Comprehensive Energy Audit
For
Napaskiak Washeteria and Lift Station

Prepared For

City of Napaskiak

September 19, 2011

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Table of Content

PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Napaskiak. 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 staff at Napaskiak Water Plant and Ms. Marcie Sherer, of AVCP.

1. EXECUTIVE SUMMARY

This report was prepared for the Napaskiak Water Plant. The scope of the audit focused on Napaskiak Washeteria and Lift Station. 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 $7,823 for Electricity, $18,313 for #1 Oil, and total energy costs are $26,136 per year.

It should be noted that this building appears to be receiving some power cost equalization subsidy from the state of Alaska. How PCE is currently being allocated and how it should be allocated should be investigated with Alaska Energy Authority. The potential for increased PCE subsidy and lower electrical costs is possible.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Napaskiak Washeteria and Lift Station. 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	Other Electrical: Uninterruptable power supply for independent heating	Improve Manual Switching	$159	$10	99.25	0.1
2	Other Electrical: Building Water Main Heat Trace	Improve Manual Switching	$48	$10	30.13	0.2
3	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Washeteria space.	$1,242	$800	23.29	0.6
4	HVAC And DHW Implementing 3.0 gph nozzles for the boilers for summer operation when the boilers only have to carry the load of the washeteria would increase burn time, reduce cycling and eliminate many of the idle losses in the summer time. Heated water piping should be insulated to reduce losses	$2,209	$2,750	15.52	1.2	

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5	Air Tightening: Mechanical Room Attic Access	Perform air sealing to reduce air leakage by 150 cfm at 50 Pascals.	$204	$150	13.96	0.7
6	Setback Thermostat: Mechanical Room	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Mechanical Room space.	$423	$600	10.57	1.4
7	Lift Station	The current thermostat should work, but if a new one is needed it would cost roughly 800 dollars to install. The lift station should only be heated to 40 degrees to keep things from freezing. Heating it to 70 degrees is not needed because there are no occupants in the lift station the vast majority of the time.	$267	$800	5.02	3.0
8	Lighting: Entryway Exterior Lighting	Replace with 2 LED 20W Module Electronic	$118	$600	1.71	5.1
9	Lighting: Exterior Lighting (Lift Station Access)	Replace with 3 LED 80W Module Electronic	$408	$3,000	1.19	7.4
	TOTAL, cost-effective measures		**$5,078**	**$8,720**	**9.13**	**1.7**
	The following measures were *not* found to be cost-effective:					
10	Other Electrical: Building Heat	Improve Manual Switching	$55	$800	0.37	14.6
	TOTAL, all measures		**$5,133**	**$9,520**	**8.40**	**1.9**

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 $5,133 per year, or 19.6% of the buildings' total energy costs. These measures are estimated to cost $9,520, for an overall simple payback period of 1.9 years. If only the cost-effective measures are implemented, the annual utility cost can be reduced by $5,078 per year, or 19.4%

of the buildings' total energy costs. These measures are estimated to cost $8,720, for an overall simple payback period of 1.7 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	Cooking	Clothes Drying	Ventilation Fans	Service Fees	Total Cost
Existing Building	$6,146	$0	$2,386	$1,431	$3,535	$548	$12,090	$0	$0	**$26,136**
With All Proposed Retrofits	$4,560	$0	$0	$905	$3,167	$280	$12,090	$0	$0	**$21,004**
SAVINGS	$1,586	$0	$2,386	$526	$367	$267	$0	$0	$0	**$5,133**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Napaskiak Washeteria and Lift Station. 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 Napaskiak Washeteria and Lift Station 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.

Napaskiak Washeteria and Lift Station is classified as being made up of the following activity areas:

1) Mechanical Room: 391 square feet
2) Washeteria: 932 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. Napaskiak Washeteria and Lift Station

3.1. Building Description

The 1,323 square foot Napaskiak Washeteria and Lift Station was constructed in 2006, with a normal occupancy of 5 people. The number of hours of operation is open four days per week from 10 a.m. to 6 p.m.

Description of Building Shell

The exterior walls are 2x8 construction with over seven inches of batt insulation.

The roof is a cold roof with 10 inches of fiberglass insulation.

The floor of the building is built on pilings with over nine inches of fiberglass insulation.

Typical windows throughout the building are double paned glass windows with wood vinyl frames.

Doors are metal urethane with thermal break.

Description of Heating and Cooling Plants

The Heating Plants used in the building are:

Burnham Boiler #1

Nameplate Information:	Burnham U9A/V111, Beckett CF800 Burner
Fuel Type:	#1 Oil
Input Rating:	594,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	4.5 gph nozzle,

Burnham Boiler #2

Nameplate Information:	Burnham U9A/V111, Beckett CF800 Burner
Fuel Type:	#1 Oil
Input Rating:	594,000 BTU/hr
Steady State Efficiency:	70 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Boiler Operation:	Oct - May
Notes:	4.5 gph nozzle,

Space Heating Distribution Systems

Baseboard heating supplies the building with heat, though in practice the building is heated primarily off jacket losses from the boilers and heat from the dryers.

Domestic Hot Water System

Domestic hot water is heated off the boiler, and is stored in an Amtrol Boiler Mate 55 gallon tank. An average of 27 gallons of hot water is used per day, primarily in washing machines and the showers.

Lighting

Interior lighting in the facility is made up primarily of electronic T8 fluorescent fixtures with 32 watt bulbs. Exterior lighting is made up of a pair of 50 watt metal halide wall packs. There are additionally three 200 watt high pressure sodium lights set on motion sensors for access to the lift station.

Plug Loads

Washing Machines are the biggest plug load in the building.

Major Equipment
Major equipment in the building includes:

Grundfos UP26-64F Water Plant Heat circulation pump\
Grundfos UP 40-160 building heat circulation pump
Grundfos UP26-99F Force Main/Lift Station heat
Grundfos UP26-64F Dryer Heat Circulation pump
Speed Queen Model ST0355SBCB2G1W04

Additionally there is an uninterruptable power supply on the monitor heater, and a heat tape on the building water main.

Lift Station
The lift station has a set of submersible pumps and is heated by a heat circulation loop supplied by the boilers in the washeteria.

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: Napaskiak, Inc - 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	$ 0.36/kWh
#1 Oil	$ 6.00/gallons

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, [Building Owner] pays approximately $26,136 annually for electricity and other fuel costs for the Napaskiak Washeteria and Lift Station.

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

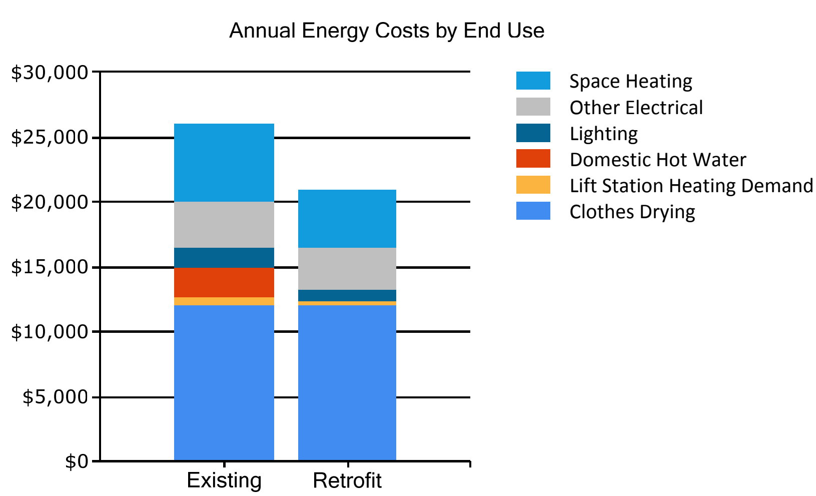


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

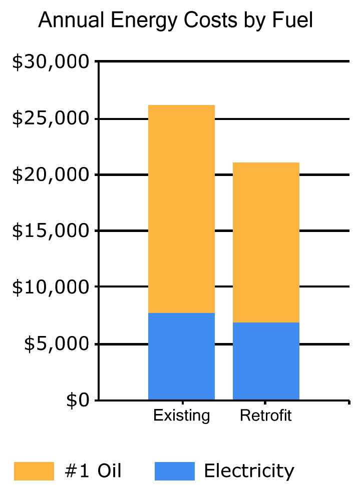
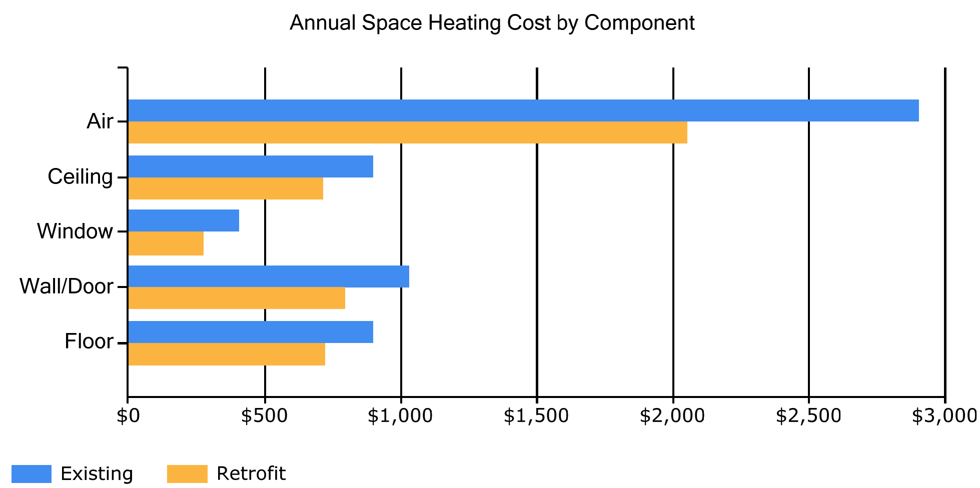


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	1070	975	1070	1035	747	430	445	445	430	1067	1035	1070
Lighting	475	432	475	459	287	108	112	112	108	473	459	475
Lift Station Heating	34	31	34	33	34	0	0	0	0	34	33	34
Clothes_Drying	636	580	636	616	636	616	636	636	616	636	616	636
Ventilation_Fans	0	0	0	0	0	0	0	0	0	0	0	0
DHW	1	1	1	2	8	8	8	8	7	2	1	1
Space_Heating	21	19	19	15	0	0	0	0	0	14	17	21

Fuel Oil #1 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Lift Station Heating	10	9	10	9	10	0	0	0	0	10	9	10
Clothes_Drying	133	121	133	129	133	129	133	133	129	133	129	133
DHW	13	12	14	18	59	58	59	59	55	22	14	13
Space_Heating	189	169	157	96	0	0	0	0	3	81	132	189

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
Napaskiak Washeteria and Lift Station 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	21,731 kWh	74,168	3.340	247,721
#1 Oil	3,052 gallons	402,886	1.010	406,915
Total		**477,054**		**654,637**
BUILDING AREA		1,323	Square Feet	
BUILDING SITE EUI		361	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		495	**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 Napaskiak Washeteria and Lift Station was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Napaskiak 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 Napaskiak. 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
Napaskiak Washeteria and Lift Station, Napaskiak, Alaska
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5	Air Tightening: Mechanical Room Attic Access	Perform air sealing to reduce air leakage by 150 cfm at 50 Pascals.	$204	$150	13.96	0.7
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Table 4.1 Napaskiak Washeteria and Lift Station, Napaskiak, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES						
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	TOTAL, cost-effective measures		**$5,078**	**$8,720**	**9.13**	**1.7**
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10	Other Electrical: Building Heat	Improve Manual Switching	$55	$800	0.37	14.6
	TOTAL, all measures		**$5,133**	**$9,520**	**8.40**	**1.9**

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)	
5	Mechanical Room Attic Access		Air Tightness estimated as: 1900 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 150 cfm at 50 Pascals.	
Installation Cost		$150	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$204
Breakeven Cost		$2,095	**Savings-to-Investment Ratio**	14.0	**Simple Payback yrs**	1
Auditors Notes: Insulating the attic access would reduce air leakage and prevent heat from entering into the attic and increase the effectiveness of the cold roof.						

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation					
4	Implementing 3.0 gph nozzles for the boilers for summer operation when the boilers only have to carry the load of the washeteria would increase burn time, reduce cycling and eliminate many of the idle losses in the summer time. Heated water piping should be insulated to reduce losses					
Installation Cost		$2,750	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$2,209
Breakeven Cost		$42,676	**Savings-to-Investment Ratio**	15.5	**Simple Payback yrs**	1
Auditors Notes: Boiler will provide maximum system efficiency with long sustained burn rates. Smaller nozzles will aid in this, and can be changed as needed throughout the season. The nozzle should only be considered too small if a well tuned boiler is unable to meet systems demands under constant fire conditions. A change in either nozzle size or pump pressure will require a change in air band settings, test equipment will be need to be on-site for proper burner adjustment. Gains in efficiency assume that boilers are cleaned and maintained regularly, and appropriate stack temperatures are set to avoid condensation problems.						

4.4.3 Night Setback Thermostat Measures

Rank	Building Space				Recommendation	
6	Mechanical Room				Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Mechanical Room space.	
Installation Cost		$600	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$423
Breakeven Cost		$6,341	**Savings-to-Investment Ratio**	10.6	**Simple Payback yrs**	1
Auditors Notes: Installing a heating setback for night and weekends would reduce the heating demand of the building. Installation of a setback thermostat in the mechanical room would be the easiest way to control this. The facility does not need to be heated to comfortable levels when no one is using the facility.						

Rank	Building Space				Recommendation	
3	Washeteria				Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Washeteria space.	
Installation Cost		$800	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,242
Breakeven Cost		$18,628	**Savings-to-Investment Ratio**	23.3	**Simple Payback yrs**	1
Auditors Notes: Installing a heating setback for night and weekends would reduce the heating demand of the building. Installation of a setback thermostat in the washeteria would be the easiest way to control this. The facility does not need to be heated to comfortable levels when no one is using the facility.						

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	Exterior Lighting (Lift Station Access)	3 HPS 200 Watt Magnetic with Occupancy Sensor, Daylight Sensor		Replace with 3 LED 80W Module Electronic	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$408
Breakeven Cost	$3,566	**Savings-to-Investment Ratio**	1.2	**Simple Payback yrs**	7
Auditors Notes: Replacing the current high pressure sodium exterior lightings with led lights will allow better function in the cold, reduce electrical load, and increase the life expectancy of the bulbs, thereby reducing maintenance.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
8	Entryway Exterior Lighting	2 MH 50 Watt Magnetic with Daylight Sensor		Replace with 2 LED 20W Module Electronic	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$118
Breakeven Cost	$1,028	**Savings-to-Investment Ratio**	1.7	**Simple Payback yrs**	5
Auditors Notes: Replacing current exterior lighting with LED wall packs will reduce the amount of electricity used, and increase the time between bulb changes, thereby reducing maintenance, as well as allow for better functioning in cold weather.					

4.5.2 Other Electrical Measures

Rank	**Location**	**Description of Existing**		**Efficiency Recommendation**	
10	Building Heat	Grundfos UPS 40-160 with Manual Switching		Improve Manual Switching	
Installation Cost	$800	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$55
Breakeven Cost	$295	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	15
Auditors Notes: This pump should be controlled by not manual switching, but by the heating demand of the building. The dryers and jacket losses of the boiler provide much of the heat, reducing the need for circulation of building heat to the baseboard heating system most of the time. This controls retrofit, though not justified based on energy savings alone, would be essential to any true effective setbacks of the facility in temperature, especially when the washeteria isn't open to customers.					

Rank	Location	Description of Existing		Efficiency Recommendation	
2	Building Water Main Heat Trace	Building Water Main Heat Trace with Manual Switching		Improve Manual Switching	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$48
Breakeven Cost	$301	**Savings-to-Investment Ratio**	30.1	**Simple Payback yrs**	0
Auditors Notes: Heat Tape should be shut off in the summer time.					

Rank	Location	Description of Existing		Efficiency Recommendation	
1	Uninterruptable power supply for independent heating	Smart-UPS 3000 with Manual Switching		Improve Manual Switching	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	7	**Energy Savings (/yr)**	$159
Breakeven Cost	$992	**Savings-to-Investment Ratio**	99.2	**Simple Payback yrs**	0
Auditors Notes: The Smart-Ups is to ensure the building never freezes if the power fails and the boilers cannot run. However, this is unnecessary in the summer months (may to October) and this could be shut off during this period.					

4.5.3 Lift Station Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
7				The current thermostat should work, but if a new one is needed it would cost roughly 800 dollars to install. The lift station should only be heated to 40 degrees to keep things from freezing. Heating it to 70 degrees is not needed because there are no occupants in the lift station the vast majority of the time.	
Installation Cost	$800	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$267
Breakeven Cost	$4,015	**Savings-to-Investment Ratio**	5.0	**Simple Payback yrs**	3
Auditors Notes:					

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.

APPENDICES

Appendix A – Listing of Energy Conservation and Renewable Energy Websites

Lighting
Illumination Engineering Society - http://www.iesna.org/

Energy Star Compact Fluorescent Lighting Program - www.energystar.gov/index.cfm?c=cfls.pr_cfls

DOE Solid State Lighting Program - http://www1.eere.energy.gov/buildings/ssl/

DOE office of Energy Efficiency and Renewable Energy - http://apps1.eere.energy.gov/consumer/your_workplace/

Energy Star – http://www.energystar.gov/index.cfm?c=lighting.pr_lighting

Hot Water Heaters

Heat Pump Water Heaters -
http://apps1.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12840

Solar Water Heating

FEMP Federal Technology Alerts – http://www.eere.energy.gov/femp/pdfs/FTA_solwat_heat.pdf

Solar Radiation Data Manual – http://rredc.nrel.gov/solar/pubs/redbook

Plug Loads

DOE office of Energy Efficiency and Renewable Energy – http:apps1.eere.energy.gov/consumer/your_workplace/

Energy Star – http://www.energystar.gov/index.cfm?fuseaction=find_a_product

The Greenest Desktop Computers of 2008 - http://www.metaefficient.com/computers/the-greenest-pcs-of-2008.html

Wind

AWEA Web Site – http://www.awea.org

National Wind Coordinating Collaborative – http:www.nationalwind.org

Utility Wind Interest Group site: http://www.uwig.org

WPA Web Site – http://www.windpoweringamerica.gov

Homepower Web Site: http://homepower.com

Windustry Project: http://www.windustry.com

Solar

NREL – http://www.nrel.gov/rredc/

Firstlook – http://firstlook.3tiergroup.com

TMY or Weather Data – http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

State and Utility Incentives and Utility Policies - http://www.dsireusa.org