Comprehensive Energy Audit
For
Kongiginak Water Treatment Plant, Tribal Offices, and Hotel

Prepared For

Native Village of Kongiganak

August 30, 2011

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PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the Native Village of Kongiganak. The authors of this report are Carl H. Remley, Certified Energy Auditor (CEA) and Certified Energy Manager (CEM) and Gavin Dixon.

The purpose of this report is to provide a comprehensive document that summarizes the findings and analysis that resulted from an energy audit conducted over the past couple months by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy efficiency measures. Discussions of site specific concerns and an Energy Efficiency Action Plan are also included in this report.

ACKNOWLEDGMENTS

The Energy Projects Group gratefully acknowledges the assistance of the City, Tribal, and operations staff for the Native Village of Kongiganak.

1. EXECUTIVE SUMMARY

This report was prepared for the Native Village of Kongiginak. The scope of the audit focused on Kongiginak Water Treatment Plant, Tribal Offices, and Hotel. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC systems, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the annual predicted energy costs for the buildings analyzed are $9,724 for Electricity, $42,835 for #1 Oil, and an assumed value of $6,421 for recovered heat from the power plant. ($7.50 per million BTU of heating.) The total energy costs are $58,980 per year.

It should be noted that this facility received the power cost equalization (PCE) study from the State of Alaska last year. Additionally the heat recovery received from the power plant is equivalent to 6,484 gallons of fuel oil, or $29,178. Without PCE or the recovered heat electricity costs for the building would have been $37,479, fuel costs would have been $72,013, and total costs would have been $109, 492.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Kongiginak Water Treatment Plant, Tribal Offices, and Hotel. 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]
1	Setback Thermostat: Water Treatment Plant Downstairs	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Downstairs space.	$973	$1,000	14.54	1.0
2	Other Electrical: Heat Tape	Improve Manual Switching	$50	$25	12.66	0.5
3	Setback Thermostat: Water Treatment Plant Upstairs	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Upstairs space.	$772	$1,000	11.53	1.3
4	Setback Thermostat: Upstairs Tribal Offices and Apartments	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Upstairs Tribal Offices and Apartments space.	$548	$1,000	8.19	1.8
5	Cooking and Clothes Drying – Clothes Dryer	Modify actuator to control air handler based on temperature	$1,127	$2,000	7.59	1.8
6	HVAC And DHW	Retrocommison Boilers, New Tekmar, Turn down Circ pumps	$5,851	$15,000	7.56	2.6
7	Other Electrical: Printers and Fax	Improve Manual Switching	$40	$20	11.81	0.5

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]**
8	Other Electrical: CB Radio	Improve Manual Switching	$8	$10	4.71	1.3
9	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	$266	$1,000	3.89	3.8
10	Other Electrical: Computers and Monitors	Improve Manual Switching	$24	$50	2.82	2.1
11	Other Electrical: Plant Controls	Replace with 19 Various Plant Controls	$8	$25	2.53	3.1
12	Lighting: Exterior Lighting	Replace with 8 LED 17W Module Electronic	$460	$2,000	2.01	4.3
13	Water Storage Tank	Getting appropriate aqua stats and controls to control the tank heat add, and keep the tank at 40 degrees. This will reduce unnecessary heat. Additionally the two tank heat add circ pumps are running in parallel, only one needs to be running. The real savings is even greater when you consider that there is currently no way to tell what the tank is being kept at. This can help prevent maintenance costs by avoiding freeze ups as well. Turning off one of the two circ pumps being currently operated in parallel would be an additional savings.	$750	$6,000	1.84	8.0
14	Air Tightening	Perform air sealing to reduce air leakage by 300 cfm at 50 Pascals.	$117	$1,000	1.18	8.6
	TOTAL, cost-effective measures		**$10,993**	**$30,130**	**6.10**	**2.7**
	The following measures were *not* found to be cost-effective:					
15	Lighting: Washeteria Lighting	Replace with 10 LED Replacement Bulbs	$152	$2,400	0.51	15.8
	TOTAL, all measures		**$11,146**	**$32,530**	**5.69**	**2.9**

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 $11,146 per year, or 18.9% of the buildings' total energy costs. These measures are estimated to cost $32,530, for an overall simple payback period of 2.9 years. If only the cost-effective measures are implemented, the annual utility cost can be reduced by $10,993 per year, or 18.6% of the buildings' total energy costs. These measures are estimated to cost $30,130, for an overall simple payback period of 2.7 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	Space Cooling	Water Heating	Lighting	Other Electrical	Water Storage Tank	Clothes Drying	Ventilation Fans	Service Fees	Total Cost
Existing Building	$20,288	$0	$4,167	$3,004	$2,599	$6,866	$21,677	$0	$0	**$58,980**
With All Proposed Retrofits	$11,884	$0	$4,167	$2,316	$2,424	$6,116	$20,550	$0	$0	**$47,835**
SAVINGS	$8,405	$0	$0	$688	$176	$750	$1,127	$0	$0	**$11,146**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Kongiginak Water Treatment Plant, Tribal Offices, and Hotel. The scope of this project included evaluating building shell, lighting and other electrical systems, and HVAC 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, ventilation, and air conditioning equipment (HVAC)
- 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 Kongiginak Water Treatment Plant, Tribal Offices, and Hotel 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.

Kongiginak Water Treatment Plant, Tribal Offices, and Hotel is classified as being made up of the following activity areas:

1) Washeteria: 2,086 square feet
2) Upstairs Tribal Offices and Apartments: 1,547 square feet
3) Water Treatment Plant Downstairs: 2,635 square feet
4) Water Treatment Plant Upstairs: 2,635 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 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. Kongiginak Water Treatment Plant, Tribal Offices, and Hotel

3.1. Building Description

The 8,903 square foot Kongiginak Water Treatment Plant, Tribal Offices, and Hotel was constructed in 1980, with a normal occupancy of 7 people. The number of hours of operation for this building average eight hours per day, considering all seven days of the week.

Description of Building Shell

The exterior walls are constructed of either 2x8 or 2x10 construction, with batt insulation of 7.5 and 9.5 inches respectively. The building has metal plywood sheathing.

The building has two roofs. The water plant has a cold roof with 6 inches of uneven batt insulation. The tribal offices and hotel apartments have a warm roof with 12 inches of polyurethane insulation.

The building is built on pilings with 12 inches of batt insulation in the floor.

Typical windows throughout the building are double paned wood/vinyl operable windows with moderate external shading.

Doors are metal urethane doors with thermal breaks. There is additionally a garage door with a urethane foam core.

Description of Heating and Cooling Plants

The Heating Plants used in the building are:

Burnam PV77WC #1

Fuel Type:	#1 Oil
Input Rating:	277,000 BTU/hr

Steady State Efficiency: 60 %
Idle Loss: 1.5 %
Heat Distribution Type: Water
Boiler Operation: Sep - Jun

Burnam PV77WC #2
Fuel Type: #1 Oil
Input Rating: 277,000 BTU/hr
Steady State Efficiency: 72 %
Idle Loss: 1.5 %
Heat Distribution Type: Water
Boiler Operation: Sep - Jun

Burnam PV77WC #3
Fuel Type: #1 Oil
Input Rating: 277,000 BTU/hr
Steady State Efficiency: 74 %
Idle Loss: 1 %
Heat Distribution Type: Water
Boiler Operation: Sep - Jun

Recovered Heat
Fuel Type: Recovered Heat
Input Rating: 800,000 BTU/hr
Steady State Efficiency: 95 %
Idle Loss: 0.5 %
Heat Distribution Type: Water
Boiler Operation: All Year

Bock Hot Water Heater
Fuel Type: #1 Oil
Input Rating: 201,000 BTU/hr
Steady State Efficiency: 86 %
Idle Loss: 1 %
Heat Distribution Type: Water
Boiler Operation: All Year

Bryan D650-W-FDO
Fuel Type: #1 Oil
Input Rating: 536,000 BTU/hr
Steady State Efficiency: 74 %
Idle Loss: 1.5 %
Heat Distribution Type: Water
Boiler Operation: All Year
Notes: 4.0 gph nozzles,

Space Heating and Cooling Distribution Systems

Heating throughout the building is supplied by either baseboard heating or unit heaters. The heat is partially supplied by recovered heat from the power plant, but also by the operation of the boilers.

Domestic Hot Water System

Domestic hot water is supplied by the Bock Hot Water Heater, which has 68 gallons of storage and an insulation value of 7. Approximately 230 gallons of hot water are used each day in the building, primarily to supply washing machines and showers with hot water. Roughly 30 loads of laundry are done in the washing machines each day, and an average of 4 showers are taken per day in the building.

Waste Heat Recovery Information

Waste heat is served to the Kongiganak WTP boiler system from the Kongiganak power plant, the system transfers heated hydronic generator cooling glycol to the WTP via insulated arctic pipe. There is a heat exchanger on either end of this system, the circulation pumps are controlled by and located in the power plant. Controls that would limit the reverse transfer of heat from the WTP to the power plant were not observed during the inspection. It is critical that the system be configured to prevent this from happening. Additionally the set-points should be carefully monitored to ensure that waste heat is utilized when it is available.

Lighting

Lighting in the building is primarily made up of T8 Electronic ballast fixtures with 2 to 4 32 watt bulbs each. There are several CFL lamps in the hotel, as well as a few T12 fixtures still in use in the water plant. Exterior lighting for the building is made up primarily of eight metal halide 100 Watt wall packs.

Plug Loads

Plug Loads in the building consist of desktop computers, monitors, radios, two coffee pots, phones, and various kitchen equipment in the hotel rooms. There are four refrigerators in the building as well. Various power tools and battery chargers are also in the building.

Major Equipment

The water plant has many pumps, including: treatment pumps, the raw water pump, backwash pump, and the pressure pumps. Additionally the water plant has many control panels, and control systems that use a fair amount of energy. Washing machines in the washeteria also are a significant electrical load. The largest non lighting electrical load in the building is for the operation of the dryers, which contain multiple motors and individual circulation pumps.

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.

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: Puvurnaq Power Company - 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	$ 0.14/kWh
#1 Oil	$ 4.50/gallons
Recovered Heat	$ 7.50/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Kongiginak pays approximately $58,980 annually for electricity and other fuel costs for the Kongiginak Water Treatment Plant, Tribal Offices, and Hotel.

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

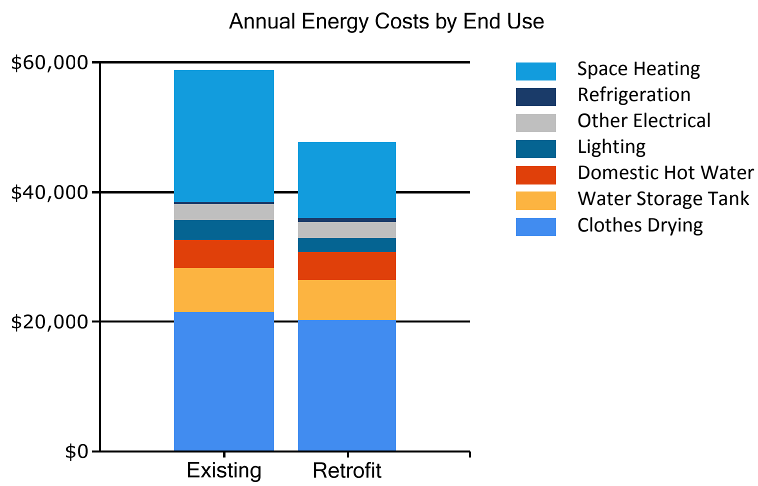


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

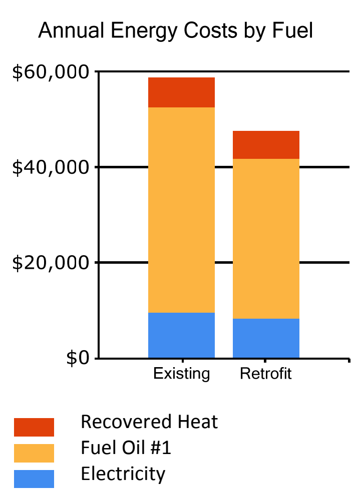
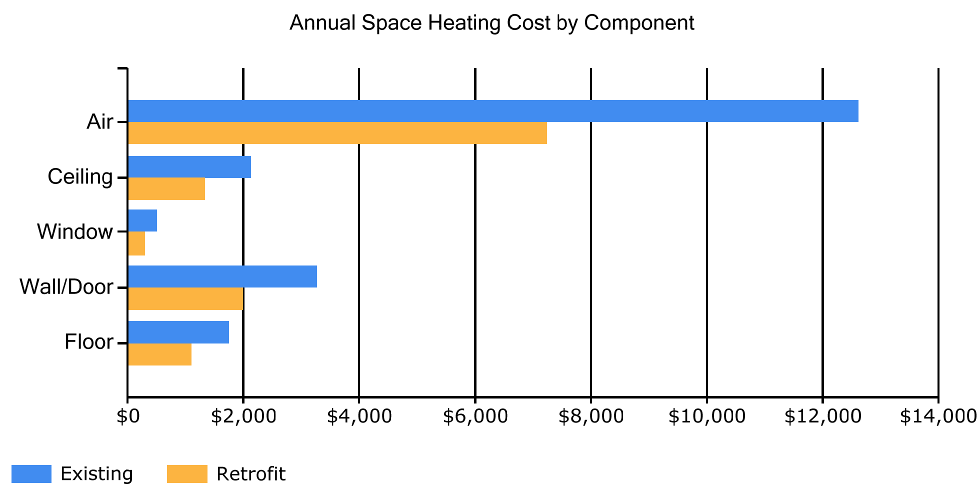


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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
Other_Electrical	1381	1259	1381	2277	1381	1319	1363	1363	2393	1381	1337	1381
Lighting	1787	1628	1787	1729	1787	1729	1787	1787	1729	1787	1729	1787
Refrigeration	225	205	225	218	225	218	225	225	218	225	218	225
Water Storage Tank	126	115	126	122	126	122	0	0	0	126	122	126
Clothes_Drying	1162	1059	1162	1124	1162	1124	1162	1162	1124	1162	1124	1162
Ventilation_Fans	0	0	0	0	0	0	0	0	0	0	0	0
DHW	71	65	71	69	71	69	71	71	69	71	69	71
Space_Heating	914	833	910	871	893	850	878	878	862	899	877	914

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Water Storage Tank	169	154	169	164	169	164	0	0	0	169	164	169
Clothes_Drying	266	242	266	257	266	257	266	266	257	266	257	266
DHW	76	70	76	74	76	74	76	76	74	76	74	76
Space_Heating	651	584	551	336	184	44	45	45	128	316	461	652

Hot Water District Ht Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Clothes_Drying	64	58	64	62	64	62	64	64	62	64	62	64
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Space_Heating	16	14	14	8	5	3	3	3	3	8	11	16

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):

Building Site EUI = (Electric Usage in kBtu + Fuel Oil Usage in kBtu + similar for other fuels)
Building Square Footage

Building Source EUI = (Electric Usage in kBtu X SS Ratio + Fuel Oil Usage in kBtu X SS Ratio + similar for other fuels)
Building Square Footage
where "SS Ratio" is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.4
Kongiginak Water Treatment Plant, Tribal Offices, and Hotel 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	68,144 kWh	232,574	3.340	776,798
#1 Oil	9,519 gallons	1,256,492	1.010	1,269,057
Recovered Heat	856.17 million Btu	856,170	1.280	1,095,897
Total		**2,345,236**		**3,141,753**
BUILDING AREA		8,903	Square Feet	
BUILDING SITE EUI		263	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		353	**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.				

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 HVAC 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 Kongiginak Water Treatment Plant, Tribal Offices, and Hotel was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Kongiganak 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 Kongiganak. 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 HVAC 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. Calculations and cost estimates for analyzed measures are provided in Appendix C.

Table 4.1
Kongiginak Water Treatment Plant, Tribal Offices, and Hotel, Kongiganak, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
1	Setback Thermostat: Water Treatment Plant Downstairs	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Downstairs space.	$973	$1,000	14.54	1.0
2	Other Electrical: Heat Tape	Improve Manual Switching	$50	$25	12.66	0.5
3	Setback Thermostat: Water Treatment Plant Upstairs	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Upstairs space.	$772	$1,000	11.53	1.3
4	Setback Thermostat: Upstairs Tribal Offices and Apartments	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Upstairs Tribal Offices and Apartments space.	$548	$1,000	8.19	1.8
5	Clothes Drying - ClothesDryer	Modify actuator to control air handler based on temperature	$1,127	$2,000	7.59	1.8
6	HVAC And DHW	Retrocommison Boilers, New Tekmar, Turn down Circ pumps	$5,851	$15,000	7.56	2.6
7	Other Electrical: Printers and Fax	Improve Manual Switching	$40	$20	11.81	0.5
8	Other Electrical: CB Radio	Improve Manual Switching	$8	$10	4.71	1.3
9	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	$266	$1,000	3.89	3.8
10	Other Electrical: Computers and Monitors	Improve Manual Switching	$24	$50	2.82	2.1
11	Other Electrical: Plant Controls	Replace with 19 Various Plant Controls	$8	$25	2.53	3.1
12	Lighting: Exterior Lighting	Replace with 8 LED 17W Module Electronic	$460	$2,000	2.01	4.3

Table 4.1 Kongiginak Water Treatment Plant, Tribal Offices, and Hotel, Kongiganak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR**	**Simple Payback (Years)**
13	Water Storage Tank	Getting appropriate aqua stats and controls to control the tank heat add, and keep the tank at 40 degrees. This will reduce unnecessary heat. Additionally the two tank heat add circ pumps are running in parallel, only one needs to be running. The real savings is even greater when you consider that there is currently no way to tell what the tank is being kept at. This can help prevent maintenance costs by avoiding freeze ups as well. Turning off one of the two circ pumps being currently operated in parallel would be an additional savings.	$750	$6,000	1.84	8.0
14	Air Tightening	Perform air sealing to reduce air leakage by 300 cfm at 50 Pascals.	$117	$1,000	1.18	8.6
	TOTAL, cost-effective measures		**$10,993**	**$30,130**	**6.10**	**2.7**
	The following measures were *not* found to be cost-effective:					
15	Lighting: Washeteria Lighting	Replace with 10 LED Replacement Bulbs	$152	$2,400	0.51	15.8
	TOTAL, all measures		**$11,146**	**$32,530**	**5.69**	**2.9**

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 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
14			Air Tightness estimated as: 12500 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 300 cfm at 50 Pascals.	
Installation Cost		$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$117
Breakeven Cost		$1,179	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	9
Auditors Notes: Insulating the attics access hatch, putting new weather stripping around doors, and using caulk or spray foam to seal leaky windows would yield a significant savings in fuel consumption in the building.						

4.4 Mechanical Equipment Measures

4.4.1 Heating Measure

Rank	Recommendation					
6	Retrocommison Boilers, New Tekmar, Turn down Circ pumps					
Installation Cost		$15,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$5,851
Breakeven Cost		$113,475	**Savings-to-Investment Ratio**	7.6	**Simple Payback yrs**	3
Auditors Notes: Several inefficiencies were found in the WTP boiler room. Electrical consumption is above what is required due to the circulation pumps being operated at their maximum setting. The lowest setting required to meet the demands of the system should be used. Additionally the existing Tekmar boiler controller is not configured to control the boilers with regards to un-occupied times, and outdoor temperature. The boilers need to be service, and set to take greater advantage of waste heat, along with a differential controller to ensure that boiler heat is not beings sent back to the power plant.						

4.4.2 Ventilation System Measures (There were no improvements in this category)

4.4.3 Night Setback Thermostat Measures

Rank	Building Space				Recommendation	
9	Washeteria				Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	
Installation Cost		$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$266
Breakeven Cost		$3,895	**Savings-to-Investment Ratio**	3.9	**Simple Payback yrs**	4
Auditors Notes: Installing setback thermostats in the various zones of the building, and programming them to reduce the demand for heat to 60 degrees at night or weekends, or when that zone of the facility is not occupied would significantly reduce the heating load of the facility. This would allow for comfortable temperatures to be automatically set when the building is occupied.						

Rank	Building Space			Recommendation	
4	Upstairs Tribal Offices and Apartments			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Upstairs Tribal Offices and Apartments space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$548
Breakeven Cost	$8,187	**Savings-to-Investment Ratio**	8.2	**Simple Payback yrs**	2
Auditors Notes: Installing setback thermostats in the various zones of the building, and programming them to reduce the demand for heat to 60 degrees at night or weekends, or when that zone of the facility is not occupied would significantly reduce the heating load of the facility. This would allow for comfortable temperatures to be automatically set when the building is occupied.					

Rank	Building Space			Recommendation	
3	Water Treatment Plant Upstairs			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Upstairs space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$772
Breakeven Cost	$11,534	**Savings-to-Investment Ratio**	11.5	**Simple Payback yrs**	1
Auditors Notes: Installing setback thermostats in the various zones of the building, and programming them to reduce the demand for heat to 60 degrees at night or weekends, or when that zone of the facility is not occupied would significantly reduce the heating load of the facility. This would allow for comfortable temperatures to be automatically set when the building is occupied.					

Rank	Building Space			Recommendation	
1	Water Treatment Plant Downstairs			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Water Treatment Plant Downstairs space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$973
Breakeven Cost	$14,542	**Savings-to-Investment Ratio**	14.5	**Simple Payback yrs**	1
Auditors Notes: Installing setback thermostats in the various zones of the building, and programming them to reduce the demand for heat to 60 degrees at night or weekends, or when that zone of the facility is not occupied would significantly reduce the heating load of the facility. This would allow for comfortable temperatures to be automatically set when the building is occupied.					

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	
15	Washeteria Lighting	10 FLUOR (4) T8 4' F32T8 28W Energy-Saver Program Electronic with Manual Switching		Replace with 10 LED Replacement Bulbs	
Installation Cost	$2,400	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$152
Breakeven Cost	$1,230	**Savings-to-Investment Ratio**	0.5	**Simple Payback yrs**	16
Auditors Notes: This measure does not have a valid payback rate, and is not recommended for energy purposes alone. But if new fixtures are to be installed, getting the most energy efficient fixtures available, such as those recommended here, would yield the aforementioned savings.					

Rank	Location	Existing Condition		Recommendation	
12	Exterior Lighting	8 MH 100 Watt Electronic with Manual Switching, Daylight Sensor		Replace with 8 LED 17W Module Electronic	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$460
Breakeven Cost	$4,025	**Savings-to-Investment Ratio**	2.0	**Simple Payback yrs**	4
Auditors Notes:					

4.5.3 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
11	Plant Controls	19 Various Plant Controls with Manual Switching		Replace with 19 Various Plant Controls	
Installation Cost	$25	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$8
Breakeven Cost	$63	**Savings-to-Investment Ratio**	2.5	**Simple Payback yrs**	3
Auditors Notes: Turn off VFD for booster pump when the booster not in use. Currently the VFD is running all the time unnecessarily.					

Rank	Location	Description of Existing		Efficiency Recommendation	
10	Computers and Monitors	6 Desktop Computers with Monitors with Manual Switching		Improve Manual Switching	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$24
Breakeven Cost	$141	**Savings-to-Investment Ratio**	2.8	**Simple Payback yrs**	2
Auditors Notes: Turn off Computers when not in use. Using power management settings on the operating system that comes with the computer can make this an easy hands free process. Computer shut be shut down or set to hibernate at the end of the day, and especially before weekends.					

Rank	Location	Description of Existing		Efficiency Recommendation	
8	CB Radio	CB Radio with Manual Switching		Improve Manual Switching	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$8
Breakeven Cost	$47	**Savings-to-Investment Ratio**	4.7	**Simple Payback yrs**	1
Auditors Notes: Turn off the CB Radio when the office is unoccupied.					

Rank	Location	Description of Existing		Efficiency Recommendation	
7	Printers and Fax	5 Brother, Epson, HP with Manual Switching		Improve Manual Switching	
Installation Cost	$20	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$40
Breakeven Cost	$236	**Savings-to-Investment Ratio**	11.8	**Simple Payback yrs**	1
Auditors Notes: Turn off printers when not in use. Leaving the fax machine on to receive fax while the office is closed is fine, but other printing devices should be turned off hen the device is not in use.					

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Heat Tape	Self regulating Heat Tape with Manual Switching		Improve Manual Switching	
Installation Cost	$25	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$50
Breakeven Cost	$316	**Savings-to-Investment Ratio**	12.7	**Simple Payback yrs**	1
Auditors Notes: Turn off Heat Tape in the Summer, when it is not necessary to keep the sewer from freezing. The heat tape is meant only to prevent freeze-ups in the winter.					

4.5.4 Water Storage Tank Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
13				Install appropriate aqua stats and controls to control the tank heat add, and keep the tank at 40 degrees. This will reduce unnecessary heat. Currently tank temperature is not being monitored; this results in unnecessary overheating of the tank. This information can help prevent maintenance costs by avoiding freezing and damage. Turning off one of the two circ pumps being currently operated in parallel will save half of the electricity currently being used needlessly. Only one of the pumps needs to be running at a time, the unused pump is designed as redundant for maintenance purposes.	
Installation Cost	$6,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$750
Breakeven Cost	$11,043	**Savings-to-Investment Ratio**	1.8	**Simple Payback yrs**	8
Auditors Notes:					

4.5.5 Clothes Drying Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
5				Retro-commission actuator to control air handler based on temperature	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,127
Breakeven Cost	$15,185	**Savings-to-Investment Ratio**	7.6	**Simple Payback yrs**	2
Auditors Notes: Currently the actuator controlling hydronic heating fluid to the air handler is not functional. This system is 'running wild' and adding heat unnecessarily to the facility. This heat is mostly being wasted, either through doors, or mechanical ventilation, and causing excessive actuation of the boiler system.					

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.