 on honey buckets, rest on piped Notes: Only fresh water port on the Yukon 100 lots on Mission property – would like to see development
Kwigillingok **8/13/2015**	WHPacific, Nuvista, AEA, AVEC	Local Barriers: Lack of collaboration, policy barriers for tribal entity, lack of oversight on grants. Village won't sign waiver of sovereign immunity – causing stall in funding for upgrades to distribution system Would like new clean energy system upgrades on power distribution, electrical, heat, transportation The power distribution system is over 20 years old and needs upgrading – turns on/off all the time creating brown outs Transportation costs are too high Lack of Energy Education for community and school – would like to see more integrated programs Would like an intertie assessment – consolidating would lower costs Land issues create barriers for Weatherization and E/E program upgrades Weatherization program ineffective – doesn't seem to help – lots of health issues due to mold (poor ventilation) especially in the old AVCP-RHA houses Some homes don't qualify for weatherization programs because of their current condition (too old and moldy) Would like to implement an energy efficiency appliance program (possibly a trade out) Educate local energy champion to help share information – Energy Fair at school? Lack of economic development Subsistence impact due to high fuel costs is substantial – getting too expensive to hunt New power plants in neighboring villages are working and tribe would like to see

		clean, renewable energy in Kwigillingok. (smart grids, cluster intertie, self-powered energy/Microgrid, need for environmental specific technology) Renewable energy doesn't always lower the costs – wind turbines raised the cost in 2014/15 Kwigillingok power lines impacted in winter – transformers break in high winds – affects security of community Heaters are electric – impacted by frequent power outages, some have wood stove back ups Demographic trends – Kwigillingok is growing and will need a larger power plant Limited access to back up generators – small scale back up plan would be nice Can Nuvista help with coastal village intertie? How far are the intertie routes? Tuntutuliak, Kongiganak, Kwigillingok, and Kipnuk (can these be intertied?) Make refinery in Fairbanks and distribute fuel through pipeline.
Nunam Iqua **9/16/2015**	WHPacific, Nuvista, AEA	Housing issues: poor job with weather, some homes told were 5 star plus and are very cold, poor design, lack of local hire and input, replacement costs are very high, lowest bidder = cheapest quality, wasted heat from maqii might be used, chimney heat reclaimer should be discussed, overcrowding High Transportation costs: mostly flown in materials, limited access to materials due to lack of barges, fuel costs don't go down when Anchorage prices do Heat costs are higher than electricity and should be addressed. Water and Sewer: Some can't afford water and sewer bills, 98% on piped system, bad payment record, $180/month, poverty level for most folks, trace heat cost lots in winter – some let pipes freeze Wind: tribe is working on integrating wind with new power plant. Climate Change: wind direction changes – might mess up wind study because takes so long. Permafrost is melting – annual frost 4' is now at surface. Erosion and flood issues – village is moving slowly. Piling posts are not secure because they can't find the bottom, so they let the other posts support the lagging ones. Priorities of top 3 project are funded for roads (BIA). New school is 6 years old. Tidal action happens 2 times a day – would like a study on tidal energy Not sure about solar, but would like more information
Toksook Bay **8/14/2015**	WHPacific, Nuvista, AEA, AVEC, NYC/LKSD, NTC, City of Nightmute, OPA, CVRF, OOK	Overcrowding in homes Poor housing design – not energy efficient, not sound proof, drafty :: asked for a specific workshop to deal with housing issues Wx program by RurAL CAP needs improvement. Better training and pay for workers from village. Lack of education on energy systems – need better understanding ARUC (Water & Sewer Management) needs to be paid. 10% on honey buckets, rest on plumbed water and sewer Freeze ups are an issue – use trace heat in winter (higher electricity costs) Housing stock is very old – 10% needs to be demolished and new housing is needed Some foundations are rotted and sinking Need better appliances in homes - better efficiency Climate change is happening. Melting permafrost is sinking foundations and some

		floors have rot. Would like more E/E programs Diesel (stove oil) $7.50, gas $7.50 Would like residential wind/solar Would like electrical assessment on meters on homes
Tununak **8/14/2015**	WHPacific, Nuvista, AEA, AVEC, Native Village of Tununak, Tununrmiut Rinit Corporation, TNK	Electrical Assessment needed in whole village E/E for housing (cold and drafty) Wx program (RurAL CAP) 2008/2009 some were done very poorly, lower quality of materials High winds cause cold drafts in homes and issues with Toyo stoves (back draft) No help for the few that own their homes – only for those who have RHA homes or low-income W & S issues – VSW and Tribe tying to address this issue – 20 homes originally on piped, only 10 still on due to high cost of M & O. Clinic has flush toilet and water well, but dumps into the ocean. School has own system. School district has agreement to be watering point for community. Drinking water spring is 2 miles away. Washeteria has piped water from creek.
Kwethluk **8/27/2015**	Kwethluk IRA, AVCP, Kwethluk, Inc., City of Kwethluk, AEA, Nuvista, AVEC, WHPacific	Community discussed corrections to the profiles and made adjustments as needed.
Bethel **8/27/2015**	City of Bethel	City Manager, Ann Capela shared her thoughts on the City of Bethel's perspective of the energy issues in the city. The City of Bethel signed a land lease agreement with AVEC for $1/year for the installation of wind turbines. A waste to heat assessment is currently being done. Current heating costs are extremely high, especially to keep the pool heated. The City would love to look into alternatives to heat the pool. There is a lack of maintenance on the existing wind turbines, which causes folks to not believe they are the best choice for this climate. All the street lights were changed out to LED, but the poles are leased from AVEC. No recommendations were made from the 2012 AHFC energy audit done on the City Hall office, the court house and the City shop. There is a lack of climate consideration when designing for new construction. Funding is very difficult to get.

CHAPTER 6

IMPLEMENTATION PLAN

IMPLEMENTATION PLAN

This chapter provides funding information and a strategy for completing the energy priorities.

6 IMPLEMENTATION PLAN

6.1 REGIONAL PRIORITIES AND IMPLEMENTATION CHART

Regional priority energy actions were identified from the Community Outreach Meetings, stakeholder interviews, and input from the Strategic Advisory Group (SAG). The priorities were categorized into immediate (0-1 year), short term (1-5 years), medium term (5-10 years) and long term (over 10 years). Potential sources, opportunities, and constraints for energy project funding are presented in Table 18. The immediate needs project list is below in Table 20. These needs are seen as the projects that needs immediate attention.

Table 20: 2015 Regional Energy Priority Project List – Immediate Needs

Priority List	Projects	Specifics
Transportation	▪ Interties ▪ Air ▪ Barge	▪ Explore Subregional intertie availability ▪ Identify lower freight costs ▪ Identify low water barge landing areas
Bulk Fuel Buy-in	▪ Regional Tank Farm	▪ Encourage SOA to look at regional bulk fuel purchases
Education	▪ Conduct Energy Fairs ▪ Implement curriculum K-12 ▪ Educate legislators of current conditions	▪ Work with schools to host Energy Fairs ▪ Implement Ak Energy Smart K-12 curriculum ▪ Host visits to region to share conditions
Energy Efficiency	▪ Create standards for EE building science ▪ EE upgrades and retrofits on residential housing	▪ Work with policy makers to encourage EE standards in codes ▪ Collaborate with AVCP-RHA

The overarching energy vision for the YK Delta Region is to be leaders pioneering a "unified, creative approach to access abundant, affordable, efficient energy utilizing local resources", according to the energy vision created by the SAG. To achieve that end, potential projects were identified and prioritized. Each of the projects addresses issues or takes advantage of opportunities to improve the energy system and reduce energy costs. The projects have gone through initial screening recognizing that grant funding is becoming scarcer and there is a need to be creative and realistic about what can be accomplished in the 20 year planning horizon. It is important that analysis of existing wind, heat recovery, solar and other energy saving measures be done to provide lessons learned for future projects.

Table 21 below lists immediate, short, medium and long- term projects planned for implementation in the YK Delta region. The table includes a brief description or title of the project, if the project is ongoing or one recently identified by the SAG or others, what the next step is in developing the project and the status of the funding, as well as potential partners.

Table 21: Implementation Chart

PROJECTS	PROJECTS STATUS	NEXT STEPS	PARTNERS	FUNDING STATUS	Estimated Costs	Community
Energy Efficiency and Education						
Audit public purpose buildings and implement recommendations	Immediate 0-1 year	Inventory audits	AEA		TBD	All
Educate public in EE and conservation	Immediate 0-1 year	Conduct energy fairs Conduct energy classes Implement RurAL CAP Energywise type programs in each village Integrate AK Energy Smart curriculum in schools	Yute, AVCP, School Districts		TBD	All
Require bidders on all new facilities to research and present at least one demonstration energy conservation feature, system or material application.	Immediate 0-1 year Short 1-5 years	Set EE and appropriate design standards for YK Delta region Direct policy changes	AEA, DCCED, AVCP, AVCP-RHA		TBD	All
Create a clearinghouse for data	Immediate 0-1 year	Locate site to			TBD	All
Work towards policy changes at the state and federal level on programs for maximum benefit	Immediate 0-1 year	Identify programs that could be modified for rural Alaska	AHFC, AEA, DOE, DCCED		TBD	All
Install metering systems, such as TED and smart meter grids, to track and collect energy production, consumption and cost	Short 1-5 years	Seek funding to implement metering systems	DOE, AEA, AHFC, USDA-RD, HUD, AVCP, AVCP-RHA		TBD	All
Conduct study to determine actual heating costs.	Short 1-5 years	Collect data when available to start database for heating costs	AEA, DOE, AVCP-RHA, RurAL CAP		TBD	All

PROJECTS	PROJECTS STATUS	NEXT STEPS	PARTNERS	FUNDING STATUS	Estimated Costs	Community
Energy Infrastructure						
Reassess current failing systems – such as water and sewer and redesign for environment and energy efficiency as needed.	Short 1-5 years	Conduct Regional assessment of current infrastructure	ANTHC, AVCP, Tribal organizations		TBD	All
Electrical Assessments and Metering (regional level)	Short 1-5 years	Conduct electrical assessments and implement metering	DOE, AEA, USDA-RUC		TBD	All
Upgrade Street Lights	Medium 5-10 years	Identify communities who need upgrades. Implement upgrades	AEA, Utilities, AVEC, USDA-RUC		TBD	All
Upgrade power plants for integration of renewable systems	Medium 5-10 years	Identify power plants that need upgrades. Implement upgrades	AEA, Utilities, AVEC, USDA- RUC		TBD	All
Upgrade village power distribution systems	Medium 5-10 years	Identify power distribution lines that need upgrades. Implement upgrades	AEA, Utilities, AVEC, USDA-RUC		TBD	All
Construct Portage Mountain Corridor	Long >10 years				TBD	
Bring natural gas to YK Delta region	Long >10 years				TBD	
Planning						
Adopt an energy element into the local and regional comprehensive plans.	Short 1-5 years	Collaborate with local and regional entities to implement	AVCP, YKHC, CDQ's		TBD	All
Maintain YK Delta strategic advisory group to monitor energy issues	Short 1-5 years	Seek funding to keep SAG going			TBD	All
Incorporate energy into local, regional, state and federal planning and CIP processes	Short 1-5 years	Create database for regional information of funding			TBD	All

PROJECTS	PROJECTS STATUS	NEXT STEPS	PARTNERS	FUNDING STATUS	Estimated Costs	Community
Coordinate with Land Management agencies early in the process and seek solutions that are acceptable to all.	Short 1-5 years	Monitor land management for future projects	DNR, BLM, F&G			
Update the Yukon-Kuskokwim Delta Regional Energy Plan on a regular basis	Medium 5-10 years					
Energy Financing						
Develop strategy to educate legislators about region and energy challenges	Immediate 0-1 year	Invite legislators to region to see firsthand current conditions			TBD	All
Provide incentive matrix for bill payment through education and energy efficiency measures that reduce monthly bills	Short 1-5 years	Develop an incentive matrix that can be used throughout the region			TBD	All
Maintenance						
Train employees for new systems, including water and sewer, housing and power generation.	Immediate 0-1 year	Assist in creating curriculum to help educate employees			TBD	All
Demolish and clean up fuel tank farms no longer in use	Short 1-5 years	Create database identifying tank farms that need demolishing			TBD	All
Install meters to monitor and manage fuel tanks more efficiently	Short 1-5 years				TBD	All

APPENDIX A. GLOSSARY

AkWarm: AHFC released AkWarm in 1996 as a software tool for builders, designers, energy raters, lenders, and homeowners. The software can be used for energy design, retrofit, or to determine an energy rating.

Alaska Energy Authority (AEA): A public corporation of the state with a separate and independent legal existence with the mission to construct, finance, and operate power projects and facilities that utilize Alaska's natural resources to produce electricity and heat. Website: http://www.akenergyauthority.org/

Alaska Retrofit Information System (ARIS): ARIS is a project funded by the Alaska Housing Finance Corporation (AHFC). The project goal is to create a means by which to collect, manage, access, and report on information relating to AHFC's rebate and weatherization programs, as well as other official uses of AkWarm.

Alaska Rural Utility Collaborative (ARUC): ARUC is a program managed by the Alaska Native Tribal Health Consortium. ARUC manages water and sewer systems in partnership with rural Alaska communities. ARUC management is intended to result in more cost-effective operations and maintenance.

ARUC sets rates with community council input. Each community's rates are set to be self-supporting, so rates will vary per community and hires a local water plant operator (and backup) in each community at good wages and retirement benefits. They purchase all fuel, parts, electricity, etc. for water/sewer system with money collected from water/sewer customer and often can find grant money to purchase fuel, supplies, and needed parts and repairs for ARUC communities in the first year of membership.

Auxiliary Generator: A generator at the electric plant site that provides power for the operation of the electrical generating equipment itself, including related demands such as plant lighting, during periods when the electric plant is not operating and power is unavailable from the grid. A black start generator used to start main central station generators is considered to be an auxiliary generator.

Backup (Standby) Generator: A generator that is used only for test purposes, or in the event of an emergency, such as a shortage of power needed to meet customer load requirements.

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

Benchmarking: Benchmarking is the preliminary data collection and analysis that takes place before the audit. Typical benchmark data consists of building age, square footage, occupancy, building drawings (original and additions), historical energy use including a minimum of two years of fuel and electrical bills, etc. It can be used to determine the level of audit needed or if retro-commissioning should be undertaken.

Bituminous coal: A dense coal, usually black, sometimes dark brown, often with well-defined bands of bright and dull material, used primarily as fuel in steam-electric power generation, with substantial quantities also used for heat and power applications in manufacturing and to make coke. Bituminous coal is the most abundant coal in active U.S. mining regions. Its moisture content usually is less than 20%. The heat content of bituminous coal ranges from 21 to 30 million BTU per ton on a moist, mineral-matter-free basis. The heat content of bituminous coal consumed in the United States averages 24 million BTU per ton, on the as-received basis (i.e. containing both inherent moisture and mineral matter).

British Thermal Unit: The British thermal unit (BTU or Btu) is a traditional unit of energy equal to about 1.06 kilojoules. It is approximately the amount of energy needed to heat one pound (0.454 kg) of water 1 °F (0.556 °C). It is used in the power, steam generation, heating and air conditioning industries. In North America, the term "BTU" is used to describe the heat value (energy content) of fuels, and also to describe the power of heating and

cooling systems. When used as a unit of power, BTU per hour (BTU/h) is the correct unit, though this is often abbreviated to just "BTU." One thousand thousand British Thermal Units is written as MMBTU.

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

Climate Change: A term used to refer to all forms of climatic inconsistency, but especially to significant change from one prevailing climatic condition to another. In some cases, "climate 20 change" has been used synonymously with the term "global warming;" scientists, however, tend to use the term in a wider sense inclusive of natural changes in climate, including climatic cooling.

Coal: A readily combustible black or brownish-black rock whose composition, including inherent moisture, consists of more than 50% by weight and more than 70% by volume of carbonaceous material. It is formed from plant remains that have been compacted, hardened, chemically altered, and metamorphosed by heat and pressure over geologic time. It is estimated that Alaska holds about 15% of the world's coal resources, amounting to 170 billion identified short tons. Major coal provinces include Northern Alaska, the Nenana area, Cook Inlet – Matanuska Valley, the Alaska Peninsula, and in the Gulf of Alaska and the Bering River. Alaska coals exhibit low metallic trace elements, good ash-fusion characteristics, and low nitrogen content making them favorable for meeting environmental constraints on combustion in power plants.

Cogeneration System: A system using a common energy source to produce both electricity and thermal energy for other uses, resulting in increased fuel efficiency.

Combined Cycle: An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

Combustion: Chemical oxidation accompanied by the generation of light and heat.

Commercial Sector: An energy-consuming sector that consists of service-providing facilities and equipment of businesses; Federal, State, and local governments; and other private and public organizations, such as religious, social, or fraternal groups. The commercial sector includes institutional living quarters. It also includes sewage treatment facilities. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and running a wide variety of other equipment. Note: This sector includes generators that produce electricity and/or useful thermal output primarily to support the activities of the above-mentioned commercial establishments.

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

Diesel #1: Also known as DF1 or Jet A. Diesel #1 is commonly used as heating fuel throughout most of northern rural AK. Diesel #1 has a lower gel temperature than Diesel #2 which is sold for heating fuel in warmer climates. Diesel #1 is same fuel the refineries sell as Jet fuel (Jet A), and in many tank farms it is stored as Jet A until sold as DF1.

Diesel #2: Is commonly used throughout the US. In Alaska, it is used for marine and highway diesel as well as heating fuel in warmer regions. Diesel #2 is preferred over #1 where it is warm enough as it has higher energy content.

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

Distillate Fuel Oil: A generic name for a refined petroleum product. It can refer to diesel, heating fuel or jet fuel.

Electric Meter, or Watt-hour Meter: Electric Meter, or Watt-hour Meter (also known as The Energy Detective or TED meters) is an instrument that measures the amount of electric energy used by a consumer. The meter is calibrated in kilowatt-hours.

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

Energy Balance: The difference between the total incoming and total outgoing energy. When the energy budget is balanced, the system neither gains nor loses energy.

Energy Information Agency (EIA): An independent agency within the U.S. Department of Energy that develops surveys, collects energy data, and analyzes and models energy issues. Website: http://www.eia.doe.gov/

Fuel: Any material substance that can be consumed to supply heat, power, or mechanical energy. Included are petroleum, coal, and natural gas (the fossil fuels), and other consumable materials such as biomass.

Biodiesel (Fish Oil)	121,000 BTU/Gal
Coal (Healy)	7,900 Btu/lb
Crude Oil	138,000 Btu/gal
Diesel #1	132,000 Btu/gal
Diesel #2	138,000 Btu/gal
Electricity	3,412 Btu/k/Wh
Garbage	4,800 Btu/lb.
Gasoline	124,000 Btu/gal
Natural Gas	1,000 Btu/cf
Paper	7,500 Btu/lb
Propane	92,000Btu/gal
Wood (Birch)	24.2 MMBtu/cord
Wood (Birch))	8,300 Btu/dry lb.
Wood (Spruce)	15.9 MMBtu/cord
Wood (Spruce)	8,100 Btu/dry lb.

Gallon: A volumetric measure equal to four quarts (231 cubic inches) used to measure fuel oil.

Gas: A non-solid, non-liquid combustible energy source that includes natural gas, coke-oven gas, blast-furnace gas, and refinery gas.

Grid: The layout of an electrical distribution system.

Heating Degree Days (HDD): A measure of how cold a location is over a period of time relative to a base temperature, most commonly specified as 65 degrees Fahrenheit. The measure is computed for each day by subtracting the average of the day's high and low temperatures from the base temperature (65 degrees), with negative values set equal to zero. Each day's heating degree days are summed to create a heating degree day measure for a specified reference period. Heating degree days are used in energy analysis as an indicator of space heating energy requirements or use.

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

Installed Capacity: The maximum theoretical production output of a plant, based either on nameplate capacity or actual (practically determined) capacity.

Kilowatt-Hour (kWh): A unit of energy equal to one kW applied for one hour; running a one kW hair dryer for one hour would dissipate one kWh of electrical energy as heat. Also, one kWh is equivalent to one thousand watt hours.

Kilowatt (kW): One thousand watts of electricity (See Watt).

Load (Electric): Amount of electricity required to meet customer demand at any given time.

MCF: One thousand cubic feet.

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

Microgrid: A microgrid is a small-scale power grid that can operate independently or in conjunction with the area's main electrical grid.

Microturbines: Microturbines combine heat and power (CHP), or cogeneration, for an efficient and clean approach to generating electric power and useful thermal energy from a single fuel source. CHP is used to replace or supplement conventional separate heat and power (i.e., central station electricity available via the grid and an onsite boiler or heater). Every CHP application involves the generation of electricity and the recovery of otherwise wasted thermal energy. Therefore, CHP provides greater energy efficiency and environmental benefits than separate heat and power. CHP systems achieve fuel use efficiencies of 60 to 90 percent, compared to a typical separate heat and power efficiency range of 45 to 55 percent. This improvement in efficiency translates to energy cost savings from reduced fuel used, reduced emissions of greenhouse gases and other regulated air pollutants, increased electricity-supply reliability and power quality, and reduced grid congestion and transmission and distribution losses.

In addition to burning liquid fuels such as diesel, kerosene, jet fuel, and liquid biofuels, microturbines can burn almost any carbon-based gaseous fuel: natural gas, propane, sour gas, sweet gas, well casing gas, flare gas, methane and other waste gases to create renewable power and heat. Waste material buried in landfills biodegrades over time to produce methane, carbon dioxide, and other gases. Treatment of domestic wastewater, agricultural waste and food processing waste using anaerobic digestion also produces methane and other gases. Many sites flare these waste gases; or worse yet vent them directly into the atmosphere. Methane has a greenhouse gas impact on the atmosphere that is 21 times that of carbon dioxide, and burning methane in a flare completely wastes its energy value.

MMBTU: One thousand thousand British Thermal Units.

Natural Gas: Gas in place at the time that a reservoir was converted to use as an underground storage reservoir in contrast to injected gas volumes.

O&M: Operations and maintenance

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

Petroleum: A broadly defined class of liquid hydrocarbon mixtures. Included are crude oil, lease condensate, unfinished oils, refined products obtained from the processing of crude oil, and natural gas plant liquids. Note:

volumes of finished petroleum products include non-hydrocarbon compounds, such as additives and detergents, after they have been blended into the products.

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

Power Cost Equalization Program (PCE): Participating utilities receive state funding to reduce the charge to consumers in rural areas where prices can be three to five times higher than prices in urban areas.

Rankine Cycle: Converts heat into power, the heat is supplied in a closed loop of water. Organic Rankine Cycle uses a liquid with lower boiling temperature.

Refinery: An installation that manufactures finished petroleum products from crude oil, unfinished oils, natural gas liquids, other hydrocarbons, and oxygenates.

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

Renewable Energy Resources: Energy resources that are naturally replenishing but flow-limited. They are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time. Renewable energy resources include biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Rural Utility Business Advisor (RUBA) Program: - The goal of the RUBA program is to increase the managerial and financial capacity of rural water and wastewater utility providers. The program is advisory only; travel and assistance is at the request of local utility staff. The program offers capacity building assistance to rural utilities throughout all regions of the state. One-on-one or small group training in the community is provided by RUBA staff for the local utility staff. http://commerce.alaska.gov/dnn/dcra/RuralUtilityBusinessAdvisorProgramRUBA.aspx

Smart Grid: A smart grid is a modernized electrical grid that uses analog or digital information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity. It also allows utility operators to shut off power to portions of the grid while making repairs.

Smart Meters: Smart meters are meters that identify energy consumption in more detail than a conventional electric or Watt Hour meter). They have the ability to communicate information via a secured network back and forth between the end user and the utility provider. This allows the utility to close portions of grid as needed for repairs or maintenance without shutting off the entire system.

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

Transmission System (Electric): An interconnected group of electric transmission lines and associated equipment for moving or transferring electric energy in bulk between points of supply and points at which it is transformed for delivery over the distribution system lines to consumers, or is delivered to other electric systems.

Turbine: A machine for generating rotary mechanical power from the energy of a moving force (such as water, hot gas, wind, or steam). Turbines convert the kinetic energy to mechanical energy through the principles of impulse and reaction, or a mixture of the two.

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

Waste to Energy or Energy from Waste: Waste-to-energy (WtE) or energy-from-waste is the process of generating energy in the form of electricity and/or heat from the incineration of waste. WtE is a form of energy recovery. Most WtE processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.

Watt (Electric): The electrical unit of power. The rate of energy transfer equivalent to one ampere of electric current flowing under a pressure of one volt at unity power factor.

Watt (Thermal): A unit of power in the metric system, expressed in terms of energy per second, equal to the work done at a rate of one joule per second.

Watt hour (Wh): The electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electric circuit steadily for one hour.

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APPENDIX C. FUNDING OPPORTUNITIES FOR ENERGY PROJECTS

The majority of energy funding resources accessed for Alaska projects come from either the State of Alaska or from U.S. Department of Energy. AHFC funds energy efficiency projects for residences, businesses, and buildings owned by municipalities and educational entities, such as the University of Alaska Anchorage. AEA provides energy audit services to commercial and governmental agencies, renewable energy funds, rural power systems upgrades, bulk fuel construction funds and alternative energy and energy efficiency development programs. AEA also provides economic assistance to rural customers where kilowatt hour charges for electricity are three to five times higher than more urban areas of the state.

Private foundations and corporations also provide funds for smaller projects, some of which can be energy improvements, but most of which are capital funds for construction or reconstruction projects.

In the table that follows, funding sources are listed by type of project and then funding agency. The description of the type of project eligible is included as well as if the funding eligibility is dependent on economic status of the applicant.

Program	Funding Agency	Description of Funding Opportunity	Restrictions for Eligibility	Comments
Direct Aid				
Power Cost Equalization	Alaska Energy Authority http://www.akenergyauthority.org/	To provide economic assistance to customers in rural areas of Alaska where the kilowatt-hour charge for electricity can be three to five times higher than the charge in more urban areas of the state. PCE only pays a portion of approximately 30% of all kWh's sold by the participating utilities.		AEA determines eligibility of community facilities and residential customers and authorizes payment to the electric utility. Commercial customers are not eligible to receive PCE credit. Participating utilities are required to reduce each eligible customer's bill by the amount that the State pays for PCE.
Low Income Home Energy Assistance Program -- LIHEAP	Department of Health and Social Services http://liheap.org/?page_id=361	Fuel assistance for low-income families.	Income-based	
Energy Efficiency Improvements				
Alaska Energy Efficiency Revolving Loan Fund Program	Alaska Housing Finance Corporation http://www.ahfc.us	Provides financing for permanent energy-efficient improvements to buildings owned by regional educational attendance areas, the University of Alaska, the State or municipalities in the state. Borrowers obtain an investment grade audit as the basis for making cost-effective energy improvements, selecting from the list of energy efficiency measures identified. All of the improvements must be completed within 365 days of loan closing.	Public facilities	

Program	Funding Agency	Description of Funding Opportunity	Restrictions for Eligibility	Comments
Commercial Energy Audit Program	Alaska Energy Authority http://www.akenergyauthority.org/	Funding for energy efficiency audits for privately owned commercial buildings across Alaska. The program provides reimbursements of qualified commercial energy audits for privately owned commercial buildings up to 160,000 square feet. The maximum reimbursement is set by the building size and complexity and ranges from $1,800 for buildings under 2,500 square feet up to $7,000 for buildings from 60,000 and above.	Owners of commercial buildings	This funding was available in 2013/2014. Check website for notice of future funding availability. Application period is typically November to December.
Energy Efficiency Interest Rate Reduction Program	Alaska Housing Finance Corporation http://www.ahfc.us	AHFC offers interest rate reductions when financing new or existing energy-efficient homes or when borrowers purchase and make energy improvements to an existing home. Any property that can be energy rated and is otherwise eligible for AHFC financing may qualify for this program. Interest rate reductions apply to the first $200,000 of the loan amount. A loan amount exceeding $200,000 receives a blended interest rate rounded up to the next 0.125 percent. The percentage rate reduction depends on whether or not the property has access to natural gas.	Energy Rating Required	
Alaska Home Energy Rebate Program	Alaska Housing Finance Corporation http://www.ahfc.us	Homeowners may receive up to $10,000 for making energy-efficient improvements. Based on before and after energy audits. Rebate is based on final energy rating audit outcome.		Upfront cost for energy audit.
Second Mortgage Program for Energy Conservation	Alaska Housing Finance Corporation http://www.ahfc.us	Borrowers may obtain a second mortgage to finance home improvements or purchase a home in conjunction with an assumption of an existing AHFC loan and make repairs if need be.		The maximum loan amount is $30,000. The maximum loan term is 15 years. The interest rate is the Taxable Program or Rural Owner-Occupied, 15-year interest rate plus 0.375.

Program	Funding Agency	Description of Funding Opportunity	Restrictions for Eligibility	Comments
Village Energy Efficiency Program	Alaska Energy Authority http://www.akenergyauthority.org/	Upgrades are performed in rural Alaskan community buildings. There are currently three phases of funding with Phase II communities recently completed. Community selection was based on the status of the respective village's Rural Power System Upgrade (RPSU). The community either recently received or is slated to receive a new power system.		
Weatherization Program	Alaska Housing Finance Corporation http://www.ahfc.us	Weatherization programs have been created to award grants to nonprofit organizations for the purpose of improving the energy efficiency of low-income homes statewide. These programs also provide for training and technical assistance in the area of housing energy efficiency. Funds for these programs come from the US Dept. of Energy and AHFC.		
RurAL CAP Weatherization	RurAL CAP http://www.ruralcap.com	Rural Alaska Community Action Program, Inc. (RurAL CAP) manages a state program administered by Alaska Housing Finance Corporation that offers free weatherization services for low and middle-income residents in western and northern Alaska, the Municipality of Anchorage, and the City and Borough of Juneau. An Anchorage family of four with income up to $87,800 qualifies.	An income-based program	

Program	Funding Agency	Description of Funding Opportunity	Restrictions for Eligibility	Comments
RurAL CAP Energy Wise	RurAL CAP http://www.ruralcap.com	The Energy Wise Program engages rural Alaskan communities in behavior change practices resulting in energy efficiency and energy conservation. This tested model uses community-based social marketing to save energy – a multi-step educational approach involving residents in changing home energy consumption behaviors. Locally hired crews are trained to educate community residents and conduct basic energy efficiency upgrades during full-day home visits. Through Energy Wise, rural Alaskans reduce their energy consumption, lower their home heating and electric bills, and save money.	No income restrictions	Communities receive the following: ten locally hired and trained crew members; on site "launch week" by a RurAL CAP staff for hiring and training of local crews; one community energy fair to engage community residents and organizations. Households receive: Full day home visit from a trained, locally hired crew; household energy consumption and cost assessment conducted with the resident; education on energy cost-saving strategies; an estimated $300 worth of basic, home energy efficiency supplies installed.
Infrastructure Development				
Alternative Energy & Energy Efficiency Development Program	Alaska Energy Authority http://www.akenergyauthority.org/	AEA's Alternative Energy and Energy Efficiency programs promote: 1.) Use of renewable energy resources and local sources of coal and natural gas alternatives to diesel-based power, heat, and fuel production; 2.) Measures to improve efficiency of energy production and end use.		

Program	Funding Agency	Description of Funding Opportunity	Restrictions for Eligibility	Comments
Bulk Fuel Construction Program	Alaska Energy Authority/Denali Commission http://www.akenergyauthority.org/	With substantial contributions from the Denali Commission, the bulk fuel upgrades program provides funding for the design/engineering, business planning and construction management services to build code-compliant bulk fuel tank farms in rural communities. The bulk fuel upgrade retrofit and revision program, with financial support from the Denali Commission, provides funding for repairs to enable affected communities to continue to receive fuel.		
Emerging Energy Technology Fund	Alaska Energy Authority http://www.akenergyauthority.org/	The Authority may make grants to eligible applicants for demonstration projects of technologies that have a reasonable expectation to be commercially viable within five years and that are designed to: test emerging energy technologies or methods of conserving energy; improve an existing energy technology; or deploy an existing technology that has not previously been demonstrated in Alaska.		Eligible applicants: An electric utility holding a certificate of public convenience and necessity under AS 42.05; an independent power producer; a local government, quasi-governmental entity, or other governmental entity, including tribal council or housing authority; a business holding an Alaska business license; or a nonprofit organization.
Renewable Energy Fund	Alaska Energy Authority http://www.akenergyauthority.org/	Solar water heat, photovoltaics, landfill gas, wind, biomass, hydroelectric, geothermal electric, fuel cells, geothermal heat pumps, CHP/cogeneration, hydrothermal, waste heat, transmission or distribution infrastructure, anaerobic digestion, tidal energy, wave energy, fuel cells using renewable fuels, geothermal direct-use		
Rural Power Systems Upgrades	Alaska Energy Authority/Denali Commission http://www.akenergyauthority.org/	Upgrades may include efficiency improvements, powerhouse upgrades or replacements, line assessments, lines to new customers, demand-side improvements and repairs to generation and distribution systems.		

Program	Funding Agency	Description of Funding Opportunity	Restrictions for Eligibility	Comments
Tier 1 Grant Program	Rasmuson Foundation http://www.rasmuson.org	Grants for capital projects, technology updates, capacity building, program expansion and creative works, including building construction/renovation/restoration, technology upgrades in community facilities, and capacity building grant support.		

Federal Funding Opportunities				
Program	**Funding Agency**	**Description of Funding Opportunity**	**Restrictions for Eligibility**	**Comments**
EERE Tribal Energy Program	U.S. Department of Energy DOE http://energy.gov/eere/office-energy-efficiency-renewable-energy	Various grants for energy efficiency and renewable energy projects, including: Biomass, energy efficiency, geothermal, hydropower, solar photovoltaics, solar water heat, wind, and other renewable energy projects.		
Rural Utilities Service Assistance to High Energy Cost Rural Communities Program	U.S. Department of Agriculture USDA http://www.rurdev.usda.gov/UEP_Our_Grant_Programs.html	Funds may be used to acquire, construct, extend, upgrade, or otherwise improve energy generation, transmission, or distribution facilities and to establish fuel transport systems that are less expensive than road and rail.		
Renewable Energy System and Energy Efficiency Improvement Guaranteed Loan and Grant Program	USDA Rural Development – Rural Energy for America Program (REAP) http://www.rurdev.usda.gov/BCP_ReapResEei.html	The Rural Energy for America Program (REAP) provides financial assistance to agricultural producers and rural small businesses in rural America to purchase, install, and construct renewable energy systems; make energy efficiency improvements to non-residential buildings and facilities; use renewable technologies that reduce energy consumption; and participate in energy audits, renewable energy development assistance, and feasibility studies.		