Comprehensive Energy Audit
For

Anvik Water Treatment Plant & Washeteria

Prepared For
City of Anvik

May 21, 2015

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 Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Anvik, Alaska. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and 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 April of 2015 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 Water Treatment Plant Operator William Nicholai, Anvik Mayor Jason Jones, Anvik City Clerk Christine Elswick, Anvik Tribal EPA Nathan Elswick, and Anvik First Chief Carl Jerue.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Anvik. The scope of the audit focused on Anvik Water Treatment Plant & Washeteria. 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.

In the near future, a representative of ANTHC will be contacting both the City of Anvik and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

The total predicted energy cost for the Anvik Water Treatment Plant and Washeteria is $27,357 per year. Fuel oil represents the largest portion with an annual cost of $23,046 for #1 fuel oil. Electricity accounts for the remaining portion with an annual cost of $4,311. This includes $1,540 paid by the City and $2,771 paid by the Power Cost Equalization (PCE) program through the State of Alaska. These predictions are based on the electricity and fuel prices at the time of the audit.

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 Anvik, the cost of electricity without PCE is $0.56/KWH and the cost of electricity with PCE is $0.20/KWH.

The Anvik Water Treatment Plant & Washeteria received funding from the Interior Regional Housing Authority (IRHA) and the Renewable Energy Fund managed by the Alaska Energy Authority for a biomass cordwood boiler to be installed to heat the water treatment plant, clinic, city office, and community hall. The projected savings for this project are reflected in this report.

The table below lists the total usage of electricity, #1 oil, and wood in the water treatment plant and washeteria before and after the proposed retrofits.

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	6,559 kWh	5,813 kWh
#1 Oil	3,841 gallons	343 gallons
Spruce Wood	0.00 cords	11.91 cords

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

Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	407.2	30.25	$21.04
With Proposed Retrofits	215.8	16.03	$6.83
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 1.1 below summarizes the energy efficiency measures analyzed for the Anvik Water Treatment Plant & Washeteria. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.1
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
1	Other – Dryers	Install two electric dryers and turn off operations of hydronic dryers.	$4,671	$10,000	4.34	2.1	16,402.0
2	Lighting - Power Retrofit: Exterior at Entrance	Replace with energy-efficient LED lighting.	$32	$100	3.81	3.1	93.0
3	Setback Thermostat: Water Treatment Plant	Use a controller to lower air temperature to 60.0 deg F when unoccupied for the Water Treatment Plant space.	$478	$2,000	3.14	4.2	1,612.2
4	Heating, Ventilation, and DHW	Install new Garn 2000 biomass boiler, new oil fired boiler, new hot water heater, and controls necessary to allow cold start of new oil fired boiler only when needed.	$12,090	$125,000	2.41	10.3	55,809.7
5	Lighting - Power Retrofit: Arctic Entry	Replace with energy-efficient LED lighting.	$9	$60	1.82	6.4	26.4
6	Other – Hydronic Loop in City Office	Re-pipe mechanical room and re-commission controls in City Office	$1,075	$20,000	0.66	18.6	1,036.2
7	Air Tightening	Weatherize the building by insulating doorways, caulking windows, and reducing air infiltration.	$75	$1,000	0.64	13.4	140.7
8	Window/Skylight: Broken Windows	Replace existing window with new, triple paned window.	$54	$1,293	0.63	24.1	100.1
	TOTAL, all measures		**$18,484**	**$159,453**	**2.30**	**8.6**	**75,220.3**

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 $18,484 per year, or 67.6% of the buildings' total energy costs. These measures are estimated to cost $159,453, for an overall simple payback period of 8.6 years.

Table 1.2 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 1.2

Annual Energy Cost Estimate						
Description	**Space Heating**	**Water Heating**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Total Cost**
Existing Building	$18,846	$942	$6,511	$242	$756	**$27,357**
With Proposed Retrofits	$6,083	$1,127	$646	$199	$758	**$8,873**
Savings	$12,764	-$185	$5,865	$43	-$2	**$18,484**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Anvik Water Treatment Plant & Washeteria. 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
- Water consumption, treatment (optional) & disposal

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 Anvik Water Treatment Plant & Washeteria 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.

Anvik Water Treatment Plant & Washeteria is classified as being made up of the following activity areas:

1) Anvik Water Treatment Plant - Washeteria: 1,300 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; heating and ventilation; 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 re-simulated 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. Anvik Water Treatment Plant & Washeteria

3.1. Building Description

The 1,300 square foot Anvik Water Treatment Plant & Washeteria was constructed in 1986, with a normal occupancy of 2 people. The number of hours of operation for this building average 13 hours per day, considering all seven days of the week.

The Anvik Water Treatment Plant & Washeteria serves as the water gathering point for the residents of the community and as a location for laundromat and shower services. There is one watering point with a 1” pipe that provides treated water for community pickup. There are four clothes washers and three hydronic dryers for public use in the washeteria. At the time of the energy audit only two clothes washers were operational.

Water is pumped in from a ground source well located inside the water treatment plant. The water is pumped through a series of filters and three pressure tanks before being stored in a hot water generator and distributed. Pressure pumps are used to keep the pressure up for use in the washeteria and showers. The facility has a single watering point that is used by the residents to collect their own water supply. The rest of the water is used in the washing machines and restrooms.

The city office is located next to the Anvik Water Treatment Plant & Washeteria and is heated by the boilers in the water treatment plant. The heat is supplied through an insulated glycol line that connects the two buildings.

Description of Building Shell

The exterior walls are constructed with a stressed skin panel with 5.5 inches of polyurethane foam insulation. The insulation is damaged. There is approximately 1752 square feet of wall space.

The rood of the building has a cathedral ceiling constructed with standard 16 inch framing and 5.5 inches of polyurethane foam insulation. The insulation is slightly damaged and there are approximately 1959 square feet of roof space.

The building is built on pilings with six inches of R-19 batt insulation. The insulation is slightly damaged and there is approximately 1,900 square feet of floor space.

There are two double-pane windows in the building with wood framing that total approximately 10 square feet of window space. There are two broken windows in the building with wood framing that total approximately 10 square feet of window space.

There are two doors in the building that are both metal doors with an insulated core. There are approximately 42 square feet of door space.

Description of Heating and Cooling Plants

The Heating Plants used in the building are:

Peerless

Fuel Type:	#1 Oil
Input Rating:	255,000 BTU/hr
Steady State Efficiency:	75 %
Idle Loss:	2 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Boiler is old and inefficient and need to be replaced.

Peerless

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Input Rating:	255,000 BTU/hr
Steady State Efficiency:	75 %
Idle Loss:	2 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	Boiler is old and inefficient and needs to be replaced.

Space Heating Distribution Systems

There are three unit heaters in the building with two unit heaters in the water treatment plant space and one unit heater in the washeteria space. The two unit heaters in the water treatment plant are both manufactured by Trane and run on thermostat call only. The heaters use 4,000 BTUH each. The washeteria unit heater is a bigger model and uses 8,000 BTUH when in operation.

Lighting

The washeteria has four fixtures with two LED 17 Watt module light bulbs in each fixture.

The rest rooms have two fixtures with two LED 17 Watt module light bulbs in each fixture.

The water treatment plant has seven fixtures with two LED 17 Watt module light bulbs in each fixture.

The exterior of the building next to the washeteria entrance has one fixture with two CFL 20 Watt module light bulbs in the fixture.

The rest rooms have three task lights that are CFL 13 Watt module light bulbs.

The arctic entry has one fixture with a single standard 75 Watt incandescent light bulb.

Plug Loads

The water treatment plant - washeteria has a variety of power tools, a telephone, and some other miscellaneous loads that require a plug into an electrical outlet. The use of these items is infrequent and consumes a small portion of the total energy demand of the building.

Major Equipment

There are three clothes washers present in the washeteria that are available for public use. The washers have an annual consumption of approximately 321 KWH.

There is an electric heat tape line that heats the well intake to prevent it from freezing. The heat tape has an annual consumption of approximately 109 KWH.

There is a well pump that is used to pump water from the ground water source into the water treatment plant. The well pump has an annual consumption of approximately 78 KWH.

There are a variety of miscellaneous pumps, controls, and alarms that all work to operate the washeteria and water treatment plant. The total miscellaneous equipment has an approximate annual consumption of 658 KWH.

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 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 following is a list of the utility companies providing energy to the building and the class of service provided:

Electricity: AVEC-Anvik - Commercial - Sm

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 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.56/kWh
#1 Oil	$ 6.00/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Anvik pays approximately $27,357 annually for electricity and other fuel costs for the Anvik Water Treatment Plant & Washeteria.

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

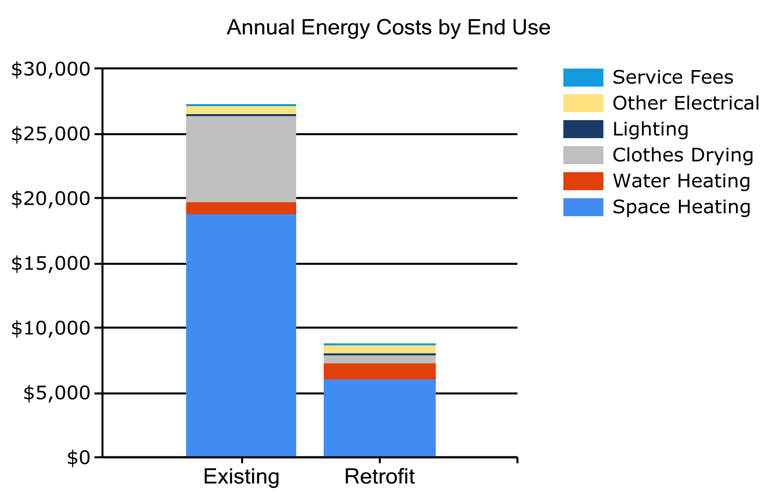


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

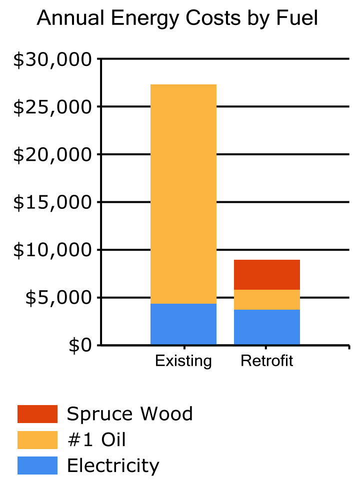
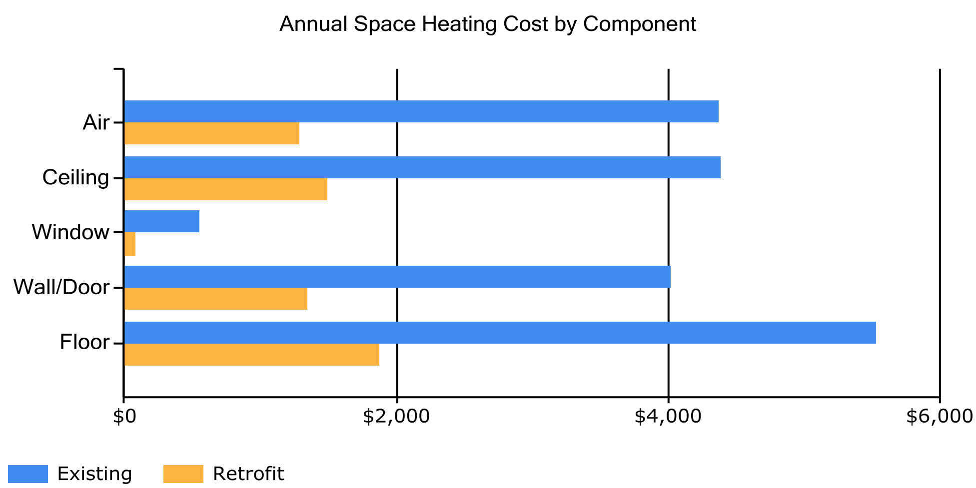


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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.

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	578	479	450	315	106	100	102	213	214	343	456	573
DHW	2	2	2	2	2	2	2	2	2	2	2	2
Clothes_Drying	90	82	90	88	92	89	93	92	89	90	87	90
Lighting	35	32	35	34	23	22	23	30	34	35	34	35
Other_Electrical	112	102	90	87	90	87	90	90	87	112	108	112

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	416	342	317	209	121	80	71	81	117	228	322	412
DHW	12	11	12	12	14	15	15	15	14	13	11	12
Clothes_Drying	72	67	75	77	88	91	97	95	85	79	72	72

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):

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

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

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

Table 3.4
Anvik Water Treatment Plant & Washeteria 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	6,559 kWh	22,384	3.340	74,763
#1 Oil	3,841 gallons	507,011	1.010	512,081
Total		**529,395**		**586,844**
BUILDING AREA		1,300	Square Feet	
BUILDING SITE EUI		407	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		451	**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

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**407.2**	**30.25**	**$21.04**
With Proposed Retrofits	**215.8**	**16.03**	**$6.83**
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 system and central plant 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 Anvik Water Treatment Plant & Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Anvik 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. Equipment cost estimate calculations are provided in Appendix D.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Anvik. 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 model does not model heating and ventilation systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

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
Anvik Water Treatment Plant & Washeteria, Anvik, 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	Other – Dryers	Install two electric dryers and turn off operations of hydronic dryers.	$4,671	$10,000	4.34	2.1	16,402.0
2	Lighting - Power Retrofit: Exterior at Entrance	Replace with energy-efficient LED lighting.	$32	$100	3.81	3.1	93.0
3	Setback Thermostat: Water Treatment Plant	Use a controller to lower air temperature to 60.0 deg F when unoccupied for the Water Treatment Plant space.	$478	$2,000	3.14	4.2	1,612.2
4	Heating, Ventilation, and DHW	Install new Garn 2000 biomass boiler, new oil fired boiler, new hot water heater, and controls necessary to allow cold start of new oil fired boiler only when needed.	$12,090	$125,000	2.41	10.3	55,809.7
5	Lighting - Power Retrofit: Arctic Entry	Replace with energy-efficient LED lighting.	$9	$60	1.82	6.4	26.4

Table 4.1 Anvik Water Treatment Plant & Washeteria, Anvik, 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**
6	Other – Hydronic Loop in City Office	Re-pipe mechanical room and re-commission controls in City Office	$1,075	$20,000	0.66	18.6	1,036.2
7	Air Tightening	Weatherize the building by insulating doorways, caulking windows, and reducing air infiltration.	$75	$1,000	0.64	13.4	140.7
8	Window/Skylight: Broken Windows	Replace existing window with new, triple paned window.	$54	$1,293	0.63	24.1	100.1
	TOTAL, all measures		**$18,484**	**$159,453**	**2.30**	**8.6**	**75,220.3**

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. When the building is in cooling mode, these items contribute to the overall cooling demands of the building; therefore, lighting efficiency improvements will reduce cooling requirements in air-conditioned buildings. Conversely, lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties and cooling benefits were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Window Measures

Rank	Location		Size/Type, Condition		Recommendation	
8	Window/Skylight: Broken Windows		Glass: No glazing - broken, missing Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.11		Replace broken window with new double-pane window.	
Installation Cost		$1,293	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$54
Breakeven Cost		$809	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	24
Auditors Notes: Replace existing window with U-0.30 vinyl window to reduce air penetration and increase insulation value of the glass.						

4.3.2 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
7			Air Tightness estimated as: 1000 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 10%.	
Installation Cost		$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$75
Breakeven Cost		$641	**Savings-to-Investment Ratio**	0.6	**Simple Payback yrs**	13
Auditors Notes: Caulk windows, implement weather stripping around doors and other wall penetrations, increase insulation usage in the building.						

4.4 Mechanical Equipment Measures

4.4.1 Heating /Domestic Hot Water Measure

Rank	Recommendation					
4	Install new Garn 2000 biomass boiler, new oil fired boiler, new hot water heater, and controls necessary to operate biomass boiler as the primary heat source and to allow cold start of new oil fired boiler only when needed..					
Installation Cost		$125,000	**Estimated Life of Measure (yrs)**	30	**Energy Savings (/yr)**	$12,090
Breakeven Cost		$301,503	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	10
Auditors Notes: This EEM is a project that has been funded by the Alaska Energy Authority through a combination of the City of Anvik, IRHA, and ANTHC						

4.4.2 Night Setback Thermostat Measures

Rank	Building Space				Recommendation	
3	Anvik Water Treatment Plant - Washeteria				Lower room temperature to 60 deg. F when unoccupied in the water treatment plant and washeteria space.	
Installation Cost		$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$478
Breakeven Cost		$6,277	**Savings-to-Investment Ratio**	3.1	**Simple Payback yrs**	4
Auditors Notes: Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Anvik Water Treatment Plant - Washeteria space.						

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	
2	Exterior at Entrance	FLUOR (2) CFL, Spiral 20 W with Manual Switching		Replace with new energy-efficient lighting.	
Installation Cost	$100	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$32
Breakeven Cost	$381	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	3
Auditors Notes: Replace with 2 LED 8 Watt Module standard electronic light bulbs.					

Rank	Location	Existing Condition		Recommendation	
5	Arctic Entry	INCAN A Lamp, Std 75W with Manual Switching		Replace with new energy-efficient lighting.	
Installation Cost	$60	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$9
Breakeven Cost	$109	**Savings-to-Investment Ratio**	1.8	**Simple Payback yrs**	6
Auditors Notes: Replace with LED 10 Watt Module standard electronic light bulbs.					

4.5.2 Other Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
1		Clothes Drying Load		Install two electric dryers and turn off operations of hydronic dryers.	
Installation Cost	$10,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$4,671
Breakeven Cost	$43,382	**Savings-to-Investment Ratio**	4.3	**Simple Payback yrs**	2
Auditors Notes: The community has enough eligible PCE electricity to accommodate the use of electric dryers at a subsidized electricity cost.					

Rank	Location	Description of Existing		Efficiency Recommendation	
6		Space Heating Load - City Office		Re-pipe mechanical room and re-commission controls in City Office	
Installation Cost	$20,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,075
Breakeven Cost	$13,291	**Savings-to-Investment Ratio**	0.7	**Simple Payback yrs**	19
Auditors Notes: The city office building is heated by the water treatment plant boilers. The piping is inefficient and should be consolidated to allow for better distribution of heat.					

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 Anvik and the water treatment plant operator to follow up on the recommendations made in this audit report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the city with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2015 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Anvik Water Treatment Plant & Washeteria	**Auditor Company:** ANTHC-DEHE
Address: P O Box 50	**Auditor Name:** Carl Remley
City: Anvik **Client Name:** William Nicholi	**Auditor Address:** 3900 Ambassador Drive, Suite 301 Anchorage, AK 99508
Client Address: P O Box 50 Anvik AK 99558	**Auditor Phone:** (907) 729-3543 **Auditor FAX:**
Client Phone: (907) 663-6328 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 1,300 square feet	**Design Space Heating Load:** Design Loss at Space: 13,810 Btu/hour with Distribution Losses: 13,810 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 21,053 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Anvik	**Design Outdoor Temperature:** -39 deg F
Weather/Fuel City: Anvik	**Heating Degree Days:** 13,462 deg F-days
Utility Information	
Electric Utility: AVEC-Anvik - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.657/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate									
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$18,846	$0	$942	$0	$6,511	$242	$756	$60	**$27,357**
With Proposed Retrofits	$6,083	$0	$1,127	$0	$646	$199	$758	$60	**$8,873**
Savings	$12,764	$0	-$185	$0	$5,865	$43	-$2	$0	**$18,484**

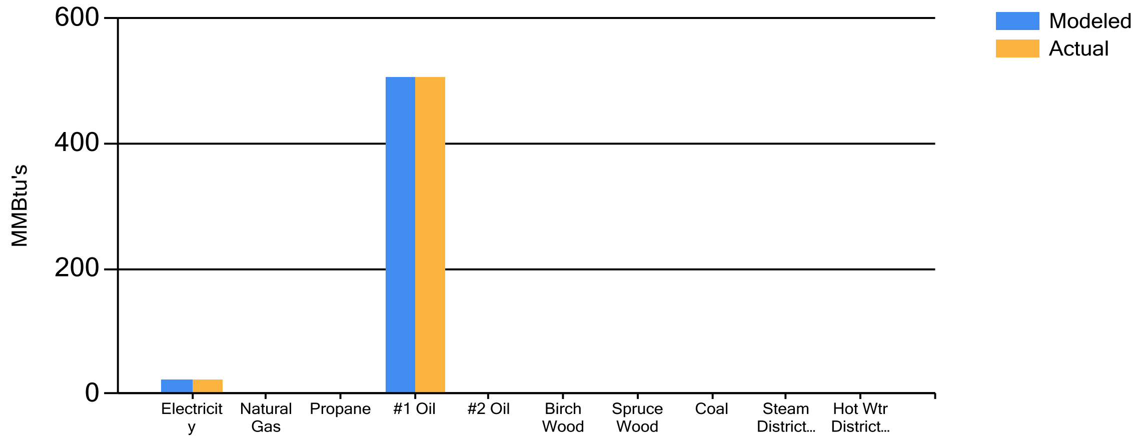
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	407.2	30.25	$21.04
With Proposed Retrofits	215.8	16.03	$6.83

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.

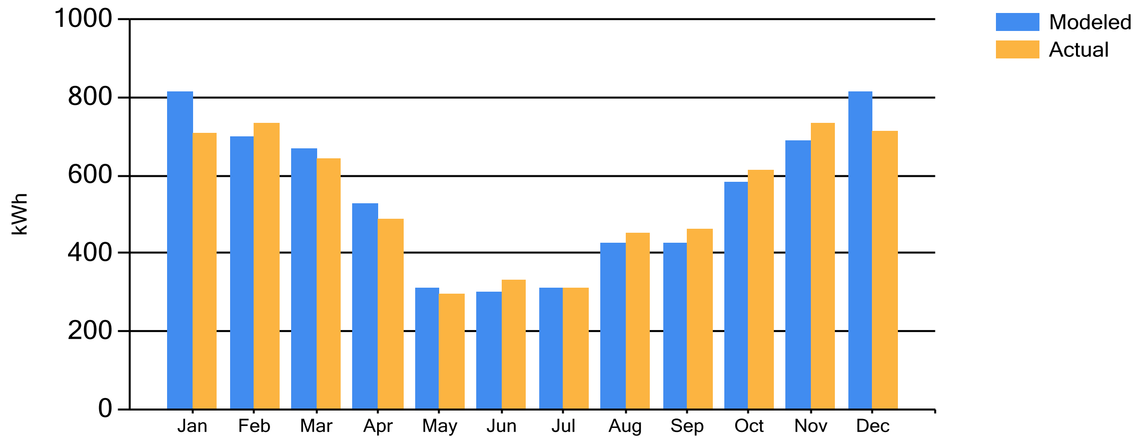
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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