Comprehensive Energy Audit
For

Quinhagak Community Health and Sanitation Building

Prepared For

City of Quinhagak

May 11, 2016

Prepared By:

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PREFACE

This energy audit was conducted using funds from the United States Department of Agriculture Rural Utilities Service as well as the State of Alaska Department of Environmental Conservation. Coordination with the State of Alaska Remote Maintenance Worker (RMW) Program and the associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Quinhagak, Alaska. The authors of this report are Chris Mercer, Certified Energy Manager (CEM); and Kevin Ulrich, Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in January of 2016 by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Energy Projects Group gratefully acknowledges the assistance of City Maintenance Person Norman Cleveland, Remote Maintenance Worker Bob White, Quinhagak City Administrator Willard Church, Quinhagak City Clerk Fannie Moore, and Quinhagak Director of Public Works George Johnson.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Quinhagak. The scope of the audit focused on Quinhagak Community Health and Sanitation Building. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, heating and ventilation systems, and plug loads.

Additional energy audits for the Quinhagak Water Treatment Plant and the Quinhagak Utility Building were conducted at the same time as this audit. The buildings are all related in their interactions. This is reflected in this energy audit report.

In the near future, a representative of ANTHC will be contacting both the City of Quinhagak and the city maintenance person to follow up on the recommendations made in this report. ANTHC will assist the community in searching for funds to perform the retrofits recommended in this report.

The total predicted energy cost for the Quinhagak Community Health and Sanitation is $78,565 per year. Fuel oil represents the largest portion with an annual cost of approximately $55,359. Electricity represents the remaining portion of the energy cost with an annual cost of approximately $23,206. This includes $11,603 paid by the community and $11,603 paid by the Power Cost Equalization (PCE) program of the State of Alaska.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower the electricity costs and make energy affordable in rural Alaska. In Quinhagak, the cost of electricity without PCE is $0.48/kWh and the cost of electricity with PCE is $0.24/kWh.

There is a heat recovery project for the building that recovers heat from the generator cooling loops at the Alaska Village Electric Cooperative (AVEC) power plant and transfers it to the Quinhagak Utility Building and the Quinhagak Community Health and Sanitation Building. Construction for the project was completed in 2015 with follow-up tasks still to be performed in both end user buildings. At the time of this audit, the Utility Building had a functional recovered heat system but the Community Health and Sanitation Building was not receiving recovered heat because of complications with the mechanical system. This is reflected in this energy audit report.

Table 1.1 lists the total usage of electricity, #1 oil, recovered heat, and propane in the water treatment plant before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Use for the Community Health & Sanitation Building

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	47,349 kWh	26,086 kWh
#1 Oil	8,263 gallons	261 gallons
Heat Recovery	0.00 million Btu	258.79 million Btu
Propane	0 gallons	1,993 gallons

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 lists several benchmarks for the audited building. More details can be found in section 3.2.2.

Table 1.2: Building Benchmarks for the Water Treatment Plant

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	158.1	13.06	$9.92
With Proposed Retrofits	71.4	5.90	$4.24
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

Table 1.3 below summarizes the energy efficiency measures analyzed for the Quinhagak Community Health and Sanitation Building. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summary of Recommended Energy Efficiency Measures

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	$1,821	$2,000	12.27	1.1	5,801.0
2	Other Electrical - Dryer Pumps	Turn pump into auto setting so that it operates only when the dryers are used. Pump usage will go to zero if propane dryers are installed in the building.	$2,711	$3,000	11.22	1.1	11,770.9
3	Setback Thermostat: Offices	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Offices space.	$1,019	$2,000	6.87	2.0	3,245.9
4	Setback Thermostat: Clinic	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Clinic space.	$933	$2,000	6.29	2.1	2,972.1

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
5	Dryers	Reduce Washeteria to 4 total dryers and convert to propane units.	$22,688	$50,000	6.15	2.2	71,574.2
6	Other Electrical - Washeteria Building Heat Pump	Turn pump into Auto setting so that it only operates when the washeteria has a call for heat.	$689	$2,000	4.27	2.9	2,994.9
7	Other Electrical - Hot Water Tank Pump	Turn pump into auto setting so that it operates only when the hot water heating system is in use.	$622	$2,000	3.85	3.2	2,709.0
8	Heating, Ventilation, and Domestic Hot Water	Repair zone valves, repair leaks in pipes and heat exchangers, replace existing boilers with downsized version to accommodate the washeteria being reduced from 8 dryers to 4, implement heat recovery system from AVEC power plant to washeteria and neighboring utility building (cost is split in this audit),	$12,742	$100,000	2.29	7.8	59,054.6
9	Lighting - Boiler Room Small Fluorescent Light	Replace with new energy-efficient LED lighting.	$14	$50	3.24	3.6	52.4
10	Other Electrical - Washers	Downsize washeteria from 8 washers to 4 washers.	$395	$2,000	2.85	5.1	1,482.8
11	Lighting - Clinic Lights	Replace with new energy-efficient LED lighting.	$162	$720	2.62	4.4	608.4
12	Lighting Clinic Exam Room Lights	Replace with new energy-efficient LED lighting.	$106	$480	2.56	4.5	397.1
13	Lighting - Dryer Plenum Lights	Replace with new energy-efficient LED lighting.	$232	$1,120	2.41	4.8	870.6
14	Lighting - Office Lights	Replace with new energy-efficient LED lighting.	$33	$160	2.40	4.8	123.9
15	Lighting - Boiler Room Lights	Replace with new energy-efficient LED lighting.	$18	$160	1.28	9.0	66.4

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
16	Lighting - Sauna Hallway Lights	Replace with new energy-efficient LED lighting.	$18	$160	1.28	9.0	66.4
17	Lighting - Shower Lights	Replace with new energy-efficient LED lighting.	$18	$160	1.28	9.0	66.3
18	Lighting - Washeteria Entry Lights	Replace with new energy-efficient LED lighting.	$27	$240	1.28	9.0	99.5
19	Lighting - Second Floor Balcony Lights	Replace with new energy-efficient LED lighting.	$27	$240	1.28	9.0	99.5
20	Lighting - Washeteria Room Lights	Replace with new energy-efficient LED lighting.	$80	$720	1.28	9.0	298.3
21	Lighting - Community Room	Replace with new energy-efficient LED lighting.	$17	$160	1.20	9.7	62.0
22	Lighting - Washeteria Closet	Replace with new energy-efficient LED lighting.	$6	$100	0.68	17.1	21.9
23	Ceiling w/ Attic: Tribal Office Ceiling	Add R-30 fiberglass batts to attic with Standard Truss.	$130	$6,559	0.44	50.5	571.7
24	Ceiling w/ Attic: Washeteria Ceiling	Add R-30 fiberglass batts to attic with Standard Truss.	$136	$6,864	0.44	50.6	597.0
25	Arctic Entry Doors	Replace the door on the door hinge so that it closes properly and does not let cold air into the building.	$57	$3,634	0.35	63.3	251.9
26	Lighting - Upstairs Restroom Lights	Replace with new energy-efficient LED lighting.	$4	$160	0.32	36.1	16.6
27	Air Tightening	Insulate around doors and windows to prevent air leakage.	$67	$2,000	0.30	29.9	293.9
28	Window/Skylight: Washeteria Room Windows	Replace existing window with triple pane window.	$16	$3,923	0.07	250.1	68.5
29	Window/Skylight: Arctic Entry Window	Replace existing window with triple pane window.	$13	$3,163	0.07	250.3	55.2
30	Window/Skylight: Office Windows - Not South	Replace existing window with triple pane window.	$17	$4,176	0.07	250.3	72.8
31	Window/Skylight: Community Room Window	Replace existing window with triple pane window.	$8	$1,898	0.07	250.5	33.1
32	Window/Skylight: Clinic Windows - Not South	Replace existing window with triple pane window.	$23	$5,821	0.07	250.4	101.4

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
33	Window/Skylight: Upstairs Balcony Windows	Replace existing window with triple pane window.	$35	$8,731	0.07	250.6	152.0
34	Window/Skylight: Entryway Windows	Replace existing window with triple pane window.	$32	$8,098	0.07	250.8	140.8
35	Window/Skylight: Clinic Windows - South	Replace existing window with triple pane window.	$27	$9,743	0.05	357.9	117.7
36	Window/Skylight: Office Windows - South	Replace existing window with triple pane window.	$21	$7,845	0.04	365.8	92.6
	TOTAL, all measures		**$44,963**	**$242,086**	**2.74**	**5.4**	**167,003.2**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

[2] Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $44,963 per year, or 57.2% of the buildings' total energy costs. These measures are estimated to cost $242,086, for an overall simple payback period of 5.4 years.

Table 1.4 below is a breakdown of the annual energy cost across various energy end use types, such as space heating and water heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.4: Detailed Breakdown of Energy Costs in the Building

Annual Energy Cost Estimate								
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Total Cost**
Existing Building	$22,015	$2,859	$1,026	$34,516	$2,941	$252	$14,897	**$78,565**
With Proposed Retrofits	$4,990	$1,609	$1,057	$16,492	$2,115	$259	$7,021	**$33,602**
Savings	$17,025	$1,250	-$31	$18,024	$826	-$7	$7,876	**$44,963**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Quinhagak Community Health and Sanitation Building. The scope of this project included evaluating building shell, lighting and other electrical systems, and heating and ventilation equipment, motors and pumps. Measures were analyzed based on life-cycle-cost techniques, which include the initial cost of the equipment, life of the equipment, annual energy cost, annual maintenance cost, and a discount rate of 3.0%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information was gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is used and what opportunities exist within a building. The entire site was surveyed to inventory the following to gain an understanding of how each building operates:

- Building envelope (roof, windows, etc.)
- Heating and ventilation equipment
- Lighting systems and controls
- Building-specific equipment

The building site visit was performed to survey all major building components and systems. The site visit included detailed inspection of energy consuming components. Summary of building occupancy schedules, operating and maintenance practices, and energy management programs provided by the building manager were collected along with the system and components to determine a more accurate impact on energy consumption.

Details collected from Quinhagak Community Health and Sanitation Building enable a model of the building's energy usage to be developed, highlighting the building's total energy consumption, energy consumption by specific building component, and equivalent energy cost. The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the building.

Quinhagak Community Health and Sanitation Building is classified as being made up of the following activity areas:

1) Washeteria: 4,595 square feet
2) Clinic: 1,682 square feet
3) Offices: 1,642 square feet

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:

- Occupancy hours
- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; HVAC; lighting, plug load, and other electrical improvements; and motor and pump systems that will reduce annual energy consumption.

EEMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. Energy savings are calculated based on industry standard methods and engineering estimations.

Our analysis provides a number of tools for assessing the cost effectiveness of various improvement options. These tools utilize **Life-Cycle Costing**, which is defined in this context as a method of cost analysis that estimates the total cost of a project over the period of time that includes both the construction cost and ongoing maintenance and operating costs.

Savings to Investment Ratio (SIR) = **Savings** divided by **Investment**

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the Department of Energy are included. Future savings are discounted to the present to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation includes the labor and materials required to install the measure. An SIR value of at least 1.0 indicates that the project is cost-effective—total savings exceed the investment costs.

Simple payback is a cost analysis method whereby the investment cost of a project is divided by the first year's savings of the project to give the number of years required to recover the cost of the investment. This may be compared to the expected time before replacement of the system or component will be required. For example, if a boiler costs $12,000 and results in a savings of $1,000 in the first year, the payback time is 12 years. If the boiler has an expected life to replacement of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the project life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money). Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

Measures are implemented in order of cost-effectiveness. The program first calculates individual SIRs, and ranks all measures by SIR, higher SIRs at the top of the list. An individual measure must have an individual SIR>=1 to make the cut. Next the building is modified and resimulated with the highest ranked measure included. Now all remaining measures are re-evaluated and ranked, and the next most cost-effective measure is implemented. AkWarm goes through this iterative process until all appropriate measures have been evaluated and installed.

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first, and then cycling through the list to find the next most cost effective measure. Implementation of more than one EEM often affects the savings of other EEMs. The savings may in some cases be relatively higher if an individual EEM is implemented in lieu of multiple recommended EEMs. For example implementing a reduced operating schedule for inefficient lighting will result in relatively high savings. Implementing a reduced operating schedule for newly installed efficient lighting will result in lower relative savings, because the efficient lighting system uses less energy during each hour of operation. If multiple EEM's are recommended to be implemented, AkWarm calculates the combined savings appropriately.

Cost savings are calculated based on estimated initial costs for each measure. Installation costs include labor and equipment to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers.

2.4 Limitations of Study

All results are dependent on the quality of input data provided, and can only act as an approximation. In some instances, several methods may achieve the identified savings. This report is not intended as a final design document. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

3. Quinhagak Community Health and Sanitation Building

3.1. Building Description

The 7,919 square foot Quinhagak Community Health and Sanitation Building was constructed in 1978, with a normal occupancy of 11 people. The number of hours of operation for this building average 4.8 hours per day, considering all seven days of the week.

The Quinhagak Community Health and Sanitation Building houses many vital functions towards the successful operations of the community. The washeteria provides laundry and shower services to residents of the community. The clinic serves as the central medical treatment facility for the community and has three exam rooms and space for other medical operations. The tribal offices are used by both city and tribal members to conduct the business of the community. The building is owned by the tribe but the city is a tenant.

Description of Building Shell

The exterior walls are constructed with 2x8" standard timber-framed construction and 16" spacing and 7.25 inches of fiberglass batt insulation. The insulation is damaged and there is approximately 4,700 square feet of wall space in the building.

The building has a sloped roof with an attic that is built with standard framing with 24" spacing and 7.25 inches of fiberglass batt insulation that is damaged.. The roof is split into three sections for the washeteria space, the clinic and tribal office space, and the arctic entry. There is approximately 4,931 square feet of roof space in the building.

The building is built on grade with a gravel pad foundation. There is approximately 3,980 square feet of floor space on the first floor of the building.

There are many windows in the building. All windows are double-paned with wood framing. The arctic entry has one window that is approximately 60"x60" in dimensions and 25 square feet in area. The washeteria entryway has two unusually shaped windows that each are approximately 32 square feet in area. The main washeteria room has two windows that are each approximately 47x47 ft. in dimension and 15 square feet in area. The upstairs community room has one window that is approximately 47"x47" in dimension and 15 square feet in area. The upstairs balcony has three total windows. One window is approximately 60"x60" in dimension and 25 square feet in area. Two windows are usually shaped and each approximately 22 square feet in area. The clinic has eight total windows that are each approximately 47"x47" in dimension and 15 square feet in area. Three of these windows are in exam rooms, two are in the office, two are in the waiting room, and one is in the hallway. The tribal offices have seven total windows. Each of the six offices has a window that is approximately 47"x47" in dimension and 15 square feet in area. The corner office has an additional window that is approximately 18"x18" in dimension and 2 square feet in area.

There are four entrances to the building. The primary entrance is the arctic entry on the front of the building. There are two single doors opposite each other in the entry with a set of glass double-doors into the main area of the building. Each of the single doors is a metal with a small window that is covered with plywood. Both of the doors are approximately 3x7 ft. in area and are hanging on the hinges such that air is entering the building. The clinic has a back entrance used for patient care that is a single metal door with a small window covered by plywood. This door is approximately 3x7 ft. There is an entrance on the second floor of the washeteria with an exterior staircase leading to the ground level. This entrance is a set of double-doors, each of which is approximately 3x7 ft. in area. The doors are metal with a small window that is covered by plywood. The boiler room also has a set of double-doors leading to the outside. Each of these doors are approximately 3x7 ft. in area. These doors are metal with an insulated core and no windows present.

Description of Heating and Cooling Plants

The Heating Plants used in the building are:

Boiler 1

Nameplate Information:	Weil Mclain BL-788WF
Fuel Type:	#1 Oil
Input Rating:	1,419,000 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Boiler 2

Nameplate Information:	Weil Mclain BL-788WF
Fuel Type:	#1 Oil
Input Rating:	1,632,000 BTU/hr
Steady State Efficiency:	50 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	Not in Operation

The existing boilers are both in poor condition and are in need of replacement. Boiler one is the only one in operation. Two of the seven sections in boiler 1 are cracked and leak glycol when in use. The siding is missing and smoke can be seen leaving the sections when in use as well. Debris has gathered in the stack and when the boiler has to perform a cold start the debris is scattered to other parts of the building such that the clinic reported high levels of carbon monoxide. The fuel nozzle and hose had been repaired the week prior to our visit by the maintenance person and the RMW. Boiler 2 is not in operation because the boiler return pipe with glycol exiting the boiler has a large crack around the edge that is temporarily "repaired" using a rubber tube and hose clamps. In addition to all these details, the boilers ae sized for eight operational dryers and a sauna when in fact only five dryers are in operation and there is no active sauna. The boiler room is not ventilated well and long exposure to the room can expose the operator to large amounts of various gases from the boiler.

Space Heating Distribution Systems

There are three unit heaters in the building that are used to provide space heat to the occupied areas. One unit heater is in the arctic entry and is a Modine Model CW. The unit produces approximately 10,350 BTU/hr. Another unit heater is in the clinic stairwell and is a Modine Model CW. The unit heater produces approximately 10,350 BTU/hr. The third unit heater is in the washeteria mechanical room and is a Modine Model HS-18. The unit produces approximately 11,150 BTU/hr. The rest of the building heat is distributed through baseboard heating or through mechanical ventilation.

Domestic Hot Water System

There is a hot water heater in the building that has not been in operation for months according to the maintenance person. The hot water tank is an Ajax Boiler Model VG4205-G-4.842 that holds 460 gallons. When in operation, the hot water heater was used to heat the restrooms and washers. For an operational improvement, it is recommended that a direct vent on-demand water heater be installed to be used for the showers and other water needs.

Heat Recovery Information

There is a heat recovery project that transfers recovered heat from the AVEC power plant to the neighboring Quinhagak Utility Building and the Quinhagak Community Health and Sanitation Building. The utility building is actively using the heat recovery system. The washeteria is not currently using the heat recovery system because there are concerns about the integration of the project to the building mechanical system in its current state of operation. The repairs necessary to repair the mechanical heating system and use the heat recovery system are included as recommendations in this energy audit report.

Description of Building Ventilation System

The building has an air-handling and distribution system to transfer and exchange air within the building and surrounding areas. The building ventilation fan is rated for 1625 CFM and operates at 800 CFM and 550 Watts whenever the building is occupied in any of the spaces. The fan is a Pace 9 model. The boiler room ventilation fan is rated at 3200 CFM but has not been in operation for months. This fan is a Penn Model ZC-15. There is a restroom exhaust fan that operates at 50 CFM and 48 Watts and is a Penn Model ZT.

Lighting

The washeteria entryway has three fixtures with two T8 4ft. fluorescent fixtures in each bulb. The lights are on for eight hours per day, three days per week all year long and they consume approximately 216 kWh annually.

The second floor balcony has three fixtures with two T8 4ft. fluorescent fixtures in each bulb. The lights are on for eight hours per day, three days per week all year long and they consume approximately 216 kWh annually.

The washeteria main room has nine fixtures with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on for eight hours per day, three days per week, all year long and they consume approximately 649 kWh annually.

There is an incandescent 60 Watt light bulb in the washeteria closet that uses approximately 19 kWh annually.

The two dryer plenums combine to have two fixtures with two T12 4ft. fluorescent light bulbs in each fixture. The lights are on for eight hours per day, three days per week, all year long and they consume approximately 181 kWh annually.

The boiler room has two fixtures with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on for eight hours per day, three days per week, all year long and they consume approximately 144 kWh annually. The boiler room also has a single CFL 42 Watt spiral light bulb that consumes approximately 53 kWh annually.

The hallway to the showers and old saunas have with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on for eight hours per day, three days per week, all year long and they consume approximately 144 kWh annually.

The showers have two fixtures with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on for eight hours per day, three days per week, all year long and they consume approximately 144 kWh annually.

The upstairs restrooms have two fixtures with two T8 4ft. light bulbs in each fixture that combine to consume approximately 36 kWh annually.

The community room has two fixtures with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on for nine hours per day, five days per week, all year long and consume approximately 135 kWh annually.

The tribal office section of the building has a combined 14 fixtures with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on nine hours per day, five days per week and consume approximately 1,892 kWh annually.

The clinic section of the building has a combined nine fixtures with two T8 4ft. fluorescent light bulbs in each fixture. The lights are on seven hours per day all year long and consume approximately 1,324 kWh annually.

The clinic exam rooms have three fixtures with four T12 4ft. fluorescent light bulbs in each fixture. The lights are on for seven hours per day all year long and consume approximately 864 kWh annually.

<u>Plug Loads</u>

The community health and sanitation building has a variety of power tools, a telephone, and some other miscellaneous tools that require a plug into an electric outlet. The use of these items is infrequent and consumes a small portion of the total energy demand of the building.

The offices and clinic have eight desktop computers and two copier/printer units that are used during daily operations. This equipment combines to use approximately 4,696 kWh annually.

<u>Major Equipment</u>

There is a hot water tank pump that is used to circulate heated water through the hot water heater and into the hot water storage tank. The pump is always on in the “hand” setting and consumes approximately 3,243 kWh annually.

There are two dryer pumps that are used to circulate heated glycol to the dryers when in operation. Both dryers are constantly operating in the "hand" setting and consume approximately 10,695 kWh annually.

There is a washeteria building heating pump that is used to circulate heated glycol throughout the washeteria for space heating purposes. The pump is constantly operating in the "hand" setting and consumes approximately 5,347 kWh annually.

There is a hot water circulation pump that is used to pump hot water to the various loads in the building. The pump operates on demand approximately 5% of the time and consumes approximately 241 kWh annually.

There are two hot water heat-add pumps that are used to pump hot water from the storage tank to the heat-add heat exchanger. One of the pumps operates constantly and consumes approximately 526 kWh annually.

There are two clinic heating pumps that are used to circulate heated glycol to the clinic for space hating purposes. One of the pumps operates on demand approximately 5% of the time and consumes approximately 64 kWh annually.

There are two discharge pumps that are used to discharge waste water to the sewage collection system. One of the pumps operates on demand approximately 10% of the time and consumes approximately 964 kWh annually.

The washeteria has five functioning electric clothes washers. An average of three washers are used at the same time throughout the washeteria business days and they combine to consume approximately 4,696 kWh annually.

There is a medical refrigerator in the clinic that is in constant operation and consumes approximately 515 kWh annually.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One KW of electric demand is equivalent to 1,000 watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

The propane usage profile shows the propane usage for the building. Propane is sold by the gallon or by the pound, and its energy value is approximately 91,800 BTUs per gallon.

The fuel oil usage profile shows the fuel oil usage for the building. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The Alaska Village Electric Cooperative (AVEC) provides electricity to the residents of Quinhagak as well as all the commercial and public facilities.

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.1: Energy Rates for each Fuel Source

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.48/kWh
#1 Oil	$ 6.70/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, [Building Owner] pays approximately $78,565 annually for electricity and other fuel costs for the Quinhagak Community Health and Sanitation Building.

Figure 3.1 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the “Retrofit” bar in the figure to the “Existing” bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

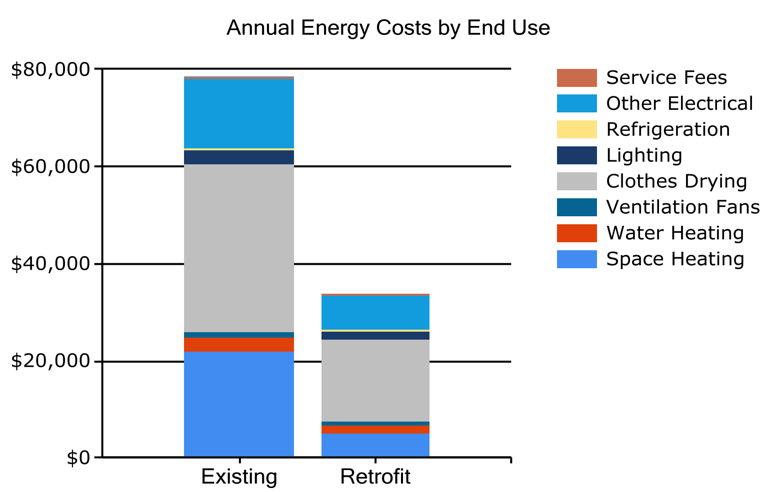


Figure 3.1: Annual Energy Costs by End Use

Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

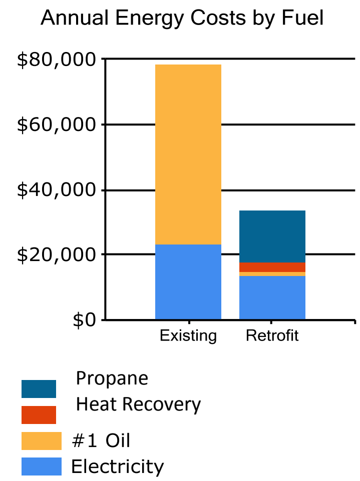


Figure 3.2: Annual Energy Costs by Fuel Type

Figure 3.3 below addresses only space heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

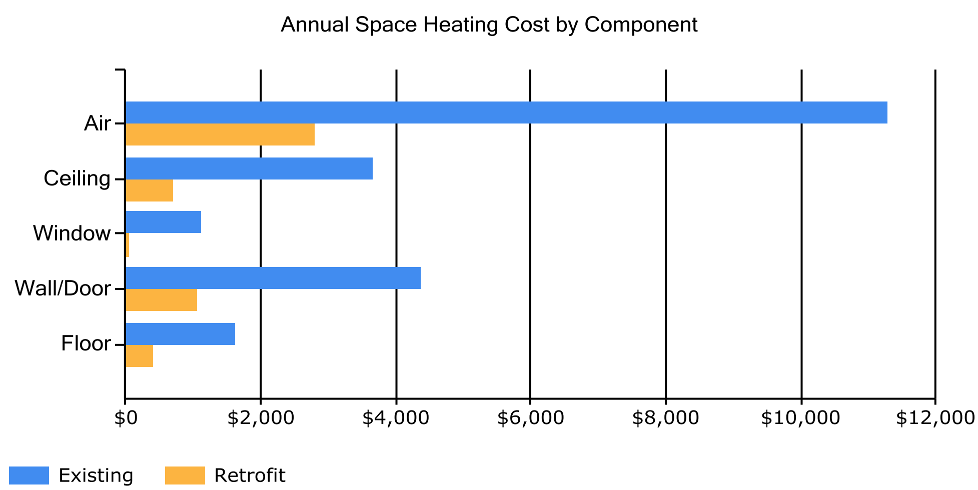


Figure 3.3: Annual Space Heating Cost by Component

The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Table 3.2: Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	363	303	270	148	68	20	6	12	46	159	256	373
DHW	416	379	416	402	416	402	416	416	402	416	402	416
Ventilation Fans	178	162	178	172	178	172	178	178	172	178	172	178
Clothes Drying	115	105	114	109	111	107	110	110	107	112	110	115
Lighting	511	465	511	494	511	494	511	511	494	511	494	511
Refrigeration	44	40	44	42	44	42	44	44	42	44	42	44
Other Electrical	2586	2357	2586	2503	2586	2503	2586	2586	2503	2586	2503	2586

Table 3.3: Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	548	458	409	225	101	45	46	46	67	243	388	563
DHW	6	5	6	6	6	6	6	6	6	6	6	6
Clothes Drying	468	423	455	418	412	385	387	389	390	426	432	469

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.
The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{(\text{Electric Usage in kBtu} + \text{Fuel Oil Usage in kBtu})}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{(\text{Electric Usage in kBtu X SS Ratio} + \text{Fuel Oil Usage in kBtu X SS Ratio})}{\text{Building Square Footage}}$$

where "SS Ratio" is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.4: Quinhagak Community Health and Sanitation Building EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	47,349 kWh	161,602	3.340	539,751
#1 Oil	8,263 gallons	1,090,651	1.010	1,101,557
Total		**1,252,253**		**1,641,308**
BUILDING AREA		7,919	Square Feet	
BUILDING SITE EUI		158	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		207	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.5: Quinhagak Community Health and Sanitation Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**158.1**	**13.06**	**$9.92**
With Proposed Retrofits	**71.4**	**5.90**	**$4.24**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The heating and ventilation systems are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Quinhagak Community Health and Sanitation Building was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Quinhagak was used for analysis. From this, the model was be calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Quinhagak. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing

information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.

The energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures are summarized in Table 4.1. Please refer to the individual measure descriptions later in this report for more detail.

Table 4.1: Recommended Energy Efficiency Measures Ranked by Economic Benefit

Quinhagak Community Health and Sanitation Building, Quinhagak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
1	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	$1,821	$2,000	12.27	1.1	5,801.0
2	Other Electrical - Dryer Pumps	Turn pump into auto setting so that it operates only when the dryers are used. Pump usage will go to zero if propane dryers are installed in the building.	$2,711	$3,000	11.22	1.1	11,770.9
3	Setback Thermostat: Offices	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Offices space.	$1,019	$2,000	6.87	2.0	3,245.9
4	Setback Thermostat: Clinic	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Clinic space.	$933	$2,000	6.29	2.1	2,972.1

Quinhagak Community Health and Sanitation Building, Quinhagak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
5	Dryers	Reduce Washeteria to 4 total dryers and convert to propane units.	$22,688	$50,000	6.15	2.2	71,574.2
6	Other Electrical - Washeteria Building Heat Pump	Turn pump into Auto setting so that it only operates when the washeteria has a call for heat.	$689	$2,000	4.27	2.9	2,994.9
7	Other Electrical - Hot Water Tank Pump	Turn pump into auto setting so that it operates only when the hot water heating system is in use.	$622	$2,000	3.85	3.2	2,709.0
8	Heating, Ventilation, and Domestic Hot Water	Repair zone valves, repair leaks in pipes and heat exchangers, replace existing boilers with downsized version to accommodate the washeteria being reduced from 8 dryers to 4, implement heat recovery system from AVEC power plant to washeteria and neighboring utility building (cost is split in this audit),	$12,742	$100,000	2.29	7.8	59,054.6
9	Lighting - Boiler Room Small Fluorescent Light	Replace with new energy-efficient LED lighting.	$14	$50	3.24	3.6	52.4
10	Other Electrical - Washers	Downsize washeteria from 8 washers to 4 washers.	$395	$2,000	2.85	5.1	1,482.8
11	Lighting - Clinic Lights	Replace with new energy-efficient LED lighting.	$162	$720	2.62	4.4	608.4
12	Lighting Clinic Exam Room Lights	Replace with new energy-efficient LED lighting.	$106	$480	2.56	4.5	397.1
13	Lighting - Dryer Plenum Lights	Replace with new energy-efficient LED lighting.	$232	$1,120	2.41	4.8	870.6
14	Lighting - Office Lights	Replace with new energy-efficient LED lighting.	$33	$160	2.40	4.8	123.9

Quinhagak Community Health and Sanitation Building, Quinhagak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**	**CO_2 Savings**
15	Lighting - Boiler Room Lights	Replace with new energy-efficient LED lighting.	$18	$160	1.28	9.0	66.4
16	Lighting - Sauna Hallway Lights	Replace with new energy-efficient LED lighting.	$18	$160	1.28	9.0	66.4
17	Lighting - Shower Lights	Replace with new energy-efficient LED lighting.	$18	$160	1.28	9.0	66.3
18	Lighting - Washeteria Entry Lights	Replace with new energy-efficient LED lighting.	$27	$240	1.28	9.0	99.5
19	Lighting - Second Floor Balcony Lights	Replace with new energy-efficient LED lighting.	$27	$240	1.28	9.0	99.5
20	Lighting - Washeteria Room Lights	Replace with new energy-efficient LED lighting.	$80	$720	1.28	9.0	298.3
21	Lighting - Community Room	Replace with new energy-efficient LED lighting.	$17	$160	1.20	9.7	62.0
22	Lighting - Washeteria Closet	Replace with new energy-efficient LED lighting.	$6	$100	0.68	17.1	21.9
23	Ceiling w/ Attic: Tribal Office Ceiling	Add R-30 fiberglass batts to attic with Standard Truss.	$130	$6,559	0.44	50.5	571.7
24	Ceiling w/ Attic: Washeteria Ceiling	Add R-30 fiberglass batts to attic with Standard Truss.	$136	$6,864	0.44	50.6	597.0
25	Arctic Entry Doors	Replace the door on the door hinge so that it closes properly and does not let cold air into the building.	$57	$3,634	0.35	63.3	251.9
26	Lighting - Upstairs Restroom Lights	Replace with new energy-efficient LED lighting.	$4	$160	0.32	36.1	16.6
27	Air Tightening	Insulate around doors and windows to prevent air leakage.	$67	$2,000	0.30	29.9	293.9
28	Window/Skylight: Washeteria Room Windows	Replace existing window with triple pane window.	$16	$3,923	0.07	250.1	68.5
29	Window/Skylight: Arctic Entry Window	Replace existing window with triple pane window.	$13	$3,163	0.07	250.3	55.2
30	Window/Skylight: Office Windows - Not South	Replace existing window with triple pane window.	$17	$4,176	0.07	250.3	72.8
31	Window/Skylight: Community Room Window	Replace existing window with triple pane window.	$8	$1,898	0.07	250.5	33.1

Quinhagak Community Health and Sanitation Building, Quinhagak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
32	Window/Skylight: Clinic Windows - Not South	Replace existing window with triple pane window.	$23	$5,821	0.07	250.4	101.4
33	Window/Skylight: Upstairs Balcony Windows	Replace existing window with triple pane window.	$35	$8,731	0.07	250.6	152.0
34	Window/Skylight: Entryway Windows	Replace existing window with triple pane window.	$32	$8,098	0.07	250.8	140.8
35	Window/Skylight: Clinic Windows - South	Replace existing window with triple pane window.	$27	$9,743	0.05	357.9	117.7
36	Window/Skylight: Office Windows - South	Replace existing window with triple pane window.	$21	$7,845	0.04	365.8	92.6
	TOTAL, all measures		**$44,963**	**$242,086**	**2.74**	**5.4**	**167,003.2**

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure in the list are implemented. If some EEMs are not implemented, savings for the remaining EEMs will be affected. For example, if ceiling insulation is not added, then savings from a project to replace the heating system will be increased, because the heating system for the building supplies a larger load.

In general, all projects are evaluated sequentially so energy savings associated with one EEM would not also be attributed to another EEM. By modeling the recommended project sequentially, the analysis accounts for interactive affects among the EEMs and does not "double count" savings.

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties benefits were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Insulation Measures

Rank	Location	Existing Type/R-Value		Recommendation Type/R-Value	
23	Ceiling w/ Attic: Tribal Office Ceiling	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: None Bottom Insulation Layer: R-25 Batt:FG or RW, 8 inches Top Insulation Layer: None Insulation Quality: Damaged Modeled R-Value: 25.3		Add R-30 fiberglass batts to attic with Standard Truss.	
Installation Cost	$6,559	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$130
Breakeven Cost	$2,868	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	51
Auditors Notes: Adding insulation to the roof will limit the heat loss through the building roof and will lower the heating demand of the building.					

Rank	Location	Existing Type/R-Value		Recommendation Type/R-Value	
24	Ceiling w/ Attic: Washeteria Ceiling	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: None Bottom Insulation Layer: R-25 Batt:FG or RW, 8 inches Top Insulation Layer: None Insulation Quality: Damaged Modeled R-Value: 25.3		Add R-30 fiberglass batts to attic with Standard Truss.	
Installation Cost	$6,864	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$136
Breakeven Cost	$2,996	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	51
Auditors Notes: Adding insulation to the roof will limit the heat loss through the building roof and will lower the heating demand of the building.					

4.3.2 Window Measures

Rank	Location	Size/Type, Condition		Recommendation	
28	Window/Skylight: Washeteria Room Windows	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46		Replace existing window with triple pane window.	
Installation Cost	$3,923	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$16
Breakeven Cost	$258	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	250
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition	Recommendation		
29	Window/Skylight: Arctic Entry Window	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.		
Installation Cost	$3,163	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$13
Breakeven Cost	$208	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	250
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition	Recommendation		
30	Window/Skylight: Office Windows - Not South	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.		
Installation Cost	$4,176	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$17
Breakeven Cost	$274	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	250
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition	Recommendation		
31	Window/Skylight: Community Room Window	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.		
Installation Cost	$1,898	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$8
Breakeven Cost	$124	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	250
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition		Recommendation	
32	Window/Skylight: Clinic Windows - Not South	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46		Replace existing window with triple pane window.	
Installation Cost	$5,821	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$23
Breakeven Cost	$382	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	250
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition		Recommendation	
33	Window/Skylight: Upstairs Balcony Windows	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46		Replace existing window with triple pane window.	
Installation Cost	$8,731	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$35
Breakeven Cost	$572	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	251
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition		Recommendation	
34	Window/Skylight: Entryway Windows	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46		Replace existing window with triple pane window.	
Installation Cost	$8,098	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$32
Breakeven Cost	$530	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	251
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition	Recommendation
35	Window/Skylight: Clinic Windows - South	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.

Installation Cost	$9,743	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$27
Breakeven Cost	$448	**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	358
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

Rank	Location	Size/Type, Condition	Recommendation
36	Window/Skylight: Office Windows - South	Glass: Double, glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.51 Solar Heat Gain Coefficient including Window Coverings: 0.46	Replace existing window with triple pane window.

Installation Cost	$7,845	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$21
Breakeven Cost	$353	**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	366
Auditors Notes: Replacing the window will reduce air leakage and prevent problems with moisture infiltration.					

4.3.3 Door Measures

Rank	Location	Size/Type, Condition	Recommendation
25	Arctic Entry	Door Type: Entrance, Metal, EPS core, metal edge, half-lite Modeled R-Value: 1.7	Replace the door on the door hinge so that it closes properly and does not let cold air into the building.

Installation Cost	$3,634	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$57
Breakeven Cost	$1,270	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	63
Auditors Notes: These doors are not on the hinges right and leave a gap for air penetration. Replace the doors on the hinges properly to prevent air leakage.					

4.3.4 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
27		Air Tightness estimated as: 4500 cfm at 50 Pascals		Insulate around doors and windows to prevent air leakage.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$67
Breakeven Cost	$601	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	30
Auditors Notes: Many of the doors do not fit properly on the hinges and leave room for air penetration. Also, most of the doors have glass with plywood covering them, which could be improved upon for better air tightening. The boiler room has visible cracks in the walls where air can come through. These are large formed by the failure of the thermosiphons surrounding the building, causing the ground to shift. The clinic also reported cracks in the walls, though this was not validated on the site visit.					

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation				
8	Repair zone valves, repair leaks in pipes and heat exchangers, replace existing boilers with downsized version to accommodate the washeteria being reduced from 8 dryers to 4, implement heat recovery system from AVEC power plant to washeteria and neighboring utility building (cost is split in this audit).				
Installation Cost	$100,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$12,742
Breakeven Cost	$228,914	**Savings-to-Investment Ratio**	2.3	**Simple Payback yrs**	8
Auditors Notes: The heating system in the building has many faulty zone valves and some evidence of leaks from the pipes. Repairing these will improve the efficiency of the heating system and lower the heating demand of the building. Converting the hydronic dryers to propane units (as mentioned in a separate EEM) would dramatically lower the heating load of the boilers and the existing boilers could be reduced to a 134 MBH unit and a 240 MBH unit for backup. Additionally, there is a heat recovery project that is in the final construction phases that transfers heat from the generator cooling loop of the power plant to the utility building and the community health & sanitation building to be used in place of existing heating sources. As of the time of this site visit, the heat recovery system had been constructed in the community health & sanitation building boiler room, but it had not been activated because of concerns regarding the existing boilers and heating demands. The use of the heat recovery system will lower the cost of heating fuel for the building and improve the efficiency of the mechanical systems.					

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Washeteria			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,821
Breakeven Cost	$24,540	**Savings-to-Investment Ratio**	12.3	**Simple Payback yrs**	1
Auditors Notes: Reduce the temperature when unoccupied to prevent unnecessary heating and extend the life of the boilers.					

Rank	Building Space			Recommendation	
3	Offices			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Offices space.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,019
Breakeven Cost	$13,732	**Savings-to-Investment Ratio**	6.9	**Simple Payback yrs**	2
Auditors Notes: Reduce the temperature when unoccupied to prevent unnecessary heating and extend the life of the boilers.					

Rank	Building Space			Recommendation	
4	Clinic			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Clinic space.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$933
Breakeven Cost	$12,579	**Savings-to-Investment Ratio**	6.3	**Simple Payback yrs**	2
Auditors Notes: Reduce the temperature when unoccupied to prevent unnecessary heating and extend the life of the boilers.					

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating and cooling loads. The building cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
9	Boiler Room Small Fluorescent Light	FLUOR CFL, Spiral 42 W		Replace with new energy-efficient LED lighting.	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$14
Breakeven Cost	$162	**Savings-to-Investment Ratio**	3.2	**Simple Payback yrs**	4
Auditors Notes: Replace existing CFL light bulb with LED 12 Watt equivalent. There is one bulb to replace.					

Rank	Location	Existing Condition		Recommendation	
11	Clinic Lights	9 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$720	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$162
Breakeven Cost	$1,885	**Savings-to-Investment Ratio**	2.6	**Simple Payback yrs**	4
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. These rooms have 9 fixtures with two light bulbs for a total of 18 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
12	Clinic Exam Room Lights	3 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$480	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$106
Breakeven Cost	$1,230	**Savings-to-Investment Ratio**	2.6	**Simple Payback yrs**	5
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. These rooms have 3 fixtures with four light bulbs for a total of 12 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
13	Office Lights	14 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$1,120	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$232
Breakeven Cost	$2,696	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. These rooms have 14 fixtures with two light bulbs for a total of 28 bulbs to be replaced					

Rank	Location	Existing Condition		Recommendation	
14	Dryer Plenum Lights	2 FLUOR (2) T12 4' F40T12 40W Standard StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$33
Breakeven Cost	$384	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. These rooms have two fixtures with two light bulbs for a total of 4 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
15	Boiler Room Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 2 LED (2) 17W Module StdElectronic	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$18
Breakeven Cost	$206	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes:					

Rank	Location	Existing Condition		Recommendation	
16	Sauna Hallway Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$18
Breakeven Cost	$206	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has two fixtures with two light bulbs for a total of 4 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
17	Shower Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$18
Breakeven Cost	$205	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has two fixtures with two light bulbs for a total of 4 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
18	Washeteria Entry Lights	3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$27
Breakeven Cost	$308	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has three fixtures with two light bulbs for a total of 6 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
19	Second Floor Balcony Lights	3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$27
Breakeven Cost	$308	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has three fixtures with two light bulbs for a total of 6 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
20	Washeteria Room Lights	9 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$720	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$80
Breakeven Cost	$924	**Savings-to-Investment Ratio**	1.3	**Simple Payback yrs**	9
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has nine fixtures with two light bulbs for a total of 18 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
21	Community Room	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$17
Breakeven Cost	$192	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	10
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has two fixtures with two light bulbs for a total of 4 bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
22	Washeteria Closet	INCAN A Lamp, Halogen 60W		Replace with new energy-efficient LED lighting.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$6
Breakeven Cost	$68	**Savings-to-Investment Ratio**	0.7	**Simple Payback yrs**	17
Auditors Notes: Replace incandescent light bulb with LED 12 Watt equivalent. There is one light bulb to replace.					

Rank	Location	Existing Condition		Recommendation	
26	Upstairs Restroom Lights	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with new energy-efficient LED lighting.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$4
Breakeven Cost	$51	**Savings-to-Investment Ratio**	0.3	**Simple Payback yrs**	36
Auditors Notes: Replace existing fluorescent light bulbs with LED 17 Watt 4ft. equivalents. The room has two fixtures with two light bulbs for a total of 4 bulbs to be replaced.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Dryer Pumps	2 Dryer Pumps		Turn pump into auto setting so that it operates only when the dryers are used. Pump usage will go to zero if propane dryers are installed in the building.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$2,711
Breakeven Cost	$33,669	**Savings-to-Investment Ratio**	11.2	**Simple Payback yrs**	1
Auditors Notes: The dryer pumps were running in hand during the site visit and were constantly pumping heated glycol through the dryers. This should only operate when the dryers are calling for heat. Additionally, there is an additional recommendation to replace the existing dryers with propane dryers. If this recommendation is completed, the usage of the pumps would be reduced to zero as the dryers would not be tied into the boilers. The savings numbers reflect the additional recommendation having been implemented.					

Rank	Location	Description of Existing		Efficiency Recommendation	
6	Washeteria Building Heat Pump	Washeteria Building Heat Pump		Turn pump into Auto setting so that it only operates when the washeteria has a call for heat.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$689
Breakeven Cost	$8,547	**Savings-to-Investment Ratio**	4.3	**Simple Payback yrs**	3
Auditors Notes: The washeteria building pump was running in hand during the site visit and was constantly pumping heated glycol throughout the building. The constant use of the pump is unnecessary and uses more electricity than needed for proper operations. Turn the pump into the Auto setting so that the usage is reduced.					

Rank	Location	Description of Existing		Efficiency Recommendation	
7	Hot Water Tank Pump	Hot Water Tank Pump		Turn pump into auto setting so that it operates only when the hot water heating system is in use.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$622
Breakeven Cost	$7,692	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	3
Auditors Notes: The hot water tank pump was running in hand during the site visit and was constantly pumping heated glycol through the tank. The hot water tank was not in operation and did not require any heating as a result. The constant use of the pump is unnecessary and uses more electricity than needed for proper operations. Turn the pump into the Auto setting so that the usage is reduced.					

Rank	Location		Description of Existing		Efficiency Recommendation	
10	Washers		4 Clothes Washers		Replace with 4 Clothes Washers. Downsize washeteria from 8 washers to 4 washers.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$395
Breakeven Cost		$5,691	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	5
Auditors Notes: Only 4 of the 8 washers in the washeteria were functional during the site visit. Due to the increase in personal clotheswashers in households, the usage in the washeteria has been reduced. Downsizing the washeteria to four washers and replacing these units with new, efficient models will reduce the water heating and electric loads of the building						

4.5.3 Other Measures

Rank	Location		Description of Existing		Efficiency Recommendation	
5	Dryers		Clothes Dryers (8)		Reduce Washeteria to 4 total dryers and convert to propane units.	
Installation Cost		$50,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$22,688
Breakeven Cost		$307,705	**Savings-to-Investment Ratio**	6.2	**Simple Payback yrs**	2
Auditors Notes: The existing boilers are very large and it is a waste of energy to turn on the boilers when only one dryer is in use. Converting the dryers to propane units and downsizing the washeteria to four dryers will allow the dryers to run individually and more efficiently.						

5. ENERGY EFFICIENCY ACTION PLAN

Through inspection of the energy-using equipment on-site and discussions with site facilities personnel, this energy audit has identified several energy-saving measures. The measures will reduce the amount of fuel burned and electricity used at the site. The projects will not degrade the performance of the building and, in some cases, will improve it.

Several types of EEMs can be implemented immediately by building staff, and others will require various amounts of lead time for engineering and equipment acquisition. In some cases, there are logical advantages to implementing EEMs concurrently. For example, if the same electrical contractor is used to install both lighting equipment and motors, implementation of these measures should be scheduled to occur simultaneously.

In the near future, a representative of ANTHC will be contacting both the City of Quinhagak and the city maintenance person to follow up on the recommendations made in this report. ANTHC will assist the community in searching for funds to perform the retrofits recommended in this report.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Quinhagak Community Health and Sanitation Building	**Auditor Company:** ANTHC-DEHE
Address: PO Box 90	**Auditor Name:** Kevin Ulrich and Chris Mercer
City: Quinhagak	**Auditor Address:** 4500 Diplomacy Dr., Anchorage, AK 99508
Client Name: Norm	
Client Address:	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 556-2181	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 7,919 square feet	**Design Space Heating Load:** Design Loss at Space: 127,776 Btu/hour with Distribution Losses: 134,502 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 205,033 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 11 people	**Design Indoor Temperature:** 67.1 deg F (building average)
Actual City: Quinhagak	**Design Outdoor Temperature:** -24.1 deg F
Weather/Fuel City: Quinhagak	**Heating Degree Days:** 12,107 deg F-days
Utility Information	
Electric Utility: AVEC-Quinhagak - Commercial - Sm	**Average Annual Cost/kWh:** $0.48/kWh

Annual Energy Cost Estimate

Description	Space Heating	Water Heating	Ventilation Fans	Clothes Drying	Lighting	Refrigeration	Other Electrical	Total Cost
Existing Building	$22,015	$2,859	$1,026	$34,516	$2,941	$252	$14,897	**$78,565**
With Proposed Retrofits	$4,990	$1,609	$1,057	$16,492	$2,115	$259	$7,021	**$33,602**
Savings	$17,025	$1,250	-$31	$18,024	$826	-$7	$7,876	**$44,963**

Building Benchmarks

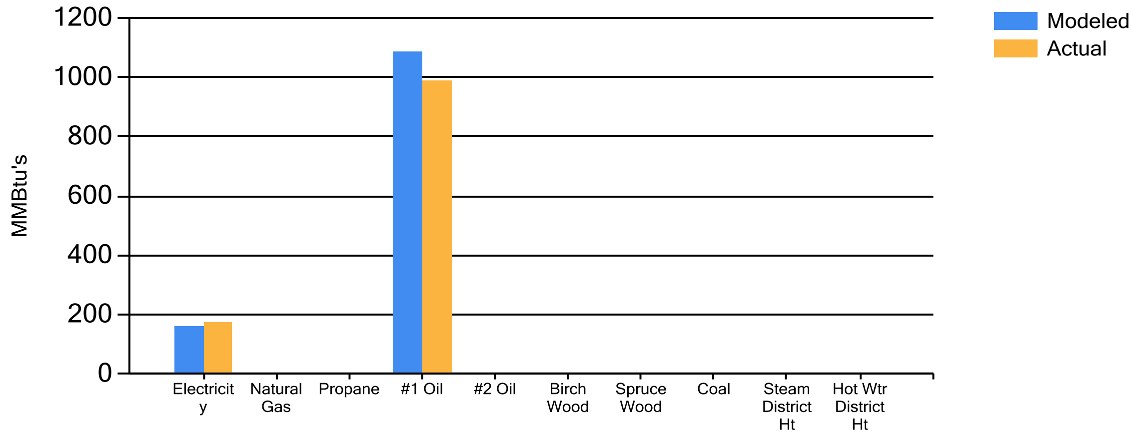
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	158.1	13.06	$9.92
With Proposed Retrofits	71.4	5.90	$4.24

EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

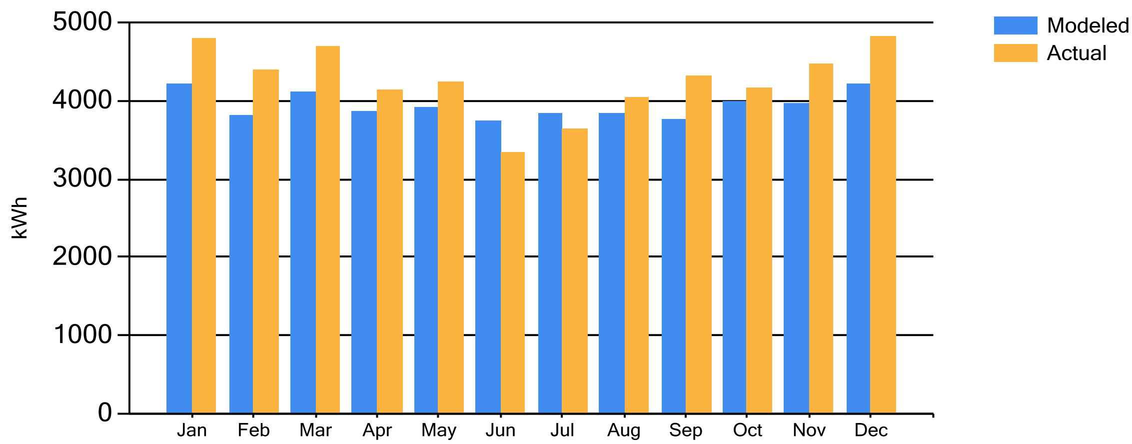
Appendix B – Actual Fuel Use versus Modeled Fuel Use

The Orange bars show Actual fuel use, and the Blue bars are AkWarm's prediction of fuel use.

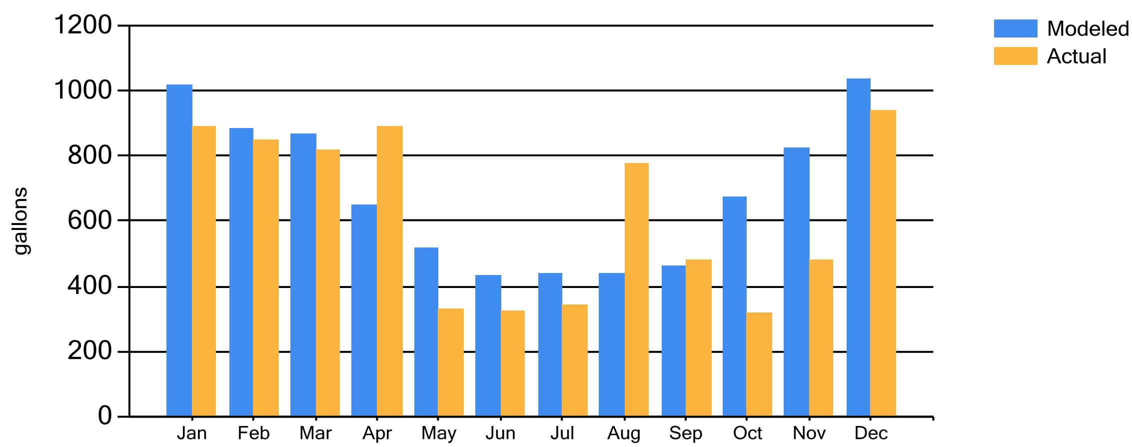
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	15.3	15.2	15.1	14.9	14.7	14.6	14.6	14.6	14.7	14.9	15.1	15.3
As Proposed	12.9	12.8	12.7	12.6	12.4	12.3	12.3	12.3	12.4	12.6	12.7	12.9

AkWarmCalc Ver 2.4.1.0, Energy Lib 3/30/2015