Executive Summary

Energy Audits of Native Village of Aniak Tribally Owned Buildings

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Prepared For

Native Village of Aniak
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Report Date:

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Energy Audits of Alaska

BACKGROUND

The Native Village of Aniak (NVA) was awarded a grant from the U.S. Department of Energy Office of Indian Energy to reduce and stabilize energy costs in tribal buildings by setting energy efficiency improvement goals through an Energy Action Plan. Outcomes include strategies and actions leading to reduced energy use, implementation of renewable energy, increased building safety and occupant comfort, and training and local capacity building. The Cold Climate Housing Research Center (CCHRC) is the prime contractor under this grant. Energy Audits of Alaska (EAA) is a subcontractor providing energy efficiency consulting and energy audits. Aniak is governed by the Aniak Traditional Council (ATC).

The buildings included in this program are:

Tribal Council Office
Community Center
VPSO building
The Duplex, aka KNA buildings #1 and #2, aka ATC Building #4
AVCP Office, aka KNA building #3, aka ATC Building #5
Large Farm Building
Small Farm Building

The EAA team performed site surveys of each building from January 16 through January 19, 2018. A preliminary findings report was produced in April 2018 and final reports in September 2018.

ACCURACY OF SAVINGS ESTIMATES

As part of the energy audit process, each building is modeled in an energy simulation software package called AkWarm-C. The model typically represents the actual use and occupancy of the building and is calibrated to match the actual electric and fuel oil consumption of the building. Various energy efficiency measures (EEMs) are then incorporated in the model and the savings are calculated.

The only fuel oil consumption data provided to EAA was for a few months in 2015 for the Community Center. Consequently, none of the AkWarm-C models are calibrated to actual fuel consumption and therefore the accuracy of their savings estimates is reduced.

CHANGING USE AND OCCUPANCY

The use and occupancy of a building has an extremely large impact on its electric and fuel oil consumption.

Only the Tribal Office and Community Hall are currently used and occupied as they have been used and occupied for the last three to four years. The use and occupancy of all other buildings are in transition. Based on conversations with on-site staff and previous EAA experience, reasonable use and occupancy scenarios were created for each building as follows:

OCCUPANCY SCENARIOS USED TO CREATE AkWARM-C MODELS			
	Used as	**No. occupants**	**Operating hours**
VPSO Building	Office for PSO, occasional holding cell for prisoner	1 officer, 1 prisoner	Officer hours: 9:00am-5:00pm, Monday-Friday. Prisoner average occupancy: 52 hrs/year or 1 hour/week
Duplex	West half as seasonal bunkhouse, East half as office for State Patrol	Bunkhouse: 10 occupants East half: 4 officers	Bunkhouse: on residential schedule, occupants in the building evenings and night time, out of the building from 10:00am-3:00pm, 7 days/week; occupied from mid-May through mid-September. East half: Building occupied from 9:00am-5:00pm, Monday-Friday
AVCP Office	Office for AVCP personnel	4 staff, 1 visitor	9:00am-5:00pm, Monday-Friday
Large Farm Building	West 1/3 as shop, East 2/3 as cold storage	West 1/3: 2 staff East 2/3: 1 staff	4 hours/day, Monday-Friday
Small Farm Building	Shop	1 staff	4 hours/day, Monday-Friday

The savings estimates in the energy audits are based on these use and occupancy scenarios.

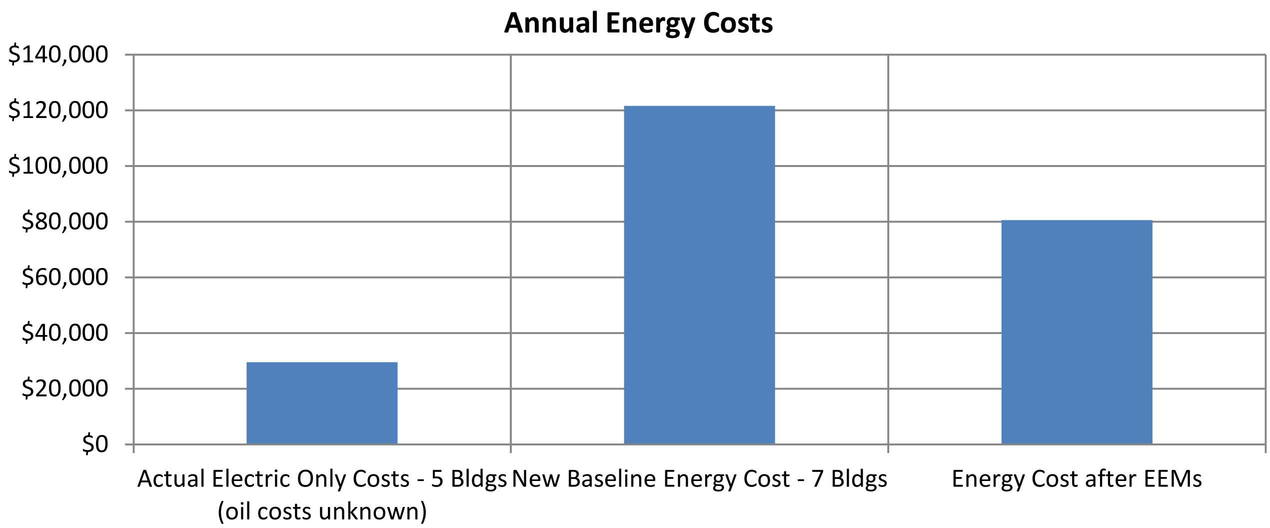
COST OF ENERGY & POTENTIAL SAVINGS

Using the actual consumption and cost of electricity in 2017, the Native Village of Aniak (NVA) spent $29,606 for electricity for these five buildings but the annual cost of fuel oil for these buildings is unknown. The large and small farm buildings do not have electric service or heat, so there are no energy costs for those buildings.

When the occupancy scenarios listed above are used as a new baseline, NVA will be spending $121,641 per year for energy costs in all seven buildings.

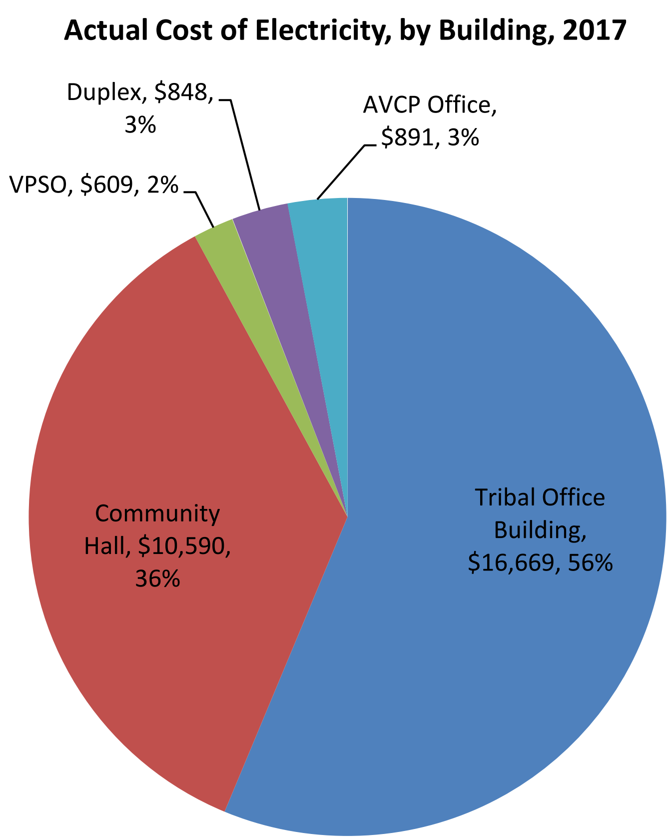
If all of the recommended EEMs are incorporated, NVA will be spending $80,601 per year on energy costs, with a savings of $40,916 per year over the new baseline. The cost to implement all of the recommended EEMs in all seven buildings is $152,050 and the simple payback on that expenditure is 3.7 years. Figure 1 shows these figures graphically.

Figure 1



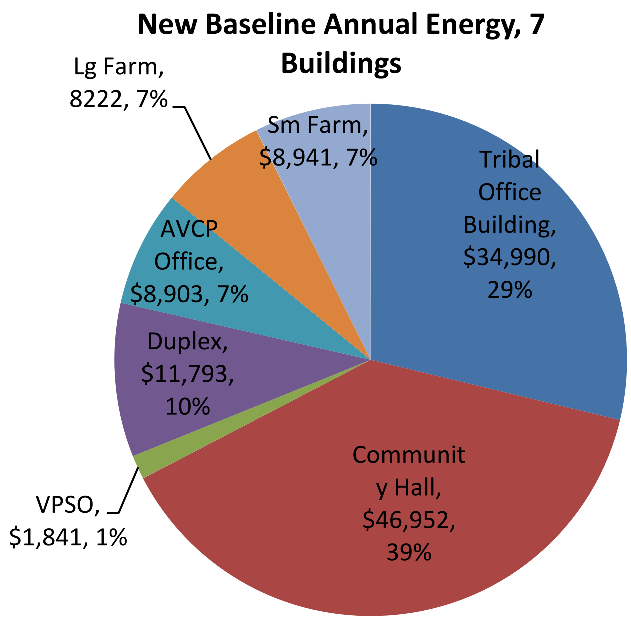
The breakdown of 2017 electric-only costs for five buildings is:

Figure 2



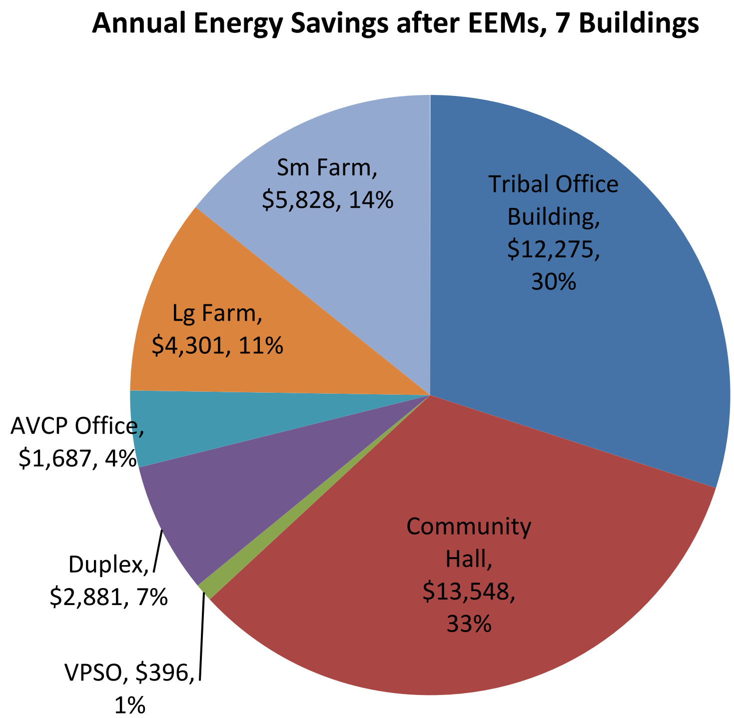
The breakdown of total energy costs, for the new modeled baseline, for all seven buildings is:

Figure 3



The breakdown of energy savings for all seven buildings after all of the recommended EEMs have been incorporated is:

Figure 4



SUMMARY OF ENERGY EFFICIENCY MEASURES

The EEMs considered for these buildings included:

- Envelope (windows, doors, insulation, air sealing)
- HVAC (setback thermostats, boiler replacement, retro-commissioning systems, controls and control strategies, variable speed motors)
- DHW (equipment upgrade at Laundromat)
- Clothes dryer replacements with hydronic units
- Clothes washer replacements with high efficiency front-loading machines
- Lighting and lighting controls

A summary of all of the recommended EEMs is shown below:

Figure 5

EEM SAVINGS SUMMARY								
	Tribal Office	**Community Center**	**VPSO**	**Duplex**	**AVCP**	**Large Farm Bldg**	**Small Farm Bldg**	**TOTALS**
Envelope		$6,915				$2,793	$4,681	**$14,389**
HVAC related	$8,045	$4,028	$282	$864	$330	$767	$914	**$15,230**
Lighting	$4,230	$2,605	$114	$2,017	$1,357	$741	$233	**$11,297**
TOTALS	**$12,275**	**$13,548**	**$396**	**$2,881**	**$1,687**	**$4,301**	**$5,828**	**$40,916**

A summary of the costs to implement EEMs for each building is shown below:

Figure 6

EEM COST SUMMARY								
	Tribal Office	**Community Center**	**VPSO**	**Duplex**	**AVCP**	**Large Farm Bldg**	**Small Farm Bldg**	**TOTALS**
Envelope		$46,933				$10,189	$10,617	**$67,739**
HVAC related	$52,300	$3,365	$4	$1,662	$1,600	$300	$1	**$59,232**
Lighting	$9,427	$8,740	$104	$1,221	$1,541	$1,850	$2,196	**$25,079**
TOTALS	**$61,727**	**$59,038**	**$108**	**$2,883**	**$3,141**	**$12,339**	**$12,814**	**$152,050**

Comprehensive Energy Audit
For the AVCP Office (aka ATC bldg #5)

Prepared For
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January 17, 2018

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Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 20, 2018
New Release – September 13, 2018

Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (EEMs), estimate the value of the savings and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that the recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of HVAC systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

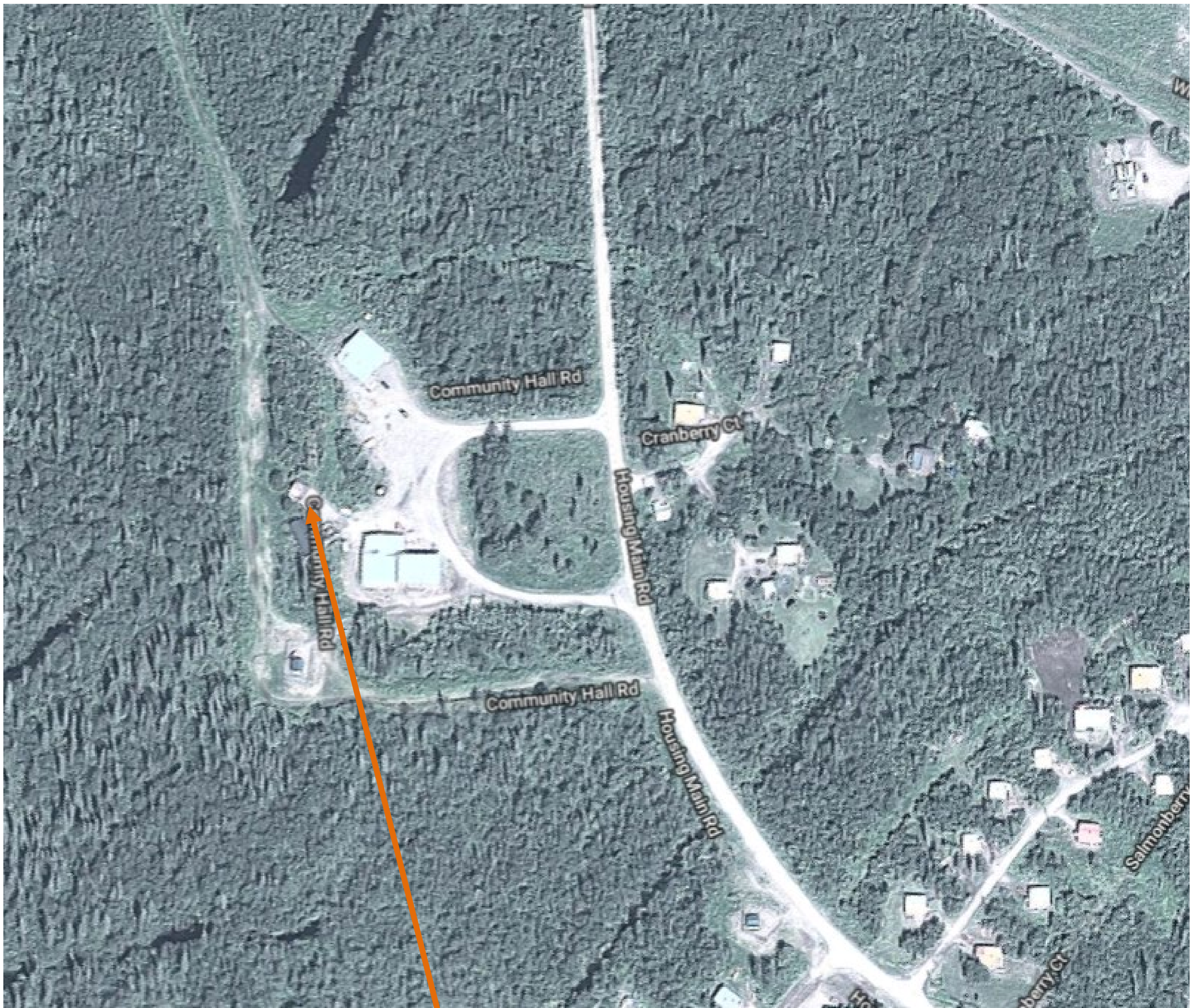
This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the ASHRAE definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy and electric usage, and the US Department of Energy who provided funding.

Project Location



NORTH

Subject Building

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1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the AVCP Office, also known as KNA building #3 and ATC building #5. The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and any process and plug loads. There are no charges for water and wastewater and these systems were not evaluated in this analysis.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy-consuming equipment, identify technically and economically feasible energy efficiency measures (EEMs) for existing equipment, and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The energy conservation measures (ECMs) identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The “avoided costs” resulting from ECMs are discussed in Section 1.7 but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 9-page summary contains all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost, and their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with the overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

Sections 2, 3, and 4 of this report and the Appendices are back-up and provide much more detailed information should the owner/operator or staff desire to investigate further.   Sections 4.3 through 4.5 include additional auditor’s notes for many EEMs. Due to their length, Appendices H, I, and J, which contain additional ECM detail, lighting information and manufacturer’s “cut sheets” of samples of recommended retrofit products, are included as a separate document.

<u>Issues that the auditor feels are of particular importance to the reader are underlined</u> and all abbreviations and acronyms used in this document are listed in Appendix G.

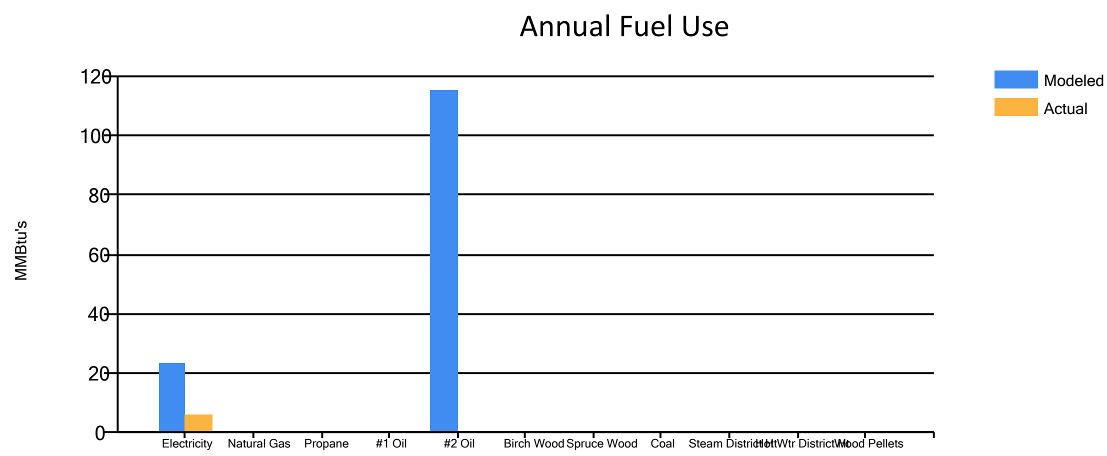
1.2 Noteworthy Points & Immediate Action

a. This building was unoccupied or only partially occupied during most of 2016 and 2017 and under a renovation construction in 2017 and early 2018, during the site survey. So, there is no baseline period of energy consumption that represents a fully occupied building. Furthermore, no fuel oil use data was provided by the owner. In order to provide the owner with realistic estimates of energy savings for a fully utilized building, the AkWarm-C model was created using the following assumptions:

    - Occupied from 9:00am until 5:00pm Monday through Friday
    - 5 occupants including visitors

- Typical plug and electric loads for an office environment

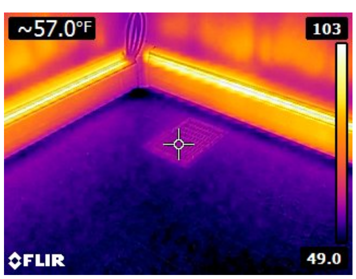
As a result of these assumptions, and as seen in the bar chart below (from Appendix F), neither the electrical or fuel oil consumption figures in the AkWarm-C model are calibrated to actual figures. The electric and fuel oil use figures predicted by the AkWarm-C model are used in this analysis unless specifically stated otherwise.

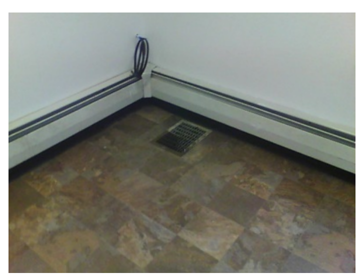


a. If all the recommended EEMs are incorporated in this building, there will be a 17.8% reduction in energy costs, totaling $1,587, with a simple payback of 1.9 years on the $3,141 implementation cost.

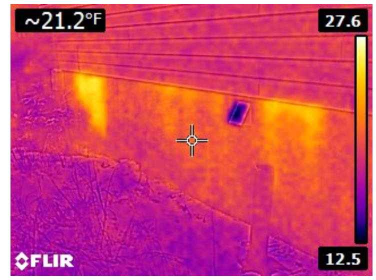
b. The unit heater in the crawlspace appears to "run wild,[1]" (the crawlspace was not accessed during the site survey except through an opening in the NW skirting and the control strategy is unknown), which means there is a continual heat loss to the crawl space any time the circulation pump is running, even when heat is not required in the crawlspace. It is recommended to install a 3-way zone valve to eliminate the running wild control scenario, and replace the thermostat with a unit controlling the zone valve and fan. There are energy savings associated with this efficiency measure (EEM #0 in Tables 1.1 and 4.1 and Section 4.4) but no way to calculate them without additional information, so EEM #0 is included with an estimated cost but no savings. This is a low cost measure ($1000) and should be implemented immediately.

c. ECMs are no-cost or low-cost energy conservation measures typically implemented by the building owner or the owner's staff. The following ECMs and maintenance issues should be rectified immediately:





[1] In a typical unit heater control scenario, the thermostat only controls the fan on/off and hydronic fluid is continually running though the heater, whether there is a call for heat or not, this is called "running wild".



- The east heating zone in this building does not appear to be functioning properly. The thermostat was calling for heat but the zone valve was not opening, yet per IR images (above) show there was heat coming from the fintube baseboard radiators in the NE office (office 1 in building schematics in Appendix D). The zone valve could be leaking past, or the thermostat could be malfunctioning; in either case, this will result in overheating and occupants likely to open windows during the heating season.
- The crawlspace insulation should be checked and repaired as needed. See the IR image at right.

d. It was assumed in this analysis that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity. It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician.
e. Because it is heated and insulated, the 1247 SF crawl space is included in the buildings total square footage in this analysis.

1.3 Current Cost and Breakdown of Energy

Based on electricity and fuel oil prices in effect at the time of the audit, and using the uncalibrated AkWarm-C© energy model[2] with the assumptions stated in Section 1.2.a above, the total predicted energy costs are $8,903 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings are as follows:

$4,142 for Electricity
$4,762 for #2 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	6,903 kWh	4,355 kWh
#2 Oil	837 gallons	827 gallons

The table below shows the relative costs per MMBTU for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.60	$175.80
Fuel Oil	$5.69	$43.10

[2] Neither electric or oil data represent a fully occupied building, see 1.2.a above for the assumptions used in creating the AkWarm-C simulation model.

Figure 1.1

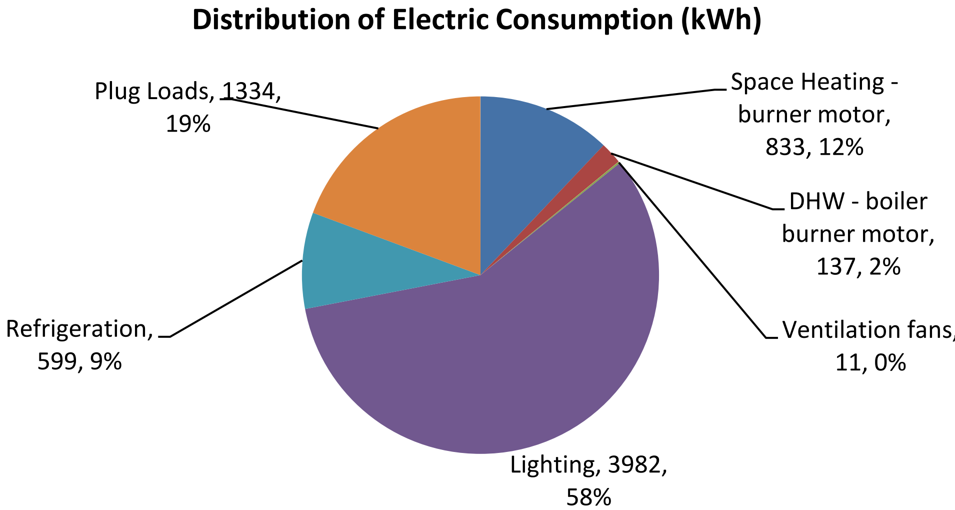
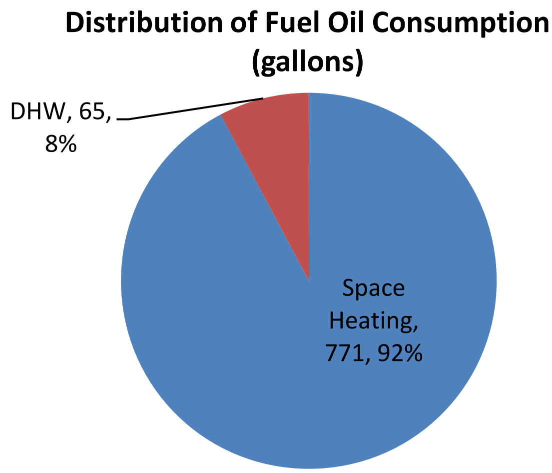


Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on space heating and lighting.

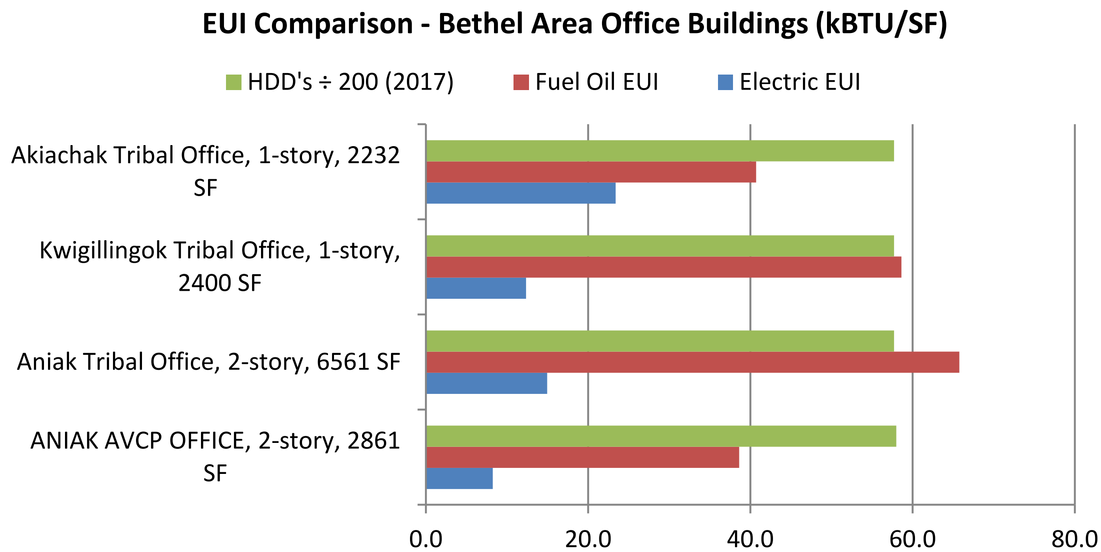
1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	48.6	3.79	$3.11
With Proposed Retrofits	45.1	3.51	$2.56
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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric EUIs are compared to similar use buildings in the region in the bar chart below. The Heating Degree Days[3] (HDDs) bars are intended to normalize the effect of weather differences, but since all the buildings are in the Bethel region, the HDDs are identical. Because the electric and heating EUI in the bar chart below represent a theoretical building, issues like a malfunctioning heater or excessive electric loads will not be evident in the EUIs below. This bar chart shows how this building compares to similar use buildings in the region when operating properly. Additional discussion is provided in Appendix B.



1.6 Energy Efficiency Measures(EEMs)

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3, and Figure 1.4 shows the reduction in cost, consumption and BTUs of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
Setback Thermostats	$1,600	$330	4.8
Lighting	$1,541	$1,357	1.1
Totals	**$3,141**	**$1,687**	**1.9**

[3] HDDs are a measure of the severity of cold weather; higher HDDs indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDDs.

Figure 1.4

	Existing (modeled) conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	6,903	23,560	4,355	14,864	36.9%
Gallons Oil	837	110,484	827	109,164	1.2%
Energy Cost	$8,903		$7,316		17.8%

Table 1.1 below summarizes the energy efficiency measures analyzed for the AVCP Office. Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM. Table 4.1 shows an additional measure of financial return on investment as well as CO_2 savings.

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
0	Crawl space unit heater control	Install 3-way zone valve, replace thermostat with a new model controlling new zone valve and fan to prevent UH from running wild.	unknown	$1000			
1	Setback Thermostat: Lobby/Reception/Office Areas	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Lobby/Reception/Office Areas space.	$251 / 5.8 MMBTU	$300	11.26	1.2	956.6
2	Lighting - Power Retrofit: Hall, Stairs T12-2 wrap	Replace with 4 LED (2) 15W Module StdElectronic	$330 + $20 Maint. Savings / 1.9 MMBTU	$295	9.99	0.8	933.7
3	Lighting - Power Retrofit: Outdoors HPS wall pack	Replace with LED 17W Module StdElectronic	$130 + $5 Maint. Savings / 0.7 MMBTU	$120	9.49	0.9	368.8
4	Lighting - Power Retrofit: Server Room Incan, A-Type, surf mt	Replace with LED 9W Module StdElectronic	$3 / 0.0 MMBTU	$5	7.35	1.6	8.9
5	Lighting - Power Retrofit: Offices, Lobby, Reception, Kitchen, Entry T12-2 wrap	Replace with 14 LED (2) 15W Module StdElectronic	$772 + $70 Maint. Savings / -0.1 MMBTU	$1,032	6.67	1.2	1,934.9

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**
6	Setback Thermostat: Hall, Server Room, Entry	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Hall, Server Room, Entry space.	$79 / 1.8 MMBTU	$300	3.52	3.8	299.2
7	Lighting - Power Retrofit: Bathroom T12-2 wrap 12x24	Replace with LED (2) 8W Module StdElectronic	$22 + $5 Maint. Savings / 0.0 MMBTU	$84	2.64	3.1	54.9
	TOTAL, cost-effective measures		**$1,587 + $100 Maint. Savings / 10.1 MMBTU**	**$3,136**	**7.33**	**1.9**	**4,556.9**
The following measures (and EEM #0 above) were *not* found to be cost-effective from a financial perspective but are still recommended:							
8	Lighting - Power Retrofit: Boiler, CFL, A-type	Replace with LED 7W Module StdElectronic	$0 / 0.0 MMBTU	$5	0.32	35.4	0.4
	TOTAL, all measures		**$1,587 + $100 Maint. Savings / 10.1 MMBTU**	**$3,141**	**7.32**	**1.9**	**4,557.3**

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.

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 existing building. 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. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate									
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing (modeled) Building	$4,890	$0	$453	$6	$2,392	$360	$802	$0	**$8,903**
With Proposed Retrofits	$4,821	$0	$459	$6	$868	$360	$802	$0	**$7,316**
Savings	$69	$0	-$6	$0	$1,524	$0	$0	$0	**$1,587**

1.7 Energy Conservation Measures (ECMs)

No and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called "avoided costs" rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring:** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC "performance drift" is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.

   There is a range of simple to very complex building monitoring systems commercially available, most utilize a user-friendly internet or network based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

   ARIS - The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owner's track and manage energy use and costs. For more information contact Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us)

   BMON - AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings, and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

   Monnit – "product model"; sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming in the building **as well as in the crawl space**	
Note inside and outside temperatures, is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric and oil	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.

4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Weather stripping should be maintained if it exists or added if it does not.

5) **Turn off plug loads** including computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves their desk, add an occupancy sensing plug load management device (PLMD) like the "Isole IDP 3050" power strip produced by Wattstopper. (See Appendix J)

6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans and thermostats in this building. An unmaintained HVAC component like a boiler can reduce its operating efficiency by 3% or more.

7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone, and turn down the heat and turn off lighting in that zone

8) Additional ECM recommendations:

a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.

b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.

c. At their end of useful life (EOL), replace refrigeration equipment with Energy Star Versions.

d. Keep refrigeration coils clean.

e. Keep heating coils in air handlers, unit heaters and fan coil units clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the AVCP Office. 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 including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager (if possible) to understand their objectives, ownership strategy and gather other information the auditor could use to make the audit most useful to the client. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment including refrigeration equipment
- Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and energy management programs (if they exist) provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from AVCP Office enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building". The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model

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, adding any HVAC systems, ventilation and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat) and the hours of operation of the building.

AVCP Office is classified as being made up of the following activity areas:

1) Lobby/Reception/Office Areas: 1,042 square feet
2) Hall, Server Room, Entry: 238 square feet
3) Second floor (storage): 334 square feet
4) Crawl space: 1,247 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model was calibrated to actual fuel consumption and was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions.

Limitations of AkWarm© Models

The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly, on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

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 and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis

Our analysis provides a number of tools for assessing the cost effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions, and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 until 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, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIR's and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR>=1 to be considered financially viable on a stand-alone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. <u>Costs are considered to be accurate within +/-30% in this level of audit;</u> they are derived from Means Cost Data, industry publications, the auditors experience and/or local contractors and equipment suppliers.

Interactive effects of EEMs:
It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of the order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases, lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in others, negatively. If all EEMs are implemented, their order of implementation is irrelevant, because the total savings after full implementation will be unchanged. If an <u>EEM is calculated outside of the AkWarm© model</u>, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:
The underlying assumptions used in the calculations made in this audit follow:

- 3413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs, or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline, shall accept full responsibility and liability for the design, engineering and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects is not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. AVCP OFFICE EXISTING CONDITIONS

3.1. Building Description

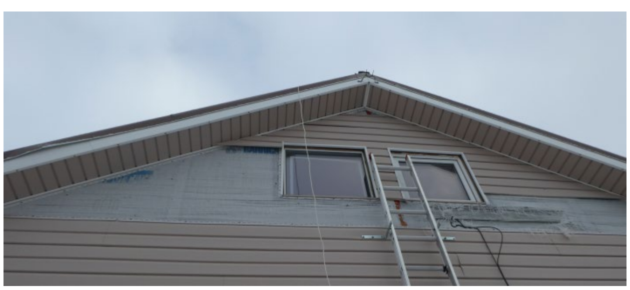
The 2,861 square foot AVCP Office (1,614 SF without the crawl space) was constructed around 1940 and used by the Federal Aviation Administration for a number of years. It was moved to its current location sometime around the year 2000 and completely renovated by its current owner. It was in the process of being renovated again during the site survey. The building was modeled in AkWarm-C as an office building having a normal occupancy of 5 people and operating hours from 9:00am until 5:00pm Monday through Friday.

Description of Building Shell

There were no plans available for this building, and given the renovations, the details of its actual construction is not known. The following details are assumed, based on observation and conversations with on-site staff.

The building is constructed over a skirted, heated, 1247 SF crawl space. The crawl space walls appear to have R-19 fiberglass batt installed between studs. Access to the crawl space was not provided, other than looking through an opening in the skirting (photo at right), no other floor or crawl space insulation was observed. The floor is supported by 2” x 12” TJI floor joists.

In the 1940’s, the original walls would likely have been constructed with 2” x 4” studs, but based on the current wall thicknesses, the walls appear to be constructed with 2” x 6” studs. It is presumed that there is R-19 batt in the stud cavities. The IR images in



Appendix E indicate that the wall insulation is not in very good condition. The interior walls are finished with gypsum and the exterior with horizontal vinyl siding, sections of which are missing or damaged (photo at left). All windows are “Alaska Windows” utilizing double pane glazing, presumably with low-E coatings, in vinyl frames. The two doors utilize ½ lites and have metal skins. The doors and windows appear to be in good condition.

The front portion of the building has a second floor which appears to be a remodeled attic with a “hot roof”. The rear portion may have an attic, but it does not appear to be vented and its insulation value is unknown. For the purposes of the AkWarm-C model, R-38 insulation was assumed in the rear portion and R-19 in the front portion. The roof deck is painted metal and several areas are in need of repair (photo at right).

The existence of a thin layer of snow on the roof during the site survey and the IR images of the second floor ceiling indicate that the insulation is at least functional.

Description of Heating and Cooling Plants

B-1

Nameplate Information:	Burnham PV74WB
Fuel Type:	#2 Oil
Input Rating:	156,000 BTU/hr
Steady State Efficiency:	71 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	156 MBH input, 136 MBH output, nominal 87% thermal efficiency when new, de-rated to 71% based on age (1997)

Space Heating and Cooling Distribution Systems

Heat is distributed throughout this building and its crawl space by a hydronic system using a single circulation pump and fintube baseboard radiators in the building and a unit heater in the crawl space. There is no cooling in the building.

Building Ventilation System

There is no mechanical ventilation in this building and outside air is provided by operable windows.

HVAC Controls

This appears to be a 4-zone hydronic system utilizing (3) Taco zone valves controlled by (2) manual, low voltage thermostats in the interior spaces, the hot water generator aquastat, and a line voltage thermostat in the crawl space controlling the unit heater fan. Three zone valves were observed, presumed to serve the east, west and hot water generator; the unit heater is presumed to run wild, so no zone valve is used. It also appears that the single circulation pump is turned on when there is a call for heat in any zone, and off when there is no call for heat. This means that the unit heater has hot water or glycol running through it, dissipating heat to the crawl space, any time there is a call for heat by either interior zone or by the hot water generator. This is a poor control strategy from an energy efficiency standpoint.

Domestic Hot Water System

DHW is provided by an indirect hot water generator located in the boiler room. There does not appear to be a DHW re-circulation pump in use.

Lighting

Interior lighting consists of 2-lamp, 48” fixtures utilizing T12 florescent lamps and magnetic ballasts. In addition there are surface mount fixtures utilizing CFL and incandescent A-type bulbs. No lighting controls appear to be in use. Exterior lighting consists of what appears to be a 50w HPS wall pack on the rear of the building and a 2-lamp LED flood fixture controlled by motion and photocell sensors.

Major Equipment and Plug Loads

A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis, to match the actual, baseline electric data and after calibration, the AkWarm© model predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

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 as predicted by the AkWarm-C model. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The utility companies providing energy to the subject building, and the class of service provided by each, are listed below:

Electricity: Aniak Light & Power - 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	$ 0.6000/kWh
#2 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or from invoices, which also included customer charges, service charges, energy costs and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically gallons delivered, not gallons consumed. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $8,903 annually for electricity and other fuel costs for the AVCP Office.

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

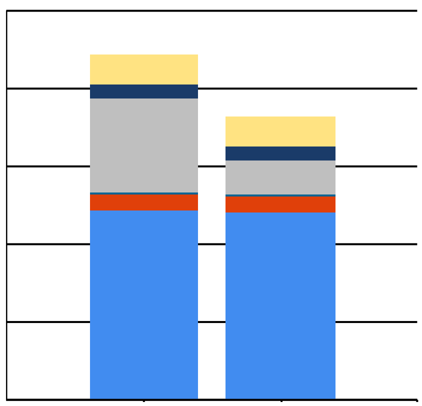


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

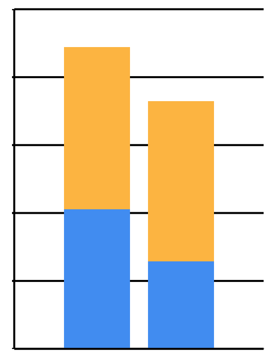
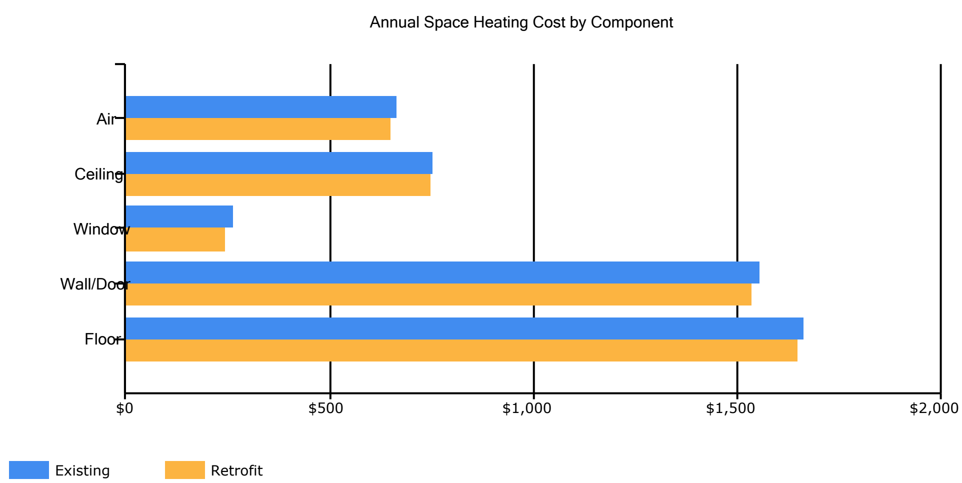


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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 the model'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	143	109	103	69	34	0	0	1	41	81	113	139
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	1	1	1	2	10	36	38	38	6	2	1	1
Ventilation_Fans	1	1	1	1	1	1	1	1	1	1	1	0
Lighting	338	308	338	327	338	327	338	338	327	338	327	338
Refrigeration	51	46	51	49	51	49	51	51	49	51	49	51
Other_Electrical	113	103	113	110	113	110	113	113	110	113	110	113

Fuel Oil #2 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	151	109	98	53	14	0	0	0	20	68	113	145
DHW	2	2	2	2	5	14	14	14	4	2	2	2

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building.
It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUIs are calculated by converting all the energy consumed by a building in one year to BTUs and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy". Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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, and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{\text{(Electric Usage in kBtu + Gas Usage in kBtu + similar for other fuels)}}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{\text{(Electric Usage in kBtu X SS Ratio + Gas Usage in kBtu X SS Ratio + similar for other fuels)}}{\text{Building Square Footage}}$$

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

Table 3.4
AVCP Office 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	6,903 kWh	23,559	3.340	78,686
#2 Oil	837 gallons	115,485	1.010	116,640
Total		**139,044**		**195,326**
BUILDING AREA		2,861	Square Feet	
BUILDING SITE EUI		49	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		68	**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	**48.6**	**3.79**	**$3.11**
With Proposed Retrofits	**45.1**	**3.51**	**$2.56**
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.**			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C.

Table 4.1
AVCP Office, Aniak, 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
0	Crawl space unit heater control	Install 3-way zone valve, replace thermostat with new model controlling new zone valve and fan to prevent UH from running wild.	unknown	$1000			
1	Setback Thermostat: Lobby/Reception/Office Areas	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Lobby/Reception/Office Areas space.	$251 / 5.8 MMBTU	$300	11.26	1.2	956.6
2	Lighting - Power Retrofit: Hall, Stairs T12-2 wrap	Replace with 4 LED (2) 15W Module StdElectronic	$330 + $20 Maint. Savings / 1.9 MMBTU	$295	9.99	0.8	933.7
3	Lighting - Power Retrofit: Outdoors HPS wall pack	Replace with LED 17W Module StdElectronic	$130 + $5 Maint. Savings / 0.7 MMBTU	$120	9.49	0.9	368.8
4	Lighting - Power Retrofit: Server Room Incan, A-Type, surf mt	Replace with LED 9W Module StdElectronic	$3 / 0.0 MMBTU	$5	7.35	1.6	8.9
5	Lighting - Power Retrofit: Offices, Lobby, Reception, Kitchen, Entry T12-2 wrap	Replace with 14 LED (2) 15W Module StdElectronic	$772 + $70 Maint. Savings / -0.1 MMBTU	$1,032	6.67	1.2	1,934.9
6	Setback Thermostat: Hall, Server Room, Entry	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Hall, Server Room, Entry space.	$79 / 1.8 MMBTU	$300	3.52	3.8	299.2
7	Lighting - Power Retrofit: Bathroom T12-2 wrap 12x24	Replace with LED (2) 8W Module StdElectronic	$22 + $5 Maint. Savings / 0.0 MMBTU	$84	2.64	3.1	54.9
	TOTAL, cost-effective measures		**$1,587 + $100 Maint. Savings / 10.1 MMBTU**	**$3,136**	**7.33**	**1.9**	**4,556.9**

Table 4.1 AVCP Office, Aniak, 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**
The following measures (and EEM #0 above) were *not* found to be cost-effective from a financial perspective but are still recommended:							
8	Lighting - Power Retrofit: Boiler, CFL, A-type	Replace with LED 7W Module StdElectronic	$0 / 0.0 MMBTU	$5	0.32	35.4	0.4
	TOTAL, all measures		**$1,587 + $100 Maint. Savings / 10.1 MMBTU**	**$3,141**	**7.32**	**1.9**	**4,557.3**

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 Insulation Measures (There were no improvements in this category)

4.3.2 Window Measures (There were no improvements in this category)

4.3.3 Door Measures (There were no improvements in this category)

4.3.4 Air Sealing Measures (There were no improvements in this category)

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Building Space			Recommendation	
0	Crawl space unit heater control			Install 3-way zone valve, replace thermostat with new model controlling new zone valve and fan to prevent UH from running wild.	
Installation Cost	$1000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	
Breakeven Cost		**Simple Payback (yrs)**		**Energy Savings (MMBTU/yr)**	
		Savings-to-Investment Ratio			
Auditors Notes: Estimated cost $500 parts + 4 hrs labor @ $125/hr, total $1000					

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

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Lobby/Reception/Office Areas			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Lobby/Reception/Office Areas space.	
Installation Cost	$300	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$251
Breakeven Cost	$3,379	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	5.8 MMBTU
		Savings-to-Investment Ratio	11.3		
Auditors Notes:					

Rank	Building Space			Recommendation	
6	Hall, Server Room, Entry			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Hall, Server Room, Entry space.	
Installation Cost	$300	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$79
Breakeven Cost	$1,057	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	1.8 MMBTU
		Savings-to-Investment Ratio	3.5		
Auditors Notes:					

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	Hall, Stairs T12-2 wrap		4 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 4 LED (2) 15W Module StdElectronic	
Installation Cost		$295	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$330
Breakeven Cost		$2,946	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	1.9 MMBTU
			Savings-to-Investment Ratio	10.0	**Maintenance Savings ($/yr)**	$20
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (4) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (8) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.						

Rank	Location		Existing Condition		Recommendation	
3	Outdoors HPS wall pack		HPS 50 Watt Magnetic with Manual Switching		Replace with LED 17W Module StdElectronic	
Installation Cost		$120	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$130
Breakeven Cost		$1,139	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.7 MMBTU
			Savings-to-Investment Ratio	9.5	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Replace (1) 50w HPS fixture with new 17w LED fixture with integral photocell sensor @ parts cost of $75 ea + 1 hr labor ea. @ $45/hr. Maintenance savings $5/fixture						

Rank	Location		Existing Condition		Recommendation	
4	Server Room Incan, A-Type, surf mt		INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 9W Module StdElectronic	
Installation Cost		$5	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3
Breakeven Cost		$37	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	7.4		
Auditors Notes: Replace (1) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.						

Rank	Location		Existing Condition		Recommendation	
5	Offices, Lobby, Reception, Kitchen, Entry T12-2 wrap		14 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 14 LED (2) 15W Module StdElectronic	
Installation Cost		$1,032	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$772
Breakeven Cost		$6,885	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	6.7	**Maintenance Savings ($/yr)**	$70
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (14) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (28) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.						

Rank	Location		Existing Condition		Recommendation	
7	Bathroom T12-2 wrap 12x24		FLUOR (2) T12 2' F20T12 40W Standard with Manual Switching		Replace with LED (2) 8W Module StdElectronic	
Installation Cost		$84	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$22
Breakeven Cost		$222	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	2.6	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 24" 8.5w T8 LED's @ $25 ea. Maintenance savings $5/fixture.						

Rank	Location		Existing Condition		Recommendation	
8	Boiler, CFL, A-type		FLUOR CFL, A Lamp 11W with Manual Switching		Replace with LED 7W Module StdElectronic	
Installation Cost		$5	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$
Breakeven Cost		$2	**Simple Payback (yrs)**	35	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.3		
Auditors Notes: Replace (1) 11w A-type CFL bulb with 7w A-type LED bulb @ $5 ea. No labor, owner to install.						

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

ALL SCHEDULES COMPILED FROM PLANS OR ON-SITE NAMEPLATE OBSERVATION, WHERE ACCESSIBLE e= estimated

EXHAUST FAN SCHEDULE

SYMBOL	MOTOR MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
EF-1	unknown	e100	e60w/115/1	Bathroom exhaust fan

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
CP-1	Taco 007-F5	23@10	0.04/115/1	Circ pump for Boiler, 0.7 amps

BOILER SCHEDULE

SYMBOL	MFGR/MODEL	NOMINAL EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
B-1	Burnham Boiler, PV74WB	87%	5.8A/120/1	156 MBH input, 136 MBH output, nominal 87% efficient de-rated to 80% for age and condition

UNIT HEATER SCHEDULE

SYMBOL	MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
UH-1	Modine HS 47S01	730	.083/115/1	Crawl space unit heater, runs wild, 30.9 MBH

Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies, and irregularities that may provide insight regarding the building's function and efficiency. Thirty-six months of historical data is sufficient to gain an understanding of the building operation. Electric consumption data from 2015 through 2017 was available, but no fuel oil delivery or consumption data was provided. As previously mentioned, the use and occupancy of this building will change significantly from the 2015-2017 period, so both the actual and AkWarm-C predicted figures are shown in this Appendix. Figures B.1, B.2 and B.3 show the known and predicted 3 year summary of consumption and costs for this facility. The shaded cells represent the data used in (or provided by) the AkWarm-C model.

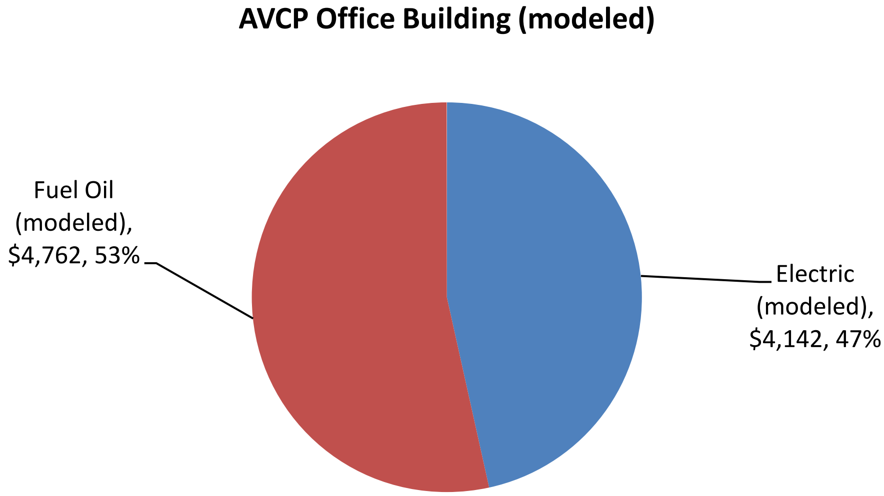
Figure B.1 – Total ACTUAL, known Building Electric Consumption and Costs

<table>
<tr><th colspan="7">AVCP OFFICE (no PCE)</th></tr>
<tr><th></th><th>Elec. Consumption (kWh)</th><th>Electric Cost</th><th>Fuel Oil use (gallons)</th><th>Fuel oil Cost</th><th>Total kBTUs of Energy</th><th>Total Utility Cost</th></tr>
<tr><td>2015</td><td>250</td><td>$146</td><td rowspan="3">Not provided by owner</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>2016</td><td>1487</td><td>$867</td></tr>
<tr><td>2017</td><td>1795</td><td>$891</td></tr>
</table>

Figure B.2 – Total Building Electric Consumption and Costs as PREDICTED by the AkWarm-C model

<table>
<tr><th colspan="7">AVCP OFFICE (no PCE)</th></tr>
<tr><th></th><th>Elec. Consumption (kWh)</th><th>Electric Cost</th><th>Fuel Oil use (predicted by AkWarm-C) - gallons</th><th>Fuel oil Cost</th><th>Total kBTUs of Energy</th><th>Total Utility Cost</th></tr>
<tr><td></td><td></td><td></td><td rowspan="3">837</td><td rowspan="3">$4,762</td><td rowspan="3">134,044</td><td rowspan="3">$8,903</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Predicted</td><td>6903</td><td>$4142</td></tr>
</table>

Figure B.3 – Distribution of PREDICTED Energy Costs



Electricity: Because the use and occupancy of this building has changed and will change again when AVCP staff move in, little can be concluded from historical data. Nonetheless, monthly and annual electric consumption figures are provided below.

Figure B.4 – 3 Years of monthly Electric Consumption

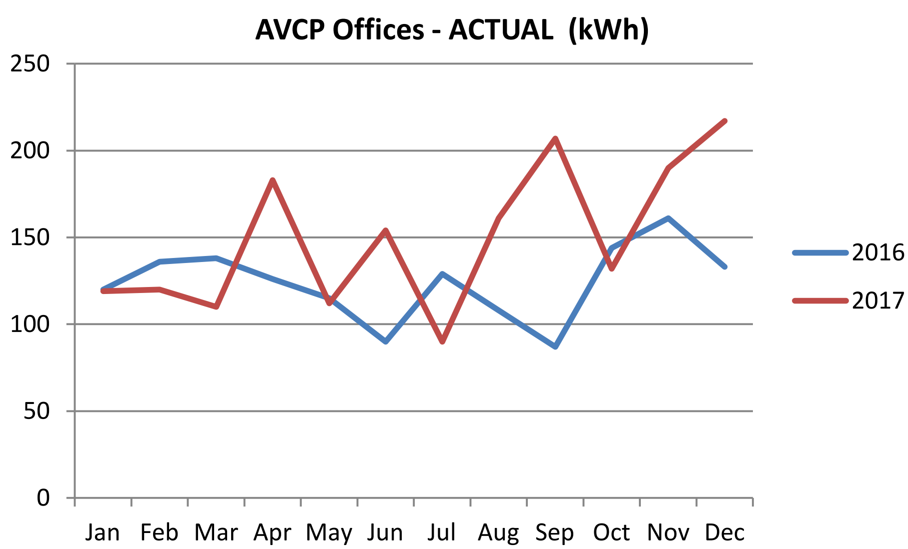
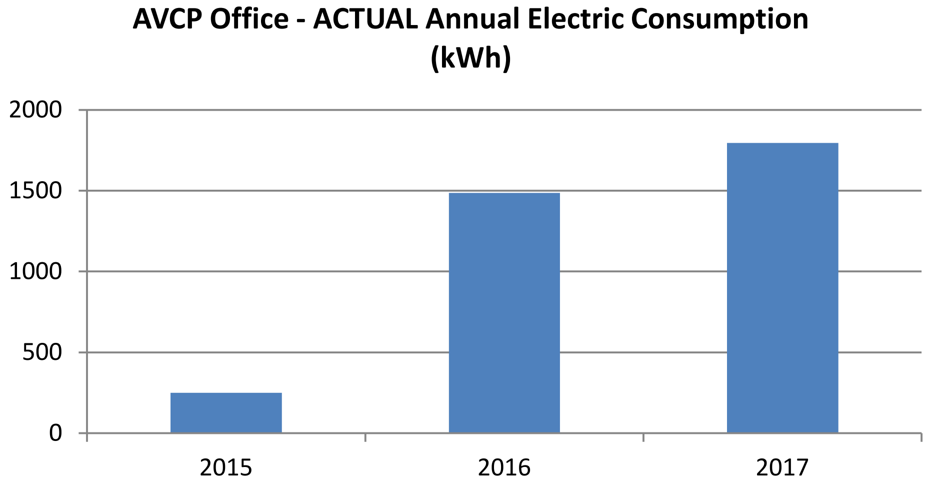


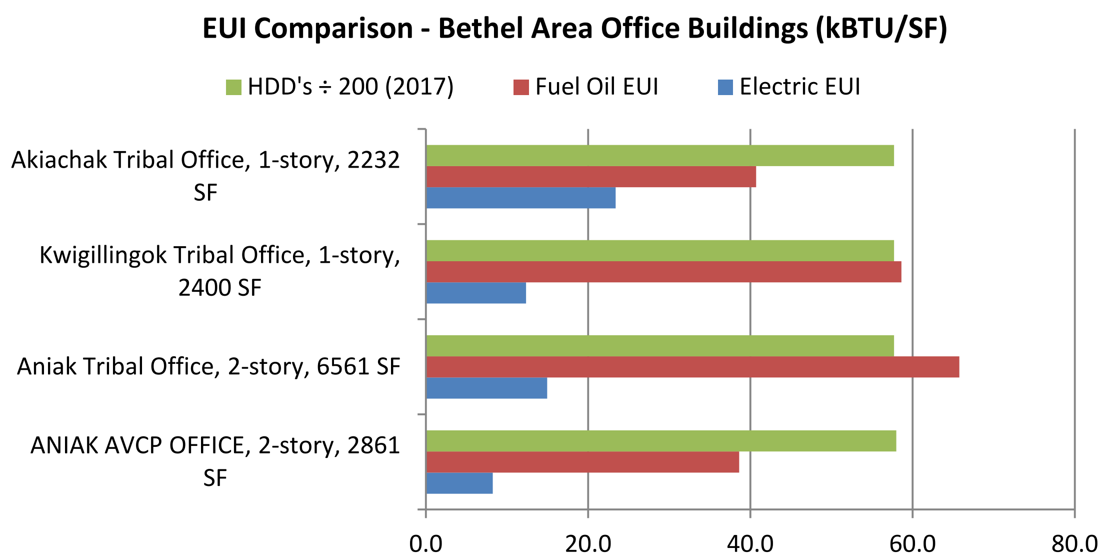
Figure B.5 – 3 years of Annual Electric Consumption



Fuel Oil: Because no oil delivery data was provided, no benchmarking can be performed on this building.

Comparing EUIs: Figure B.6 and the discussion in Section 1.5 above indicate that if this building's heating system is operating correctly it has the most efficient heating and electric EUIs of all the comparison buildings. Because the building's occupancy is the lowest (on a per square foot basis) of all the buildings, its electric EUI would also be expected to be the lowest.

Figure B.6 – EUIs



After performing the historical analysis in Section 1.5 and above, a baseline period is typically selected as a benchmark based on factors including the consistency of the data, the periods for which data was available, and the current use and occupancy of the building versus its historical use and occupancy. But since its use and occupancy are in flux, the benchmark baseline selected for this building is the electric and fuel oil predictions made by the AkWarm-C model shown in Figure B.2 above.

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering (if they are required) and construction management costs are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit, and are derived from one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- Local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified electrician $125/hr

This level of work includes changing street light heads and light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work $ 45/hr

Includes installing switch-mounted occupancy sensors that do not require re-wire or pulling additional wires, weather-stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work $125/hr

Includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities $45/hr

Includes maintaining light fixtures, door and window weather-stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

ENERGY AUDIT REPORT – PROJECT SUMMARY

General Project Information

PROJECT INFORMATION	AUDITOR INFORMATION
Building: AVCP Office	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Laura Simeon	
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 675-4349	**Auditor Comment:**
Client FAX:	

Design Data

Building Area: 2,861 square feet	**Design Space Heating Load:** Design Loss at Space: 27,615 Btu/hour with Distribution Losses: 30,683 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 46,773 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 5 people	**Design Indoor Temperature:** 61.3 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days

Utility Information

Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.600/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

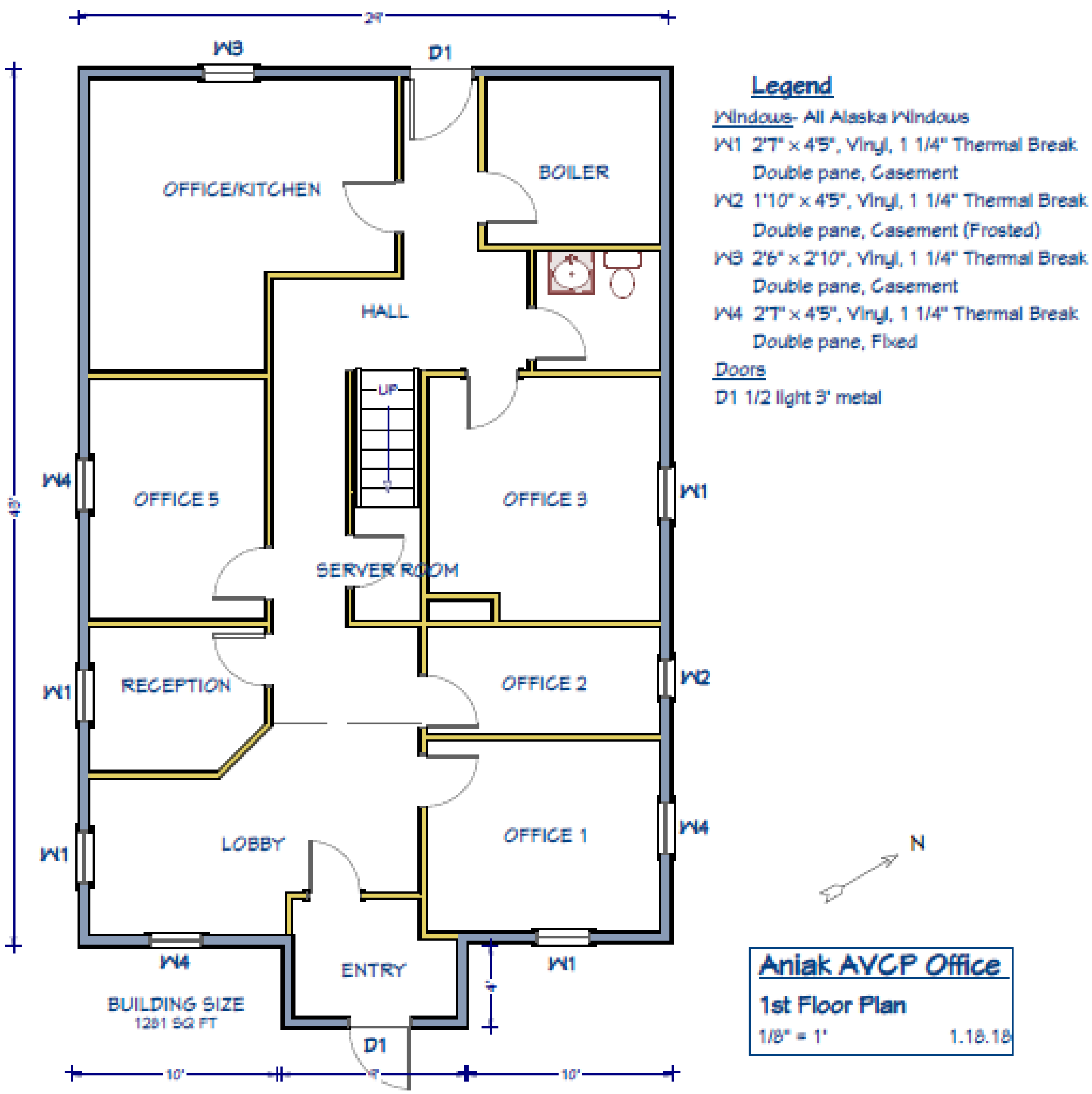
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$4,890	$0	$453	$6	$2,392	$360	$802	$0	**$8,903**
With Proposed Retrofits	$4,821	$0	$459	$6	$868	$360	$802	$0	**$7,316**
Savings	$69	$0	-$6	$0	$1,524	$0	$0	$0	**$1,587**

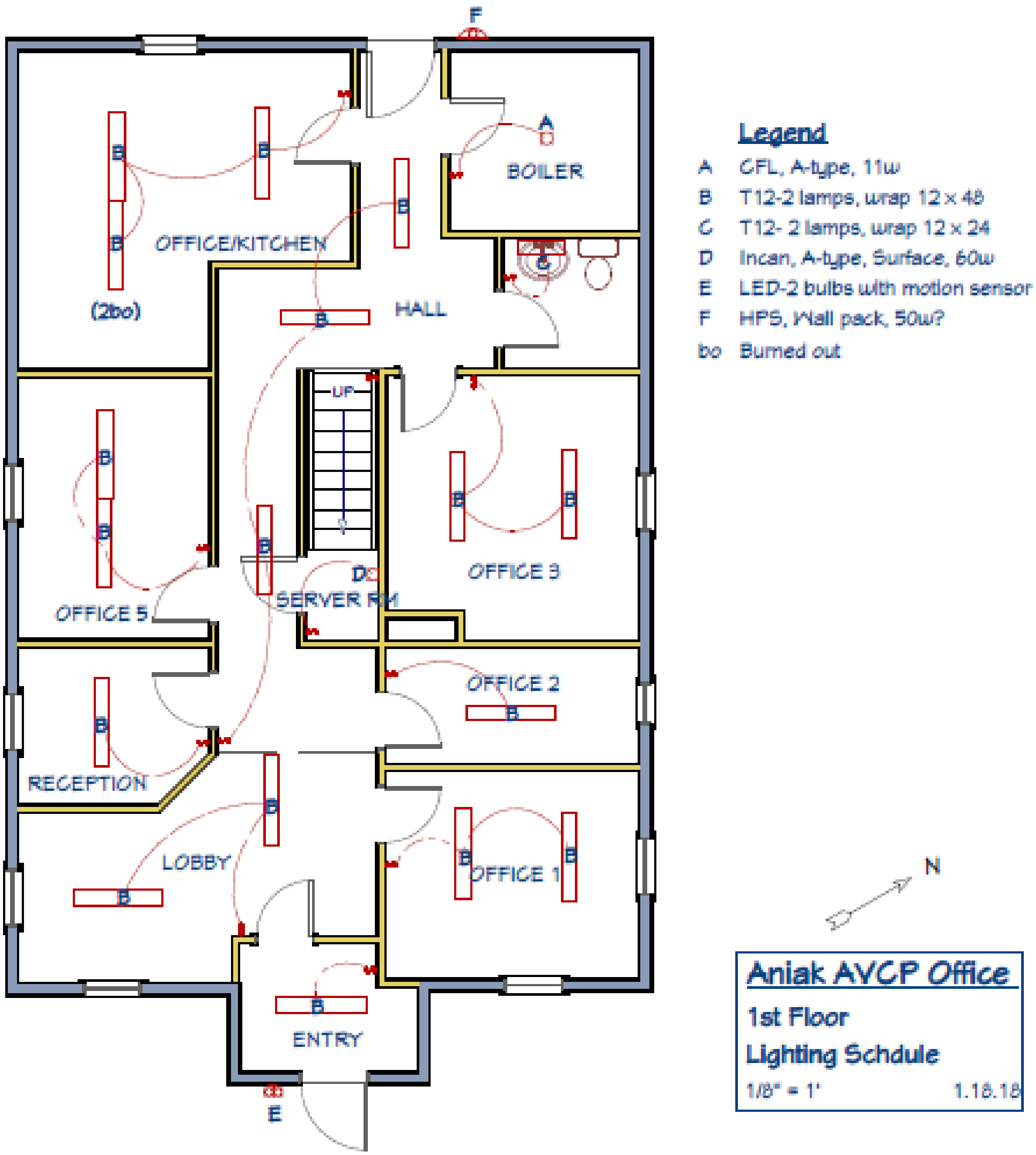
Building Benchmarks

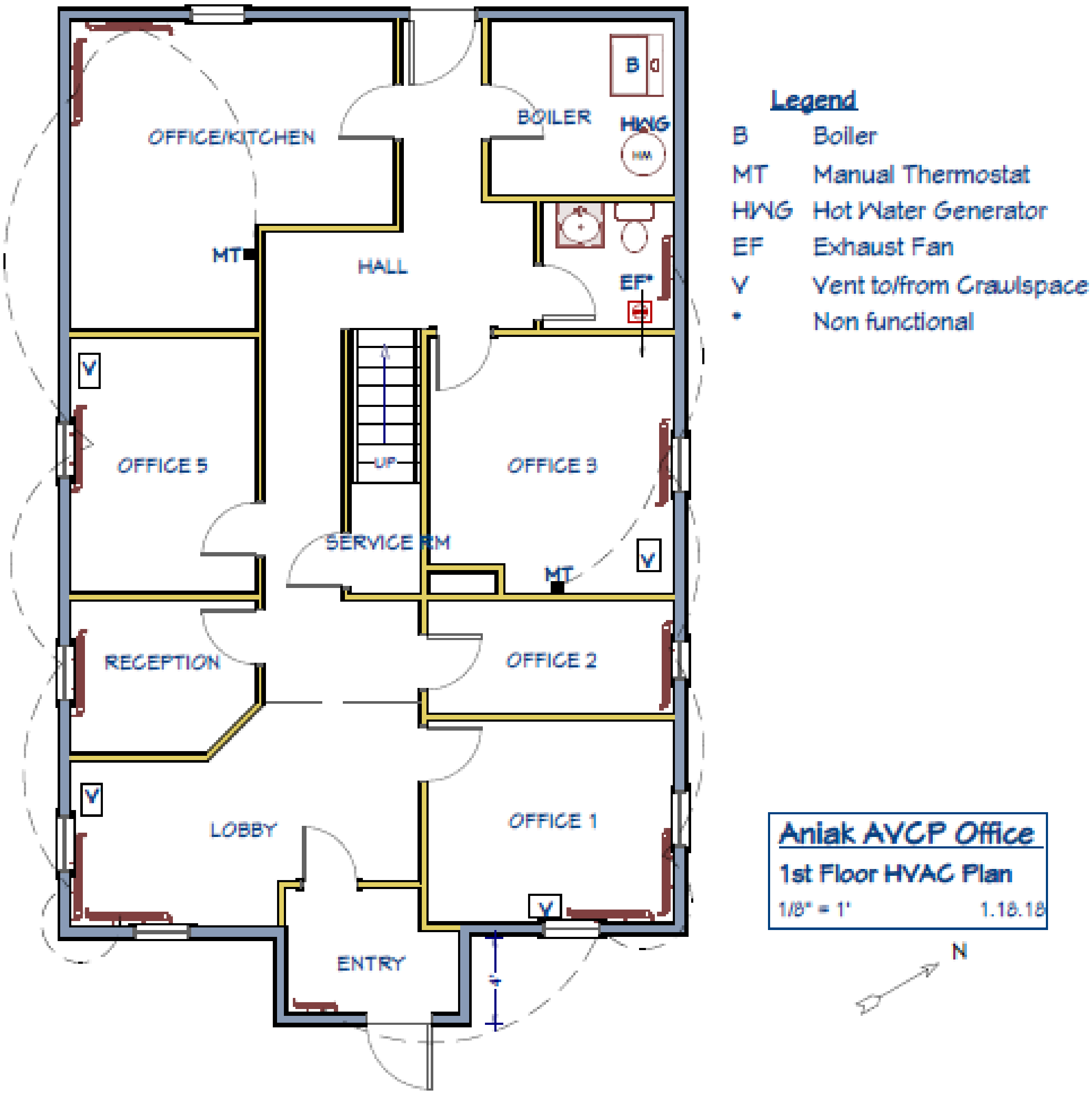
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	48.6	3.79	$3.11
With Proposed Retrofits	45.1	3.51	$2.56

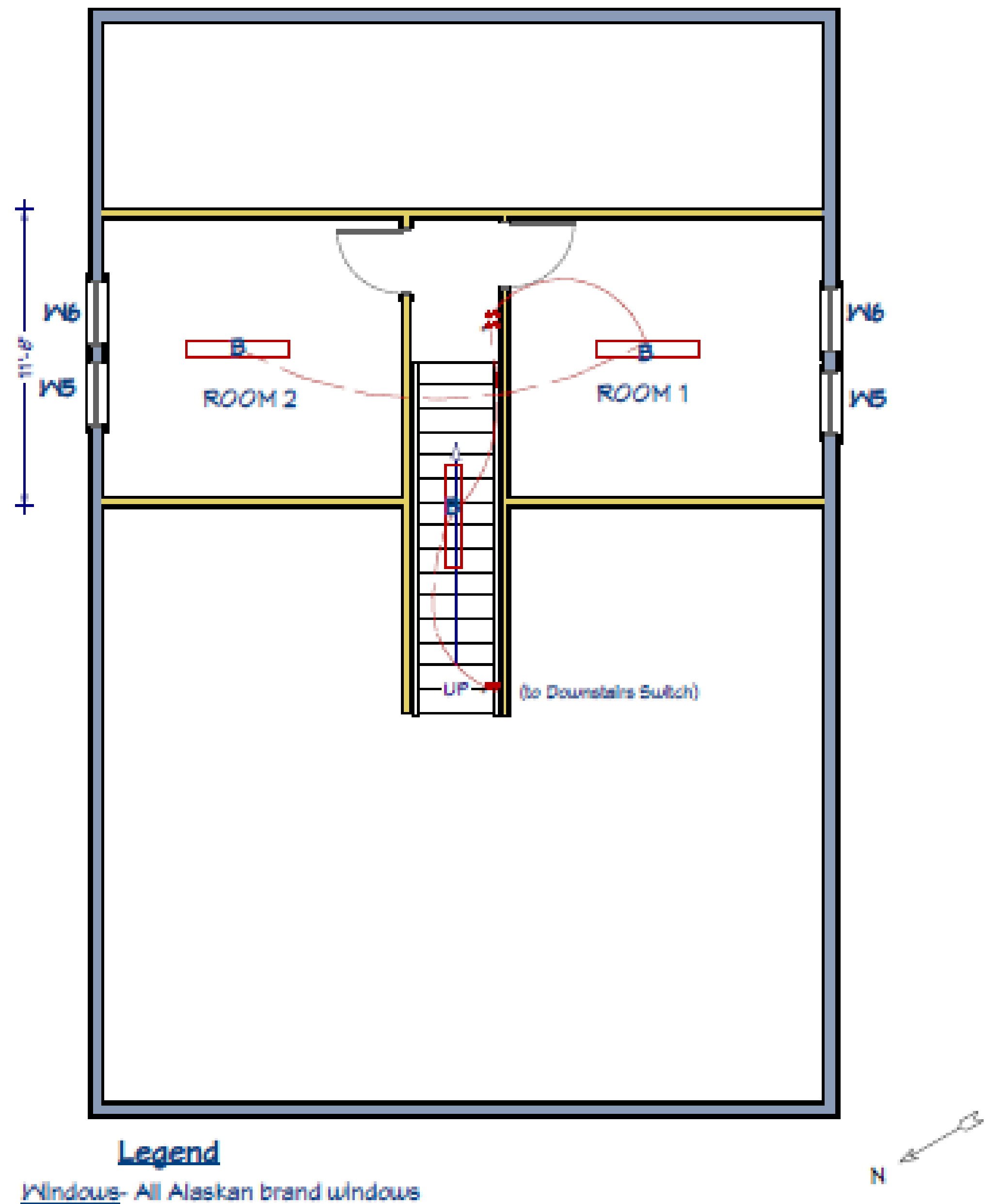
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

BUILDING SCHEMATICS




F
A
BOILER
OFFICE/KITCHEN
(2bo)
HALL
C
UP
OFFICE 3
OFFICE 5
D
SERVER RM
OFFICE 2
RECEPTION
LOBBY
OFFICE 1
ENTRY
E
Legend
A CFL, A-type, 11w
B T12-2 lamps, wrap 12 x 48
C T12- 2 lamps, wrap 12 x 24
D Incan, A-type, Surface, 60w
E LED-2 bulbs with motion sensor
F HPS, Wall pack, 50w?
bo Burned out
N
Aniak AVCP Office
1st Floor
Lighting Schdule
1/8" = 1'
1.18.18


OFFICE/KITCHEN
BOILER
B
HWG
HM
MT
HALL
EF*
V
OFFICE 5
UP
OFFICE 3
SERVICE RM
MT
RECEPTION
OFFICE 2
LOBBY
OFFICE 1
ENTRY
Legend
B Boiler
MT Manual Thermostat
HWG Hot Water Generator
EF Exhaust Fan
V Vent to/from Crawlspace
* Non functional
Aniak AVCP Office
1st Floor HVAC Plan
1/8" = 1'
1.18.18
N



Legend

Windows- All Alaskan brand windows
W5 2'6" x 2'9", Vn, 11/4" Dp TB, Fixed
W6 2'6" x 2'9", Vn, 11/4" Dp TB, Casement
Lighting
B T12-2 lamps, wrap, 12 x48
HVAC
None

Aniak AVCP Office Building
2nd Floor, Lighting & HVAC Plan
1/8" = 1' 1.18.18

Appendix E – Photographs & IR Images

Boiler room, hot water generator on left, crawlspace access in foreground

Four zones in the building: east, west, crawlspace and hot water generator; the crawl pace zone does not have a zone valve

Crawlspace unit heater with line voltage thermostat controlling fan; thermostat should be located further from the heater to provide proper readings and control

Second floor office/storage

Newly renovated first floor

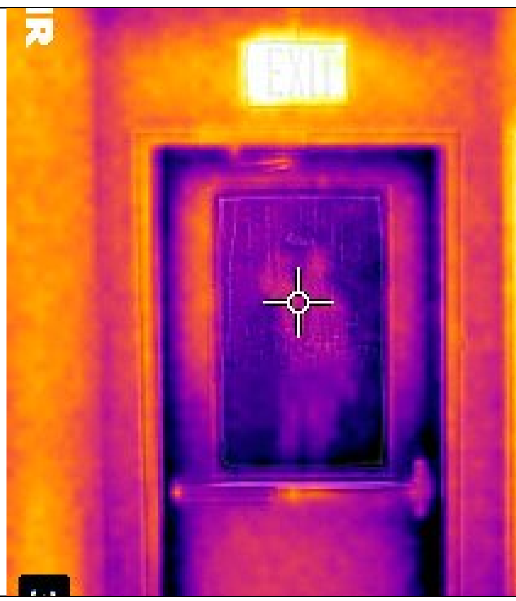
Typical newly renovated office

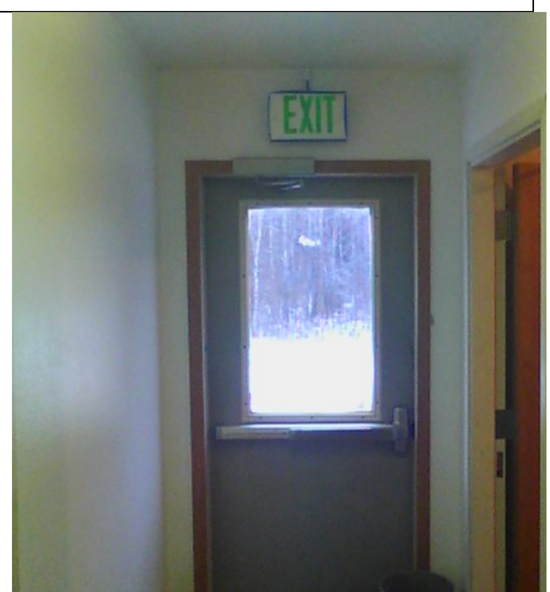
Crawlspace skirting in need of repair

Siding in need of repair; no staircase to back deck is a code violation

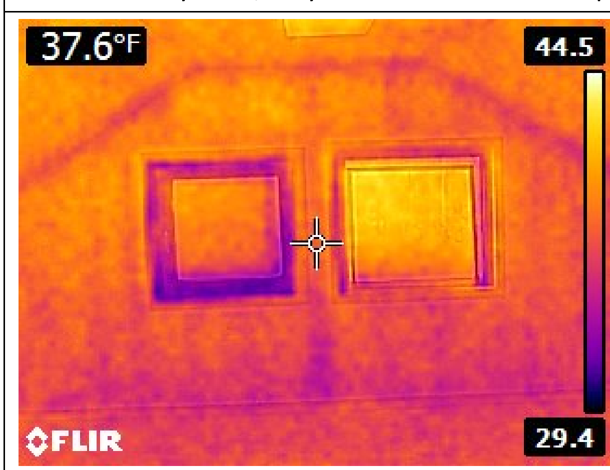
Large section of missing siding, in need of repair

1. Front entry door, in good condition

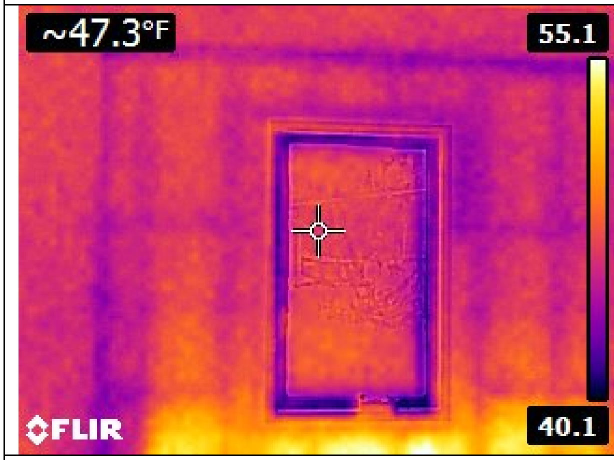




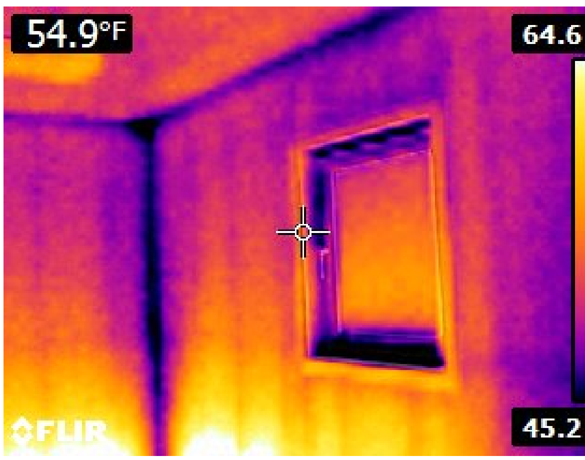
2. Rear entry door, may need new weather stripping



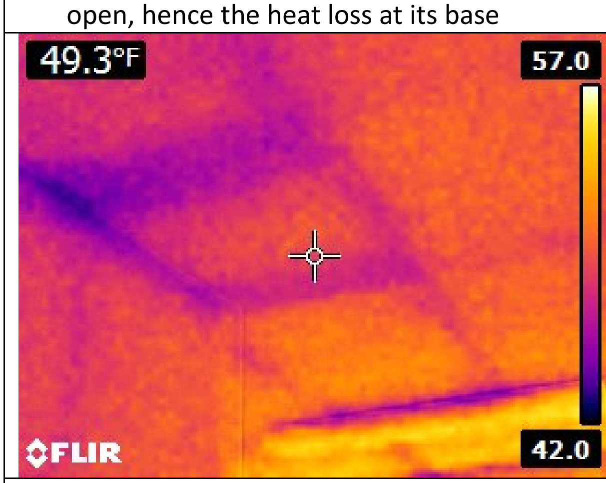
3. Second floor walls and ceiling insulation and windows appear to be good condition

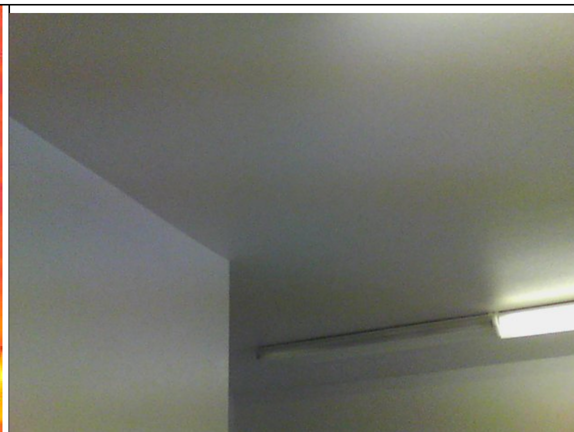


4. First floor studs wicking heat to the exterior

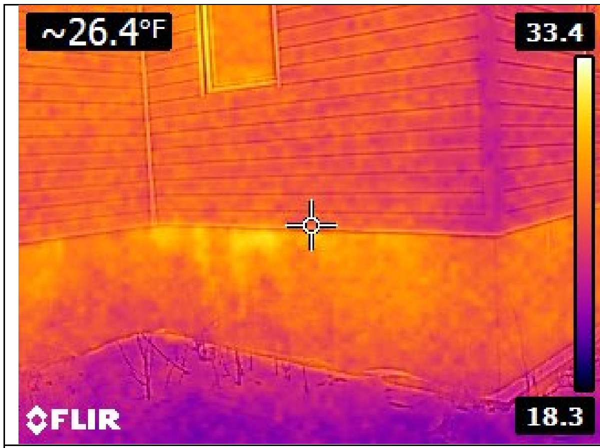


5. Corner insulation is lacking; this is fairly typical in old buildings. This window may be slightly open, hence the heat loss at its base

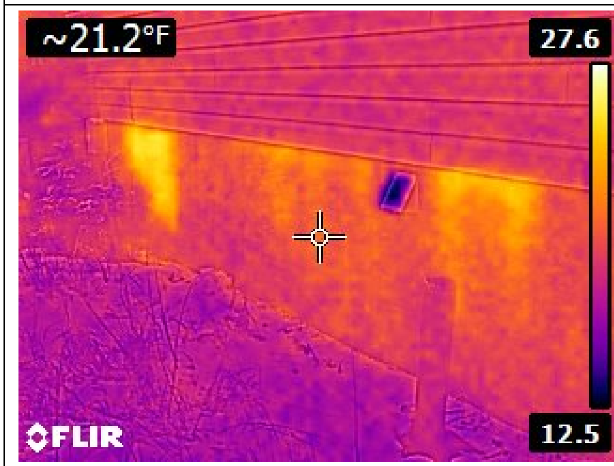




6. Rear portion of the building has some damaged ceiling/attic insulation



7. Skirting insulation could be improved with repair of these areas

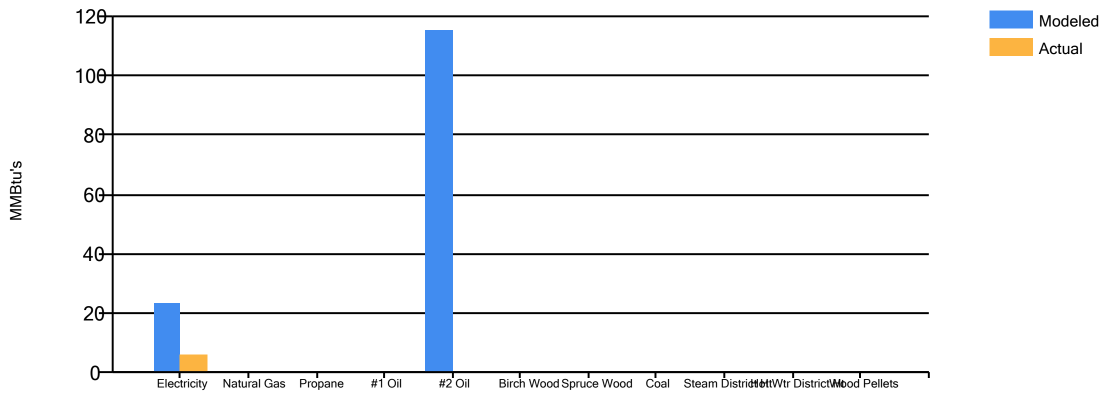


8. Same as #7 above

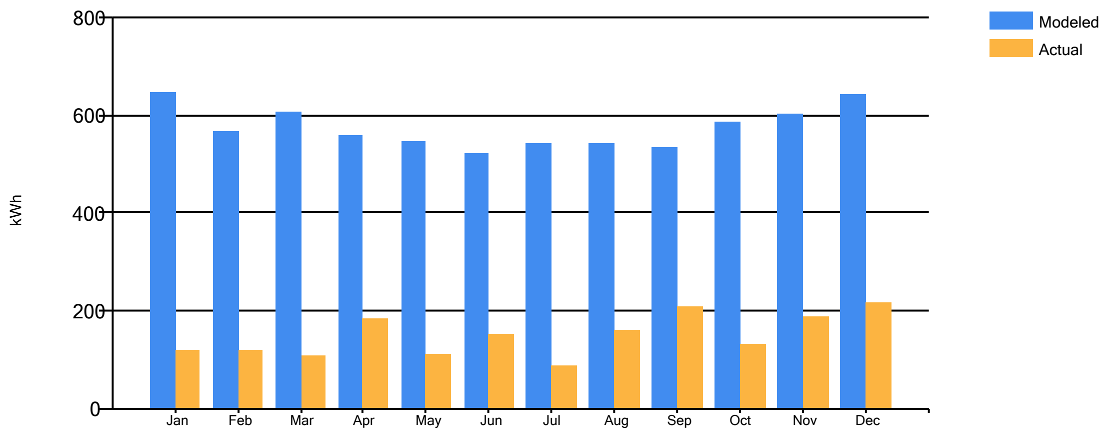
Appendix F – Actual Fuel Use versus Modeled Fuel Use

The orange bars show actual fuel use and blue bars are AkWarm's prediction of fuel use.

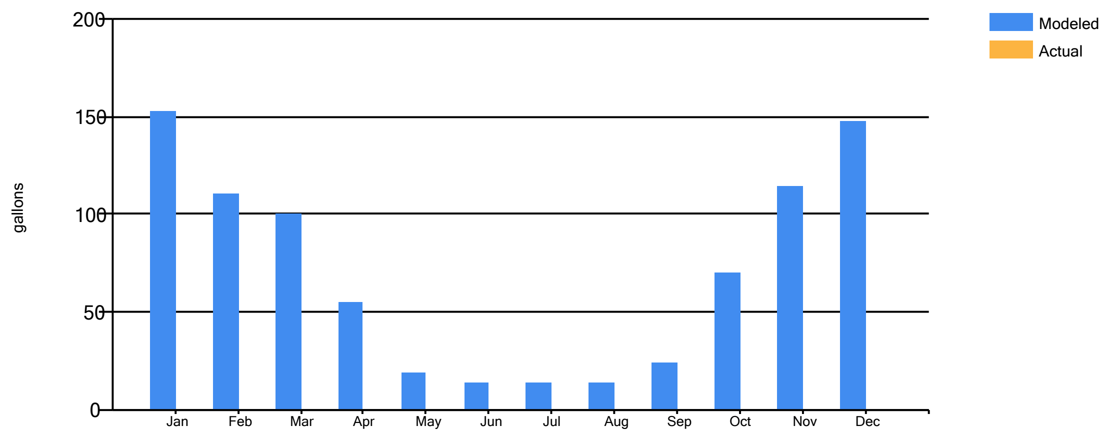
Annual Fuel Use



Electricity Fuel Use



#2 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
AKA	Also Known As
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
CFM	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OSA	Outside Air
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECMs, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

Comprehensive Energy Audit
For Community Center

Prepared For

Native Village of Aniak
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Energy Audits of Alaska

Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 21, 2018
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Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (EEMs), estimate the value of the savings and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of HVAC systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

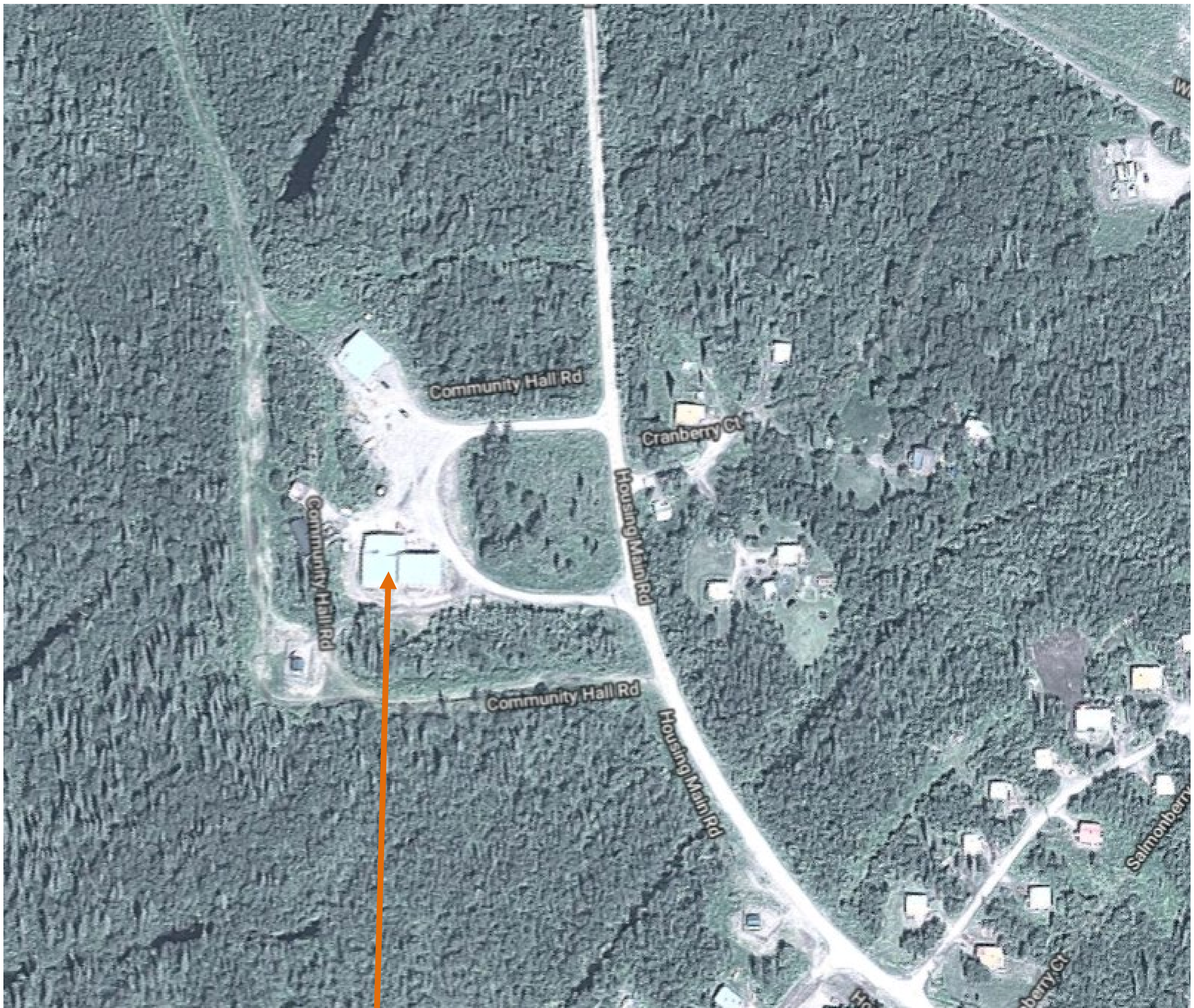
This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the ASHRAE definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy and electric usage, and the US Department of Energy who provided funding.

Project Location



NORTH

Subject Building

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1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the Community Center. The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and any process and plug loads. There are no charges for water and wastewater and these systems were not evaluated in this analysis.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy-consuming equipment, identify technically and economically feasible EEMs for existing equipment, and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The ECMs identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The "avoided costs" resulting from ECMs are discussed in Section 1.7, but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 11-page summary contains all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost, and their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with the overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

Sections 2, 3, and 4 of this report and the appendices are back-up and provide much more detailed information should the owner/operator or building staff desire to investigate further. Sections 4.3 through 4.5 include additional auditor's notes for many EEMs. Due to their length, Appendices H, I, and J, which contain additional ECM detail, lighting information, and manufacturer's "cut sheets" of samples of recommended retrofit products, are included as a separate document.

<u>Issues that the auditor feels are of particular importance to the reader are underlined</u> and all abbreviations and acronyms used in this document are listed in Appendix G.

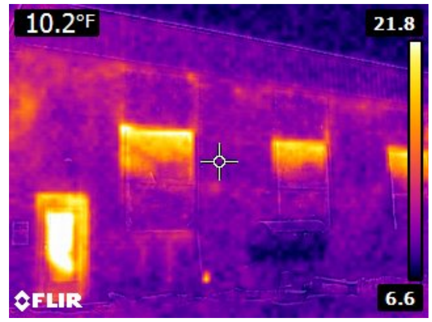
1.2 Noteworthy Points & Immediate Action

Energy conservation measures (ECMs) are no-cost or low-cost measures typically implemented by the building owner or staff. The following ECMs related to the electric service provided by Aniak Light and Power should be investigated as soon as possible:

a. There are 5 electric meters serving this building and only 3 of them receive the current PCE discount of $0.3303/kWh. If possible, the other 2 meters should be put on the same rate schedule and receive the PCE discount. This would save $3,522/year and cost nothing.

b. If the 5 meters could be combined (and the PCE discount retained for the entire usage), an additional $0.05/kWh for all kWh used over 1600/month would be realized. This is a total of another $355/year in savings.

Building Envelope and the Auditorium heat:



c. This building's envelope, particularly the auditorium, is a source of great heat loss and the following aspects should be prioritized for immediate repair (see IR images in Appendix E and at right). It should be noted that the lack of mechanical ventilation in the auditorium and the lack of operable windows may be in violation of code.
   - The former windows on the south wall of the auditorium are covered with plywood on the exterior and plastic on the interior. These openings should be framed in properly, a minimum of R-30 insulation added, and interior and exterior surfaces finished with appropriate materials.
   - The boarded-up door on the south wall of the auditorium should be replaced with a pre-hung unit with a minimum U =0.16.

d. Onsite staff indicated that the 3 Toyo stoves providing heat in the auditorium are not able to maintain comfortable temperatures during the colder periods of winter, despite the fact that they are running continuously. Toyo stoves are not designed to run continually, so their lives will be significantly shortened by operating at this duty cycle. They should be replaced with oil-fired cabinet unit heaters or unit heaters of sufficient capacity to maintain comfortable temperatures and allow setback temperatures during unoccupied periods.

Total Savings possible:

e. <u>If all the recommended EEMs (excluding EEM #35) are incorporated in this building, there will be a 28.7% reduction in energy costs, totaling $13,546, with a simple payback of 4.4 years on the $59,038 implementation cost.</u>

f. EEM #35, highlighted in red in Tables 1.1 and 4.1 is not recommended at this time and its associated cost and savings are not included in the recommended EEM totals in this report; it is presented for the building owners' information should they decide to re-side the entire building at some point in the future.

Fuel Oil delivery data not available:

g. Fuel oil delivery data for this building was not provided by the building owner, therefore the fuel oil consumption figures in this analysis had to be derived from the AkWarm-C energy simulation model. The modeled figures may not represent the actual consumption figures and therefore the energy savings may lose accuracy.

Electrical labor rates used:

h. It was assumed in this analysis that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity. It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician.

Clothes dryers

i. Hydronic clothes dryers cost 58% less than electric dryers to operate in Aniak. But the analysis shows that based on 25 loads/week, there would be a 15-year payback on the estimated $19,000 in costs[1] and $1231/yr in energy savings. This payback is longer than the life expectancy of the equipment, so the EEM is not recommended.

1.3 Current Cost and Breakdown of Energy

Aniak Light and Power Company (the electric utility provider) has a 2-tier rate structure. The first 1600 kWh/month are charged at one rate and all kWh after are charged at a slightly reduced rate, then the $0.3303/kWh PCE discount is deducted if it applies. Only 3 of the 5 electric meters serving this building receive the PCE discount, so a blended average cost electricity of $0.4026/kWh was used in this analysis for all 5 meters. It was calculated by dividing the total electric cost for all 5 meters in 2017 by the total kWh consumption for all 5 meters.

Based on this electricity price and the fuel oil price in effect at the time of the audit, and using the uncalibrated AkWarm-C© energy model[2], the total predicted energy costs are $46,910 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$10,548 for Electricity
$36,362 for #1 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	26,199 kWh	18,176 kWh
#1 Oil	6,391 gallons	4,601 gallons

The table below shows the relative costs per MMBTU for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.403	$118.08
Fuel Oil	$5.69	$43.10

[1] Add a Toyotomi-type hot water heater, piping, circulation pump for $10,000 and 6 hydronic dryers @ $1500 each
[2] If both electric and oil consumption data were available, the AkWarm-C model would normally be calibrated to these figures resulting in more accurate savings projections.

Figure 1.1

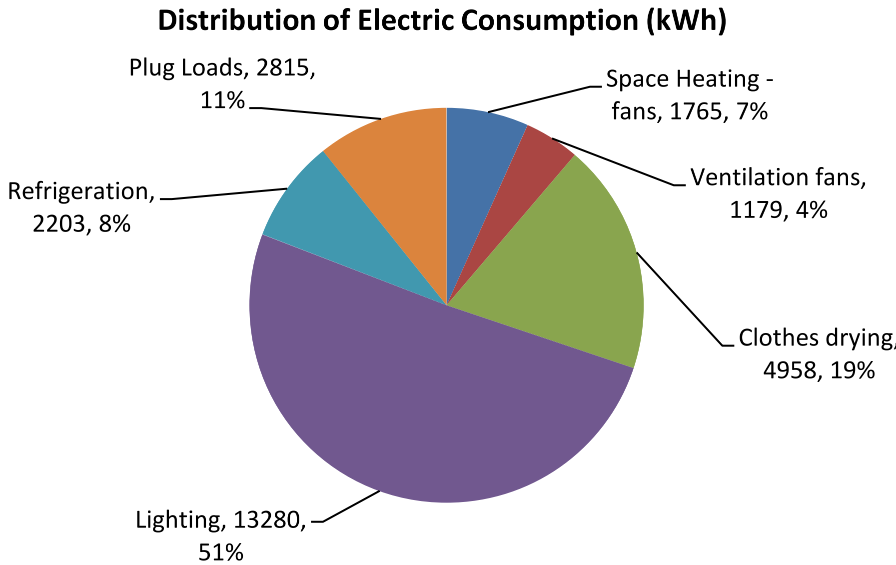
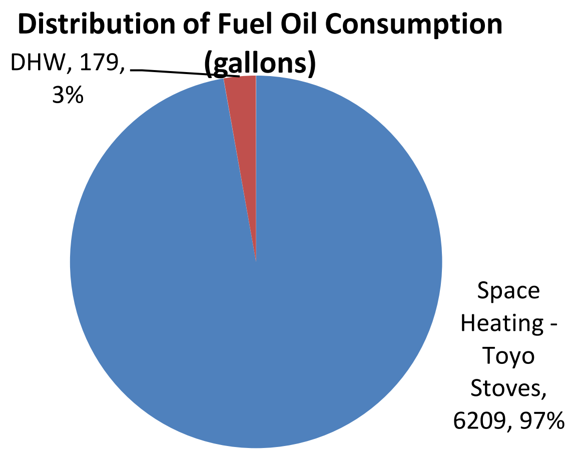


Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on lighting and space heating and the primary factor affecting space heating is the building's envelope and infiltration.

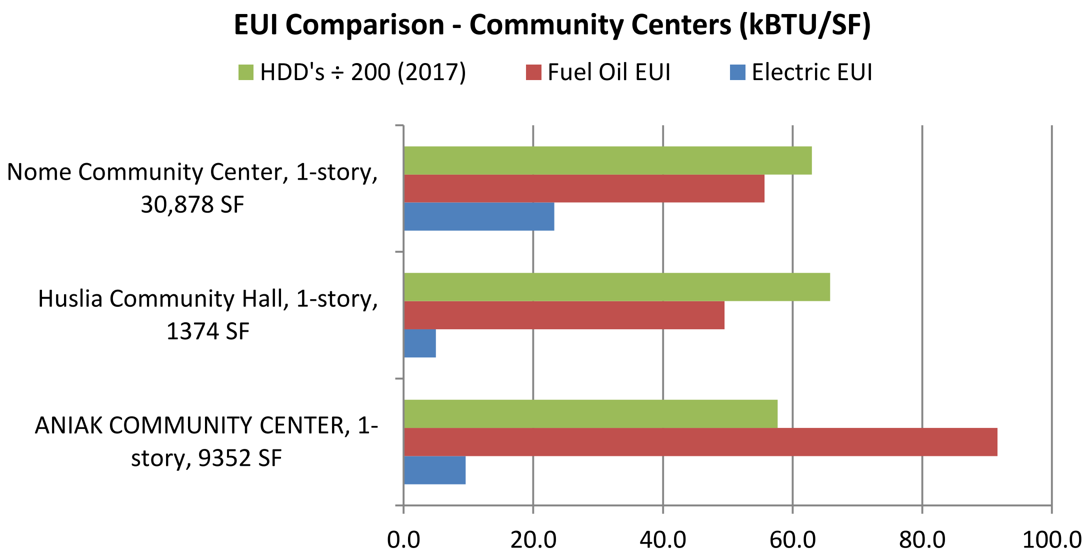
1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	99.8	7.78	$5.02
With Proposed Retrofits	71.6	5.58	$3.58
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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric EUIs are compared to similar use buildings in the region in the bar chart below. The Heating Degree Days[3] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart, the subject building's heating EUI is 50% higher than the average of the other 2 comparison community centers, even though their weather is more severe (i.e. higher HDDs) while the subject building's electric EUI is 25% lower than the average of the 2 comparison buildings. The higher heating EUI is likely related to the poor envelope conditions of the subject building and the lower electric EUI is likely due to its lower use and occupancy, on a per square foot basis. Additional discussion is provided in Appendix B.



1.6 Energy Efficiency Measures(EEMs)

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3, and Figure 1.4 shows the reduction in cost, consumption, and BTUs of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
Envelope	$46,933	$6,913	6.8
HVAC related	$3,365	$4,028	0.8
Lighting	$8,740	$2,605	3.4
Totals	**$59,038**	**$13,546**	**4.4**

[3] HDDs are a measure of the severity of cold weather; higher HDDs indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDDs.

Figure 1.4

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	26,304	89,776	18,176	62,035	30.9%
Gallons Oil	6,391	843,612	4,601	607,332	28.0%
Building Energy Cost	$46,952		$33,497		29.18%

Table 1.1 below summarizes the energy efficiency measures analyzed for the Community Center. Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM. Table 4.1 shows an additional measure of financial return on investment as well as CO_2 savings. EEM #35, highlighted in red below, is provided for the owner's information should they decide to re-side the entire building; the costs and savings for this EEM are not included in the recommended EEM totals in this report.

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	Setback Thermostat: Day Care / Day Room / Office 2	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Day Care / Day Room / Office 2 space.	$918 / 21.1 MMBTU	$1	12435.56	0.0	3,414.8
2	Setback Thermostat: Community Hall, Dressing	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Community Hall, Dressing space.	$1,799 / 41.4 MMBTU	$3	8123.42	0.0	6,690.7
3	Setback Thermostat: Library	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Library space.	$507 / 11.7 MMBTU	$1	6870.31	0.0	1,886.7
4	Lighting - Power Retrofit: Outside Single Socket A-type	Replace with LED 9W Module StdElectronic	$31 / -0.1 MMBTU	$5	48.37	0.2	141.8
5	Lighting - Power Retrofit: Entry Incan A-type	Replace with LED 7W Module StdElectronic	$17 / 0.0 MMBTU	$5	26.19	0.3	74.5
6	Lighting - Power Retrofit: Infant Care closet Incan A-type	Replace with LED 7W Module StdElectronic	$8 / 0.1 MMBTU	$5	15.81	0.6	34.1
7	Lighting - Power Retrofit: Infant Care restroom Incan A-type	Replace with LED 7W Module StdElectronic	$9 / 0.0 MMBTU	$5	13.68	0.6	38.8
8	Lighting - Power Retrofit: Quiet Room T12-2M 24x48 rec trof	Replace with 4 LED (2) 15W Module StdElectronic	$155 + $20 Maint. Savings / 1.3 MMBTU	$295	5.00	1.7	653.6

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
9	Air Tightening	Perform air sealing to reduce air leakage by 50%.	$3,891 / 89.3 MMBTU	$9,000	4.01	2.3	14,474.2
10	HVAC And DHW	1.) Replace oil fired storage hot water heater with oil fired on demand water heater (Toyotomi OM-122 or equivalent), estimated parts cost $3000 + 8 hrs labor @ $45/hr = $2560.	$554 + $250 Maint. Savings / 12.9 MMBTU	$3,360	3.98	4.2	2,056.2
11	Lighting - Power Retrofit: Toilet T12-2M surf mt	Replace with 3 LED (2) 15W Module StdElectronic	$94 + $10 Maint. Savings / 0.8 MMBTU	$222	3.95	2.1	396.7
12	Lighting - Power Retrofit: Toilet T8-4E 24x48 rec trof	Replace with 2 LED (4) 15W Module (2) StdElectronic	$83 + $15 Maint. Savings / 0.7 MMBTU	$228	3.61	2.3	348.9
13	Exterior Door: Metal 1/2 light, broken & boarded up	Remove existing door and install standard pre-hung U-0.16 insulated door.	$130 / 3.0 MMBTU	$886	3.46	6.8	483.5
14	Lighting - Power Retrofit: Outside HPS Wall Pack, 70w	Replace with 2 LED 17W Module StdElectronic	$89 + $5 Maint. Savings / 0.8 MMBTU	$240	3.29	2.6	374.3
15	Lighting - Power Retrofit: Dayroom/Daycare T12-2M 24x48 rec trof	Replace with 17 LED (4) 15W Module (2) StdElectronic	$604 + $85 Maint. Savings / 0.3 MMBTU	$1,934	2.85	2.8	2,717.2
16	Lighting - Combined Retrofit: Kitchen (1)T12-2M & (1)T12-4M	Replace with 3 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$155 + $10 Maint. Savings / 0.0 MMBTU	$488	2.69	3.0	700.6
17	Lighting - Power Retrofit: Infant Care T12-2M 24x48 rec trof	Replace with 4 LED (2) 15W Module StdElectronic	$70 + $20 Maint. Savings / 0.0 MMBTU	$295	2.45	3.3	314.9
18	Lighting - Power Retrofit: Office2 T12-2U 24x24 rec trof	Replace with 3 LED (2) 15W Module StdElectronic	$66 + $15 Maint. Savings / 0.6 MMBTU	$282	2.43	3.5	280.1
19	Auditorium Ceiling/Roof	Repair or replace existing insulation, effectively adding R-11 to the current value.	$664 / 15.2 MMBTU	$6,927	2.26	10.4	2,469.5
20	Lighting - Power Retrofit: Library T12-3M, 24x48 rec trof	Replace with 16 LED (3) 15W Module StdElectronic	$335 + $80 Maint. Savings / 0.0 MMBTU	$1,500	2.22	3.6	1,514.9
21	Lighting - Power Retrofit: Lobby T8-4E 24x48 rec trof	Replace with 8 LED (4) 15W Module (2) StdElectronic	$205 + $40 Maint. Savings / -0.1 MMBTU	$910	2.15	3.7	928.7

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
22	Lighting - Combined Retrofit: Laundry T8-4E 24x48 rec trof	Replace with 6 LED (4) 15W Module (2) StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$189 + $30 Maint. Savings / 1.6 MMBTU	$983	1.88	4.5	798.7
23	Lighting - Power Retrofit: Comm Hall, dressing, T8-2E strip	Replace with 2 LED (2) 15W Module StdElectronic	$13 + $10 Maint. Savings / 0.0 MMBTU	$148	1.73	6.5	57.9
24	South wall Auditorium, boarded up windows	Frame openings, add R-30 insulation, finish interior and exterior surfaces	$1,700 / 39.0 MMBTU	$19,001	1.55	11.2	6,325.2
25	West wall, main entry	Remove existing door and install standard pre-hung U-0.16 insulated door.	$166 / 3.8 MMBTU	$2,775	1.42	16.7	618.7
26	East wall, near entry	Replace existing window with U-0.28 wood window.	$49 / 1.1 MMBTU	$647	1.30	13.3	180.8
27	Lighting - Power Retrofit: Comm Hall, T8-4E, 24x48 rec.troffer	Replace with LED (4) 15W Module (2) StdElectronic	$13 + $5 Maint. Savings / 0.0 MMBTU	$114	1.27	6.4	58.5
28	Lighting - Power Retrofit: Comm Hall, T8-2E Strip	Replace with 2 LED (2) 15W Module StdElectronic	$13 + $10 Maint. Savings / 0.0 MMBTU	$148	1.27	6.5	58.5
29	Lighting - Power Retrofit: Mechanical T8-2E strip	Replace with 3 LED (2) 15W Module StdElectronic	$12 + $15 Maint. Savings / 0.0 MMBTU	$222	1.17	8.2	54.8
30	Lighting - Power Retrofit: Mechanical T8-2E strip	Replace with LED (2) 15W Module StdElectronic	$4 + $5 Maint. Savings / 0.0 MMBTU	$74	1.17	8.2	18.2
31	Furnace room	Remove existing door and install standard pre-hung U-0.16 insulated door.	$55 / 1.3 MMBTU	$1,182	1.11	21.3	206.2
	TOTAL, cost-effective measures		**$12,596 + $625 Maint. Savings / 245.6 MMBTU**	**$51,887**	**3.24**	**3.9**	**48,371.8**
The following measures (if any are listed) were *not* found to be cost-effective from a financial perspective; EEMs #32, 33 and 34 are still recommended while #35 is provided for the owner's information:							
32	Lighting - Power Retrofit: Pantry T8-2E Strip	Replace with LED (2) 15W Module StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$74	0.92	10.5	9.3
33	Lighting - Power Retrofit: Office1 T12-3M 24x48 rec trof	Replace with 6 LED (3) 15W Module StdElectronic	$28 + $30 Maint. Savings / 0.0 MMBTU	$563	0.84	9.8	125.4
34	South wall	Replace existing window with U-0.28 wood window.	$260 / 6.0 MMBTU	$6,515	0.69	25.0	968.1

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
35	Auditorium walls, exterior	Install R-20 rigid foam board to exterior and cover with T1-11 siding or equivalent.	$526 / 12.1 MMBTU	$37,901	0.33	72.0	1,957.9
	TOTAL, all measures		**$13,412 + $660 Maint. Savings / 263.6 MMBTU**	**$96,939**	**1.92**	**6.9**	**51,433**

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 pay back 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.

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 existing building. The second row shows the expected breakdown of energy cost for the building assuming all the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$36,038	$0	$1,034	$475	$1,996	$5,347	$886	$1,134	$0	**$46,910**
With Proposed Retrofits	$26,297	$0	$437	$475	$1,996	$2,274	$886	$1,134	$0	**$33,497**
Savings	$9,741	$0	$598	$0	$0	$3,074	$0	$0	$0	**$13,412**

1.7 Energy Conservation Measures (ECMs)

No and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O&M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called "avoided costs" rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring:** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC "performance drift" is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.

   There is a range of simple to very complex building monitoring systems commercially available, and most utilize a user-friendly internet- or network-based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

   ARIS – The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owners track and manage energy use and costs. For more information contact Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us).

   BMON – AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings and can be installed by anyone with basic IT skills. This software is available at https://code.ahfc.us/energy/bmon.

   Monnit – "product model" sensors are purchased (costing $500-$1500) and installed, while the basic network-based dashboard is free. A more comprehensive, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures; is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas, and/or oil	
Re-program Toyo stoves after a power outage	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.

4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Weather stripping should be maintained or added if it does not exist.

5) **Turn off plug loads** including computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves the desk, add an occupancy sensing plug load management device (PLMD) like the "Isole IDP 3050" power strip produced by Wattstopper. (See Appendix J)

6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans, and thermostats in this building. An unmaintained HVAC component like a boiler can reduce its operating efficiency by 3% or more.

7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone, and turn down the heat and turn off lighting in that zone.

8) **Additional ECM recommendations**:

   a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes, and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.

   b. Purchase an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.

   c. At the end of useful life (EOL), replace refrigeration equipment and commercial cooking equipment with Energy Star versions.

d. Keep refrigeration coils clean.

e. Keep heating coils in air handlers, unit heaters and fan coil units clean.

f. Install programmable set-back thermostats and program for unoccupied setback temperatures of 60F to 63F.

g. Investigate why 2 of the 5 electric meters do not receive the PCE discount.

h. Either add windows to the boarded-up former window openings in the auditorium south wall or properly frame and insulate the openings.

i. When the existing clothes washers reach their EOL, replace them with top-loading machines, which use less than 50% less water and less than 25% of the hot water than top-loading machines.

ALL FRONT LOAD DOE "J1" TESTING				
Water Temp.	Hot	Cold	Total Water Consumption	DOE Cycle %
Hot	5.0	9.8	14.8 Gal	14%
Warm	1.8	13.0	14.8 Gal	49%
Cold	0.0	14.8	14.8 Gal	37%
Average Hot Water Per Cycle				1.59 Gal
* Water usages may vary from your particular application. All rinses automatically use cold water.				

SWT020 replace by SWNMN Top load washer

HOME TOP LOAD DOE "J1" TESTING				
Water Temp.	Hot	Cold	Total Water Consumption	DOE Cycle %
Hot	17.1	19.6	36.7 Gal	14%
Warm	6.0	30.7	36.7 Gal	49%
Cold	0	36.7	36.7 Gal	37%
Average Hot Water Per Cycle				5.33 Gal
* Water usages may vary from your particular application.				

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Community Center. 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%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager (if possible) to understand their objectives and ownership strategy and gather other information to make the audit most useful to the client. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment including refrigeration equipment
- Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and energy management programs (if they exist) provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from Community Center enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building." The analysis involves distinguishing the different fuels used on site and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model

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, adding any HVAC systems, ventilation and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat) and the hours of operation of the building.

Community Center is classified as being made up of the following activity areas:

1) Community Hall, Dressing: 4,266 square feet
2) Kitchen & Pantry: 292 square feet
3) Day Care / Day Room / Office 2: 1,450 square feet
4) Entry / Lobby: 523 square feet
5) Toilet rooms (3): 297 square feet
6) Closets & storage: 122 square feet
7) Infant Care / Quiet Room: 517 square feet
8) Mechanical Room / Janitor: 443 square feet
9) Library: 735 square feet
10) Office 1: 285 square feet
11) Laundry: 422 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model was calibrated to actual fuel consumption and was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions.

Limitations of AkWarm© Models

The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis

Our analysis provides a number of tools for assessing the cost-effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions, and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 until 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, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIRs and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR greater than or equal to 1 to be considered financially viable on a standalone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. Costs are considered to be accurate within +/-30% in this level of audit; they are derived from Means Cost Data, industry publications, the auditor's experience, and/or local contractors and equipment suppliers.

Interactive effects of EEMs:
It is important to note that the savings for each recommendation is calculated based on implementing the most cost-effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of the order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases, lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in others negatively. If all EEMs are implemented, their order of implementation is irrelevant because the total savings after full implementation will be unchanged. If an EEM is calculated outside of the AkWarm© model, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:
The underlying assumptions used in the calculations made in this audit follow:

- 3413 BTU/kWh

- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs, or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline shall accept full responsibility and liability for the design, engineering, and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects is not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. COMMUNITY CENTER EXISTING CONDITIONS

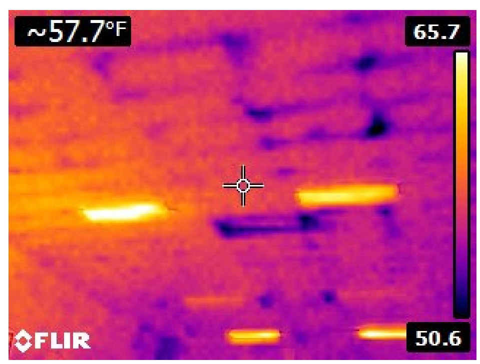
3.1. Building Description

The 9,352-square-foot Community Center was constructed in 1985. It is a mixed-use building, providing youth services, day care, after school activities, bingo, a Laundromat, a library, and a music room. Normal occupancy includes a full-time staff of 2, a part-time staff of 2, from 15-30 children per day, 30-40 bingo players in the evenings and 100 or more people in the auditorium during community events. Normal operating hours are from 9:00am until 5:00pm Monday through Friday and from 10:00am until 4:30pm on Saturday and Sunday. Additionally, bingo is held on Tuesdays and Thursdays from 6:30pm until 10:00pm.

Description of Building Shell

A set of original 1983 building plans were available; details below are provided by those plans or personal observations.

This building is constructed on perimeter foundation walls using 2” x 10” studs whose cavities are filled with R-30 fiberglass batt. The foundation walls support floor trusses, with no additional insulation. The building walls are also constructed with 2” x 10” wood studs, 24” OC, with R-30 batt. The interior walls are finished with gypsum, the exterior walls are finished with horizontal wood siding.



The windows utilize double-pane glass in either wood or vinyl frames. The doors are all metal, some with ½ lites and one with a full lite boarded up. The doors are in poor condition as are the wood windows (photo at right) while the vinyl windows are in good condition other than several cracked panes.

The painted metal roof is supported by trusses with 14” of fiberglass batt with an original insulation value of R-55. The IR images at right (and in Appendix E) show that the ceiling insulation is in very poor condition, so it was de-rated to R-42 in the AkWarm-C simulation model.

Overall, the building envelope is in poor condition.

Description of Heating and Cooling Plants

Toyo Laser 30

Nameplate Information:	Toyo Laser 30
Fuel Type:	#1 Oil
Input Rating:	15,000 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	Thermal efficiency 87% when new, de-rated to 80% for age and condition.

(3) Toyo Laser 73

Nameplate Information:	Toyostove Laser 73
Fuel Type:	#1 Oil
Input Rating:	120,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	Thermal efficiency 87% when new, de-rated to 82% for age. Nominal 40,000 Btu input each

Toyo Laser 73 Daycare

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	Thermal efficiency 87% when new, de-rated to 82% for age.

Oil-Fired Water Heater

Nameplate Information:	Bock model 32E
Fuel Type:	#1 Oil
Input Rating:	104,000 BTU/hr
Steady State Efficiency:	65 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	Thermal efficiency 80% when new, de-rated to 65% for age and condition

Space Heating and Cooling Distribution Systems

This building was originally heated by (2) 350 MBH, oil-fired forced-air furnaces. These heat plants are no longer used. Heat is now provided by (5) oil-fired Toyo or Monitor stoves located in the auditorium, library, furnace room, and daycare room. There is no cooling in the building.

Building Ventilation System

There is no mechanical ventilation in the building. Ventilation in the daycare and library areas is provided by operable windows. No operable windows are located in the auditorium, which is likely in violation of code ventilation requirements.

HVAC Controls

Each Toyo or Monitor stove is controlled by its own remote thermostat. Each has a programmable setback feature, but none were programmed or in use.

Domestic Hot Water System

DHW is provided to lavatory sinks and the laundromat by a 32-gallon oil-fired hot water heater located in the furnace room. There does not appear to be a DHW re-circulation pump in use.

Lighting

The interior lighting consists mainly of 48" linear florescent fixtures utilizing either T8 or T12 lamps with electronic and magnetic ballasts, respectively. No lighting controls appear to be in use. Exterior lighting consists of A-type LED bulbs in the soffit light fixtures, wall packs with what appear to be 50w or 70w HPS lamps or A-type bulbs. A pole light attached to the SE corner of the building is non-functional. No exterior lighting controls appear to be in use.

Major Equipment and Plug Loads

A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis to match the actual baseline electric data and after calibration, the AkWarm© model predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

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 as predicted by the AkWarm-C model. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The utility companies providing energy to the subject building, and the class of service provided by each, are listed below:

Electricity: Aniak Light & Power - 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	$ 0.4026/kWh
#1 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or from invoices, which also included customer charges, service charges, energy costs, and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically <u>gallons delivered, not gallons consumed</u>. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $46,910 annually for electricity and other fuel costs for the Community Center.

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

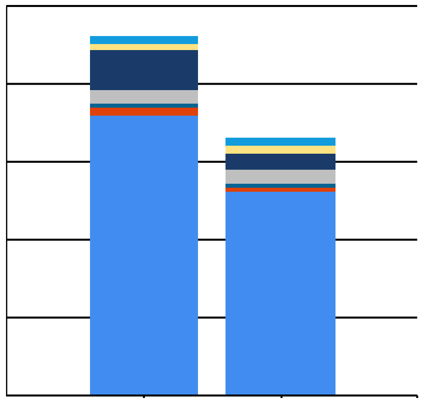


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

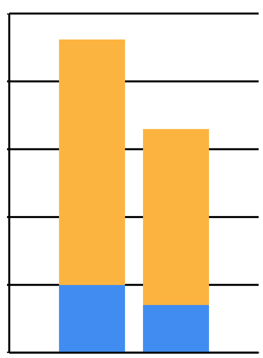
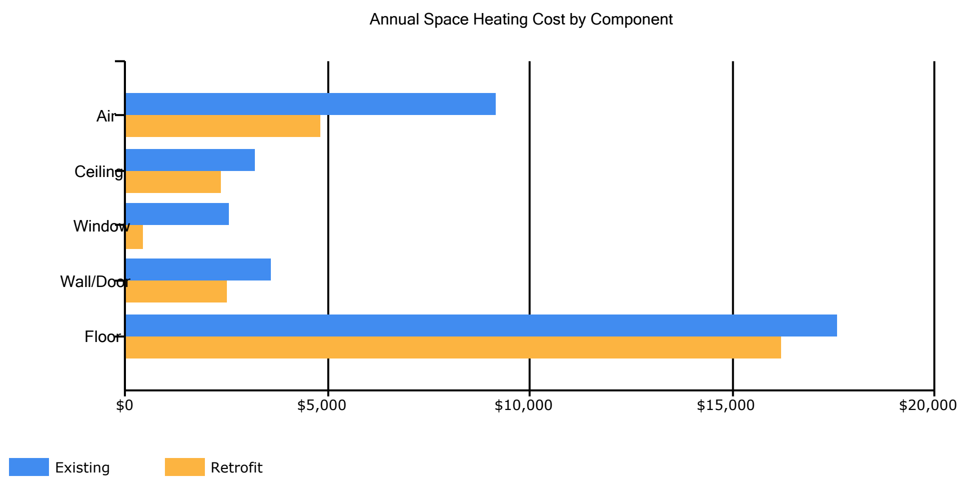


Figure 3.3 below addresses only space heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the walls/doors. For each component, the space heating cost for the existing 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 the model's estimate of monthly fuel use for each of the fuels used in the building. For each fuel, fuel use is broken down across 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	271	228	218	141	74	33	26	41	75	157	230	271
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	100	91	100	97	100	97	100	100	97	100	97	100
Clothes_Drying	421	383	421	407	421	407	421	421	407	421	407	421
Lighting	1127	1027	1127	1091	1127	1091	1127	1127	1091	1127	1091	1127
Refrigeration	187	170	187	181	187	181	187	187	181	187	181	187
Other_Electrical	239	218	239	231	239	231	239	239	231	239	231	239

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	1088	825	780	483	215	59	31	86	222	540	828	1052
DHW	15	14	15	15	15	15	15	15	15	15	15	15

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building.
It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUIs are calculated by converting all the energy consumed by a building in one year to BTUs and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy." Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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, and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

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 + Gas Usage in kBtu + similar for other fuels)
Building Square Footage

Building Source EUI = (Electric Usage in kBtu X SS Ratio + Gas 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
Community Center 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	26,199 kWh	89,415	3.340	298,648
#1 Oil	6,391 gallons	843,549	1.010	851,984
Total		**932,964**		**1,150,632**
BUILDING AREA		9,352	Square Feet	
BUILDING SITE EUI		100	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		123	**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	**99.8**	**7.78**	**$5.02**
With Proposed Retrofits	**71.6**	**5.58**	**$3.58**
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.**			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C. EEM #35, highlighted in red below, is provided for the owner's information should they decide to re-side the entire building; the costs and savings are not included in the recommended EEM totals in this report.

Table 4.1
Community Center, Aniak, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Setback Thermostat: Day Care / Day Room / Office 2	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Day Care / Day Room / Office 2 space.	$918 / 21.1 MMBTU	$1	12435.56	0.0	3,414.8
2	Setback Thermostat: Community Hall, Dressing	Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Community Hall, Dressing space.	$1,799 / 41.4 MMBTU	$3	8123.42	0.0	6,690.7
3	Setback Thermostat: Library	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Library space.	$507 / 11.7 MMBTU	$1	6870.31	0.0	1,886.7
4	Lighting - Power Retrofit: Outside Single Socket A-type	Replace with LED 9W Module StdElectronic	$31 / -0.1 MMBTU	$5	48.37	0.2	141.8
5	Lighting - Power Retrofit: Entry Incan A-type	Replace with LED 7W Module StdElectronic	$17 / 0.0 MMBTU	$5	26.19	0.3	74.5
6	Lighting - Power Retrofit: Infant Care closet Incan A-type	Replace with LED 7W Module StdElectronic	$8 / 0.1 MMBTU	$5	15.81	0.6	34.1
7	Lighting - Power Retrofit: Infant Care restroom Incan A-type	Replace with LED 7W Module StdElectronic	$9 / 0.0 MMBTU	$5	13.68	0.6	38.8

Table 4.1
Community Center, Aniak, 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
8	Lighting - Power Retrofit: Quiet Room T12-2M 24x48 rec trof	Replace with 4 LED (2) 15W Module StdElectronic	$155 + $20 Maint. Savings / 1.3 MMBTU	$295	5.00	1.7	653.6
9	Air Tightening	Perform air sealing to reduce air leakage by 50%.	$3,891 / 89.3 MMBTU	$9,000	4.01	2.3	14,474.2
10	HVAC And DHW	1.) Replace oil fired storage hot water heater with oil fired on demand water heater (Toyotomi OM-122 or equivalent), estimated parts cost $3000 + 8 hrs labor @ $45/hr = $2560.	$554 + $250 Maint. Savings / 12.9 MMBTU	$3,360	3.98	4.2	2,056.2
11	Lighting - Power Retrofit: Toilet T12-2M surf mt	Replace with 3 LED (2) 15W Module StdElectronic	$94 + $10 Maint. Savings / 0.8 MMBTU	$222	3.95	2.1	396.7
12	Lighting - Power Retrofit: Toilet T8-4E 24x48 rec trof	Replace with 2 LED (4) 15W Module (2) StdElectronic	$83 + $15 Maint. Savings / 0.7 MMBTU	$228	3.61	2.3	348.9
13	Exterior Door: Metal 1/2 light, broken & boarded up	Remove existing door and install standard pre-hung U-0.16 insulated door.	$130 / 3.0 MMBTU	$886	3.46	6.8	483.5
14	Lighting - Power Retrofit: Outside HPS Wall Pack, 70w	Replace with 2 LED 17W Module StdElectronic	$89 + $5 Maint. Savings / 0.8 MMBTU	$240	3.29	2.6	374.3
15	Lighting - Power Retrofit: Dayroom/Daycare T12-2M 24x48 rec trof	Replace with 17 LED (4) 15W Module (2) StdElectronic	$604 + $85 Maint. Savings / 0.3 MMBTU	$1,934	2.85	2.8	2,717.2

Table 4.1 Community Center, Aniak, 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
16	Lighting - Combined Retrofit: Kitchen (1)T12-2M & (1)T12-4M	Replace with 3 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$155 + $10 Maint. Savings / 0.0 MMBTU	$488	2.69	3.0	700.6
17	Lighting - Power Retrofit: Infant Care T12-2M 24x48 rec trof	Replace with 4 LED (2) 15W Module StdElectronic	$70 + $20 Maint. Savings / 0.0 MMBTU	$295	2.45	3.3	314.9
18	Lighting - Power Retrofit: Office2 T12-2U 24x24 rec trof	Replace with 3 LED (2) 15W Module StdElectronic	$66 + $15 Maint. Savings / 0.6 MMBTU	$282	2.43	3.5	280.1
19	Auditorium Ceiling/Roof	Repair or replace existing insulation, effectively adding R-11 to the current value.	$664 / 15.2 MMBTU	$6,927	2.26	10.4	2,469.5
20	Lighting - Power Retrofit: Library T12-3M, 24x48 rec trof	Replace with 16 LED (3) 15W Module StdElectronic	$335 + $80 Maint. Savings / 0.0 MMBTU	$1,500	2.22	3.6	1,514.9
21	Lighting - Power Retrofit: Lobby T8-4E 24x48 rec trof	Replace with 8 LED (4) 15W Module (2) StdElectronic	$205 + $40 Maint. Savings / -0.1 MMBTU	$910	2.15	3.7	928.7
22	Lighting - Combined Retrofit: Laundry T8-4E 24x48 rec trof	Replace with 6 LED (4) 15W Module (2) StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$189 + $30 Maint. Savings / 1.6 MMBTU	$983	1.88	4.5	798.7
23	Lighting - Power Retrofit: Comm Hall, dressing, T8-2E strip	Replace with 2 LED (2) 15W Module StdElectronic	$13 + $10 Maint. Savings / 0.0 MMBTU	$148	1.73	6.5	57.9
24	South wall Auditorium, boarded up windows	Frame openings, add R-30 insulation, finish interior and exterior surfaces	$1,700 / 39.0 MMBTU	$19,001	1.55	11.2	6,325.2

Table 4.1 Community Center, Aniak, 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**
25	West wall, main entry	Remove existing door and install standard pre-hung U-0.16 insulated door.	$166 / 3.8 MMBTU	$2,775	1.42	16.7	618.7
26	East wall, near entry	Replace existing window with U-0.28 wood window.	$49 / 1.1 MMBTU	$647	1.30	13.3	180.8
27	Lighting - Power Retrofit: Comm Hall, T8-4E, 24x48 rec.troffer	Replace with LED (4) 15W Module (2) StdElectronic	$13 + $5 Maint. Savings / 0.0 MMBTU	$114	1.27	6.4	58.5
28	Lighting - Power Retrofit: Comm Hall, T8-2E Strip	Replace with 2 LED (2) 15W Module StdElectronic	$13 + $10 Maint. Savings / 0.0 MMBTU	$148	1.27	6.5	58.5
29	Lighting - Power Retrofit: Mechanical T8-2E strip	Replace with 3 LED (2) 15W Module StdElectronic	$12 + $15 Maint. Savings / 0.0 MMBTU	$222	1.17	8.2	54.8
30	Lighting - Power Retrofit: Mechanical T8-2E strip	Replace with LED (2) 15W Module StdElectronic	$4 + $5 Maint. Savings / 0.0 MMBTU	$74	1.17	8.2	18.2
31	Furnace room	Remove existing door and install standard pre-hung U-0.16 insulated door.	$55 / 1.3 MMBTU	$1,182	1.11	21.3	206.2
	TOTAL, cost-effective measures		**$12,596 + $625 Maint. Savings / 245.6 MMBTU**	**$51,887**	**3.24**	**3.9**	**48,371.8**
The following measures (if any are listed) were *not* found to be cost-effective from a financial perspective; EEMs #32, 33 and 34 are still recommended while #35 is provided for the owner's information:							
32	Lighting - Power Retrofit: Pantry T8-2E Strip	Replace with LED (2) 15W Module StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$74	0.92	10.5	9.3

Table 4.1 Community Center, Aniak, 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**
33	Lighting - Power Retrofit: Office1 T12-3M 24x48 rec trof	Replace with 6 LED (3) 15W Module StdElectronic	$28 + $30 Maint. Savings / 0.0 MMBTU	$563	0.84	9.8	125.4
34	South wall	Replace existing window with U-0.28 wood window.	$260 / 6.0 MMBTU	$6,515	0.69	25.0	968.1
35	Auditorium walls, exterior	Install R-20 rigid foam board to exterior and cover with T1-11 siding or equivalent.	$526 / 12.1 MMBTU	$37,901	0.33	72.0	1,957.9
	TOTAL, all measures		**$13,412 + $660 Maint. Savings / 263.6 MMBTU**	**$96,939**	**1.92**	**6.9**	**51,432.5**

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure 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 Insulation Measures

Rank	Location		Existing Type/R-Value		Recommendation Type/R-Value	
19	Auditorium Ceiling/Roof		Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: R-4 Batt:FG or RW, 1.25 inches Bottom Insulation Layer: R-38 Batt:FG or RW, 12 inches Top Insulation Layer: None Modeled R-Value: 42.5		Repair or replace existing insulation, effectively adding R-11 to the current value.	
Installation Cost		$6,927	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$664
Breakeven Cost		$15,684	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	15.2 MMBTU
			Savings-to-Investment Ratio	2.3		
Auditors Notes: IR images show the insulation over auditorium to be in very poor condition. Repair existing insulation or remove and replace with R-60. Estimated cost is $4000 materials + 40 hrs labor @ $45/hr + man lift rental @ $1000 = $6800						

Rank	Location		Existing Type/R-Value		Recommendation Type/R-Value	
35	Auditorium walls, exterior		Wall Type: Single Stud Siding Configuration: Siding and Sheathing Insul. Sheathing: None Structural Wall: 2 x 10, 24 inches on center R-30 Batt:FG or RW, 9.25 inches Window and door headers: Not Insulated Modeled R-Value: 25.1		Install R-20 rigid foam board to exterior and cover with T1-11 siding or equivalent.	
Installation Cost		$37,901	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$526
Breakeven Cost		$12,435	**Simple Payback (yrs)**	72	**Energy Savings (MMBTU/yr)**	12.1 MMBTU
			Savings-to-Investment Ratio	0.3		
Auditors Notes: Repair existing T1-11 siding as needed, add R-20 rigid foam, new rain barrier, flashing as required and new T1-11 siding.						

4.3.2 Window Measures

Rank	Location		Size/Type, Condition		Recommendation	
24	South wall Auditorium, boarded up windows		Glass: No glazing - broken, missing Frame: Wood\Vinyl Modeled U-Value: 0.94		Frame openings, add R-30 insulation, finish interior and exterior surfaces	
Installation Cost		$19,001	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$1,700
Breakeven Cost		$29,525	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	39.0 MMBTU
			Savings-to-Investment Ratio	1.6		
Auditors Notes: Remove plastic and plywood, frame in openings, install vapor barrier and gypsum on interior, install new siding on exterior.						

Rank	Location		Size/Type, Condition		Recommendation	
26	East wall, near entry		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 existing window with U-0.28 wood window.	
Installation Cost		$647	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$49
Breakeven Cost		$844	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	1.1 MMBTU
			Savings-to-Investment Ratio	1.3		
Auditors Notes: Replace with new double pane glass, low-E						

Rank	Location		Size/Type, Condition		Recommendation	
34	South wall		Glass: Single, Glass Frame: Wood\Vinyl Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 0.94 Solar Heat Gain Coefficient including Window Coverings: 0.52		Replace existing window with U-0.28 wood window.	
Installation Cost		$6,515	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$260
Breakeven Cost		$4,519	**Simple Payback (yrs)**	25	**Energy Savings (MMBTU/yr)**	6.0 MMBTU
			Savings-to-Investment Ratio	0.7		
Auditors Notes: Replace with low-E, double pane glass window						

4.3.3 Door Measures

Rank	Location		Size/Type, Condition		Recommendation	
13	Exterior Door: Metal 1/2 light, broken & boarded up		Door Type: Entrance, Metal, EPS core, metal edge, half-lite Modeled R-Value: 1		Remove existing door and install standard pre-hung U-0.16 insulated door.	
Installation Cost		$886	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$130
Breakeven Cost		$3,071	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	3.0 MMBTU
			Savings-to-Investment Ratio	3.5		
Auditors Notes: Replace door with new pre-hung, higher insulation value door.						

Rank	Location	Size/Type, Condition		Recommendation	
25	West wall, main entry	Door Type: Entrance, Metal, EPS core, metal edge, no glass Modeled R-Value: 2.7		Remove existing door and install standard pre-hung U-0.16 insulated door.	
Installation Cost	$2,775	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$166
Breakeven Cost	$3,929	**Simple Payback (yrs)**	17	**Energy Savings (MMBTU/yr)**	3.8 MMBTU
		Savings-to-Investment Ratio	1.4		
Auditors Notes: Replace (2) doors with pre-hung, better insulated doors.					

Rank	Location	Size/Type, Condition		Recommendation	
31	Furnace room	Door Type: Entrance, Metal, EPS core, metal edge, no glass Modeled R-Value: 2.7		Remove existing door and install standard pre-hung U-0.16 insulated door.	
Installation Cost	$1,182	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$55
Breakeven Cost	$1,309	**Simple Payback (yrs)**	21	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	1.1		
Auditors Notes: Replace with pre-hung, better insulated door.					

4.3.4 Air Sealing Measures

Rank	Location	Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
9		Air Tightness estimated as: 10000 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 50%.	
Installation Cost	$9,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$3,891
Breakeven Cost	$36,118	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	89.3 MMBTU
		Savings-to-Investment Ratio	4.0		
Auditors Notes:					

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation				
10	1.) Replace oil fired storage hot water heater with oil fired on demand water heater (Toyotomi OM-122 or equivalent), estimated parts cost $3000 + 8 hrs labor @ $45/hr = $2560.				
Installation Cost	$3,360	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$554
Breakeven Cost	$13,372	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	12.9 MMBTU
		Savings-to-Investment Ratio	4.0	**Maintenance Savings ($/yr)**	$250
Auditors Notes:					

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

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Day Care / Day Room / Office 2			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Day Care / Day Room / Office 2 space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$918
Breakeven Cost	$12,436	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	21.1 MMBTU
		Savings-to-Investment Ratio	12,435.6		
Auditors Notes:					

Rank	Building Space			Recommendation	
2	Community Hall, Dressing			Implement a Heating Temperature Unoccupied Setback to 55.0 deg F for the Community Hall, Dressing space.	
Installation Cost	$3	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,799
Breakeven Cost	$24,370	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	41.4 MMBTU
		Savings-to-Investment Ratio	8,123.4		
Auditors Notes:					

Rank	Building Space			Recommendation	
3	Library			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Library space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$507
Breakeven Cost	$6,870	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	11.7 MMBTU
		Savings-to-Investment Ratio	6,870.3		
Auditors Notes:					

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	
4	Outside Single Socket A-type	INCAN A Lamp, Std 40W with Manual Switching		Replace with LED 9W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$31
Breakeven Cost	$242	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	48.4		
Auditors Notes: Replace (1) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
5	Entry Incan A-type	INCAN A Lamp, Std 40W with Manual Switching		Replace with LED 7W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$17
Breakeven Cost	$131	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	26.2		
Auditors Notes: Replace (1) A-type incandescent bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
6	Infant Care closet Incan A-type	INCAN A Lamp, Std 40W with Manual Switching		Replace with LED 7W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$8
Breakeven Cost	$79	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	15.8		
Auditors Notes: Replace (1) A-type incandescent bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
7	Infant Care restroom Incan A-type	INCAN A Lamp, Std 40W with Manual Switching		Replace with LED 7W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$9
Breakeven Cost	$68	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	13.7		
Auditors Notes: Replace (1) A-type incandescent bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
8	Quiet Room T12-2M 24x48 rec trof	4 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 4 LED (2) 15W Module StdElectronic	
Installation Cost	$295	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$155
Breakeven Cost	$1,474	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	5.0	**Maintenance Savings ($/yr)**	$20
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (4) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (8) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
11	Toilet T12-2M surf mt	3 FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic	
Installation Cost	$222	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$94
Breakeven Cost	$876	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	3.9	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (3) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (6) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
12	Toilet T8-4E 24x48 rec trof	2 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 2 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$228	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$83
Breakeven Cost	$824	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.7 MMBTU
		Savings-to-Investment Ratio	3.6	**Maintenance Savings ($/yr)**	$15
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (2) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (8) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
14	Outside HPS Wall Pack, 70w	HPS 70 Watt Magnetic with Manual Switching		Replace with 2 LED 17W Module StdElectronic	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$89
Breakeven Cost	$789	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	3.3	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Replace (2) 70w HPS fixture with new 17w LED fixture with integral photocell sensor @ parts cost of $75 ea + 1 hr labor ea. @ $45/hr. Maintenance savings $5/fixture					

Rank	Location	Existing Condition		Recommendation	
15	Dayroom/Daycare T12-2M 24x48 rec trof	17 FLUOR (4) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching		Replace with 17 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$1,934	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$604
Breakeven Cost	$5,518	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	2.9	**Maintenance Savings ($/yr)**	$85
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (17) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (68) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
16	Kitchen (1)T12-2M & (1)T12-4M	3 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$488	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$155
Breakeven Cost	$1,310	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.7	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (2) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (6) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) ceiling mounted occupancy sensor @ $175 parts + 1 hr labor @ $125/hr.					

Rank	Location	Existing Condition		Recommendation	
17	Infant Care T12-2M 24x48 rec trof	4 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 4 LED (2) 15W Module StdElectronic	
Installation Cost	$295	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$70
Breakeven Cost	$723	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.4	**Maintenance Savings ($/yr)**	$20
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (4) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (8) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
18	Office2 T12-2U 24x24 rec trof	3 FLUOR (2) T12 F40T12 40W U-Tube Standard Magnetic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic	
Installation Cost	$282	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$66
Breakeven Cost	$687	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
		Savings-to-Investment Ratio	2.4	**Maintenance Savings ($/yr)**	$15
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (3) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (6) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
20	Library T12-3M, 24x48 rec trof	16 FLUOR (3) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 16 LED (3) 15W Module StdElectronic	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$335
Breakeven Cost	$3,333	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.2	**Maintenance Savings ($/yr)**	$80
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (16) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (48) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
21	Lobby T8-4E 24x48 rec trof	8 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 8 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$910	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$205
Breakeven Cost	$1,959	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	2.2	**Maintenance Savings ($/yr)**	$40
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (8) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (32) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
22	Laundry T8-4E 24x48 rec trof	6 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 6 LED (4) 15W Module (2) StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$983	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$189
Breakeven Cost	$1,849	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	1.6 MMBTU
		Savings-to-Investment Ratio	1.9	**Maintenance Savings ($/yr)**	$30
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (6) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (24) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) ceiling mounted occupancy sensor @ $175 parts + 1 hr labor @ $125/hr.					

Rank	Location	Existing Condition		Recommendation	
23	Comm Hall, dressing, T8-2E strip	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 2 LED (2) 15W Module StdElectronic	
Installation Cost	$148	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$13
Breakeven Cost	$255	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.7	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (2) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (4) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
27	Comm Hall, T8-4E, 24x48 rec.troffer	FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with LED (4) 15W Module (2) StdElectronic	
Installation Cost	$114	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$13
Breakeven Cost	$145	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.3	**Maintenance Savings ($/yr)**	$5

Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (4) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
28	Comm Hall, T8-2E Strip	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 2 LED (2) 15W Module StdElectronic	
Installation Cost	$148	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$13
Breakeven Cost	$188	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.3	**Maintenance Savings ($/yr)**	$10

Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (2) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (4) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
29	Mechanical T8-2E strip	3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic	
Installation Cost	$222	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$12
Breakeven Cost	$259	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr)**	$15

Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (3) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (6) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
30	Mechanical T8-2E strip	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$74	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$4
Breakeven Cost	$86	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.2	**Maintenance Savings ($/yr)**	$5

Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
32	Pantry T8-2E Strip	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$74	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$2
Breakeven Cost	$68	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.9	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
33	Office1 T12-3M 24x48 rec trof	6 FLUOR (3) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 6 LED (3) 15W Module StdElectronic	
Installation Cost	$563	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$28
Breakeven Cost	$475	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.8	**Maintenance Savings ($/yr)**	$30
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (6) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (18) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

ALL SCHEDULES COMPILED FROM PLANS OR ON-SITE NAMEPLATE OBSERVATION, WHERE ACCESSIBLE e= estimated

EXHAUST FAN SCHEDULE

SYMBOL	MOTOR MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
	unknown	e100	e60w/115/1	Bathroom exhaust near infant care
	unknown	e100	e60w/115/1	Range hood

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
Well Pump	unknown		unknown	

HEATING PLANT SCHEDULE

SYMBOL	MFGR/MODEL	EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
Hall 1	Toyo Laser 73	88%	76w/120/1	40 MBH input
Hall 2	Toyo Laser 73	88%	76w/120/1	40 MBH input
Hall 3	Toyo Laser 73	88%	76w/120/1	40 MBH input
Furnace room	Toyo Laser 30	88%	60w/120/1	15 MBH input
Library	Monitor 2200	88%	60w/120/1	22 MBH input
Daycare	Toyo Laser 73	88%	76w/120/1	40 MBH input

HOT WATER HEATER SCHEDULE

SYMBOL	MFGR/MODEL	GALLONS	NUMBER OF ELEMENTS	ELEMENT SIZE
HWH-1	Bock 32E	32	n/a	104 MBH input, oil-fired water heater with Bock burner model MSR

PLUMBING FIXTURES				
SYMBOL	FIXTURE	GPF	QUANTITY	REMARKS
	W.C.	1.28	5	manually operated
	Urinal	1.0	1	auto-flush
	Showers	e1.0	1	
	Lavatory	1.5	1	manually operated
	Lavatory	2.0	2	manually operated

PLUG LOAD SUMMARY				
SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	9	200w	
	Personal printers	1	85w	
	Personal fan	1	50w	
	Commercial coffee machine	3	1500w	
	Personal coffee machine	1	1200w	
	Microwaves	1	1000w	
	Large Chest Freezer	1	1000 kWh/yr	1/2 full
	Small Chest Freezer	1	400 kWh/yr	
	Whirlpool full size refrigerator, model WRF535SWHZ00	1	800 kWh/yr	empty & running
	Capitol Presidential Bingo console	1		
	Bingo scoreboards	3	360w/each	
	Crate Amp	1	60w	
	Server, UPS, Hubs, ethernet switches	1	est 1000 w	
	Crock Pots	2		
	Beverage Refrigerator	1	900w	full
	popcorn machine	1	1050w	
	Electrolux 4-burner electric stove, model LGEF3043KFM	1	13.5kW@240V	
	Whirlpool washing machines, model CAE2743BQ0	7	1000w	
	Whirlpool electric dryers, model CEM2743BQ0	6	2900w	
	Fender Rumble 200	1	400w	
	Emcee LPV-10A Agile VHF Transmitter	1		

	Blonder Tongue Agile AM Modulator	1		
	Furman Power Conditioner	1		
	Scientific Atlanta Powervu Commercial Satellie Receiver	1		
	Bext XT 30 FM Exciter	1		
	Kross Music Workstation	1		
	Basic 60 Amplifier	1	50w	
	Perfect 10 Amplifier	1	40w	
	Hot Rod Deluxe Amplifier PR246	1	180w	
	Acoustic Chorus AC-33	1		
	Roland Amplifier	1		
	Soundcraft EFX-12 soundboard	1		
	Air Hockey table	1	e200w	
	Sound system	2	e100w	
	TV - flat screen	5		

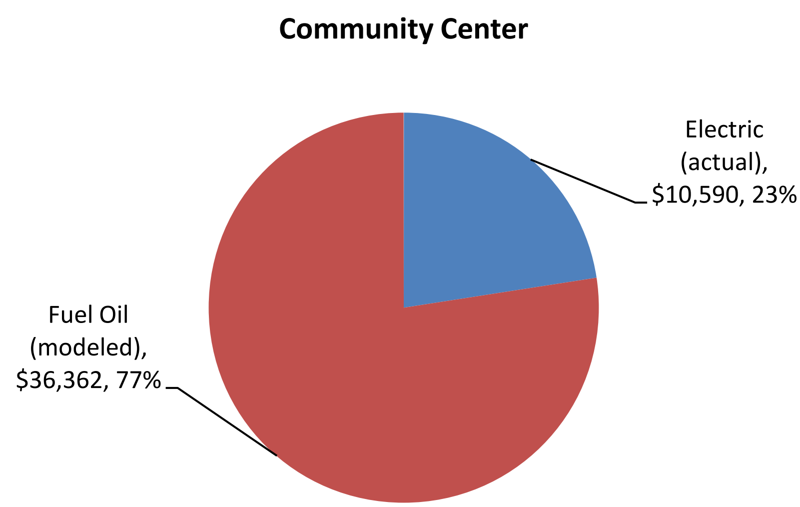
Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies, and irregularities that may provide insight regarding the building's function and efficiency. Thirty-six months of historical data is usually sufficient to gain an understanding of the building operation. Electric consumption data from 2015 through 2017 was available, but no fuel oil delivery or consumption data was provided. Figures B.1 and B.2 show the 3-year summary of consumption and costs for this facility. The shaded cells represent data used in the AkWarm-C model.

Figure B.1 – Total Building Energy Consumption and Costs

COMMUNITY CENTER (3 of 5 meters have PCE)						
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use (predicted by AkWarm-C)	Fuel oil Cost	Total kBTUs of Energy	Total Utility Cost
2015	16,887	$9,843	6,391	$36,362	933,388	$46,952
2016	21,005	$12,243				
2017	26,304	$10,590				

Figure B.2 - Costs



Electricity: Figure B.3 shows that electric consumption in this building was fairly consistent until summer of 2016, when it increased substantially and remains higher than previous years. Figure B.4 shows that each year has increased and Figure B.5 shows that the laundromat consumption more than doubled from 2016 to 2017, likely attributed to the conversion from propane dryers to electric dryers.

It is not clear why consumption increased from 2016 to 2017 at the Youth Center and why, when lighting in the auditorium was changed to LED, there is no indication of savings in the bar chart.

Figure B.3 – 3 Years of monthly Electric Consumption

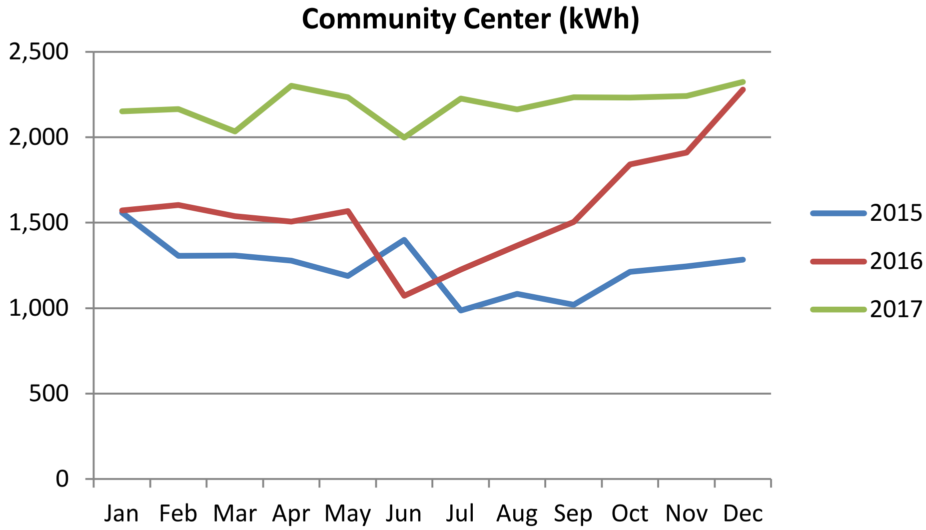


Figure B.4 – 3 years of Annual Electric Consumption

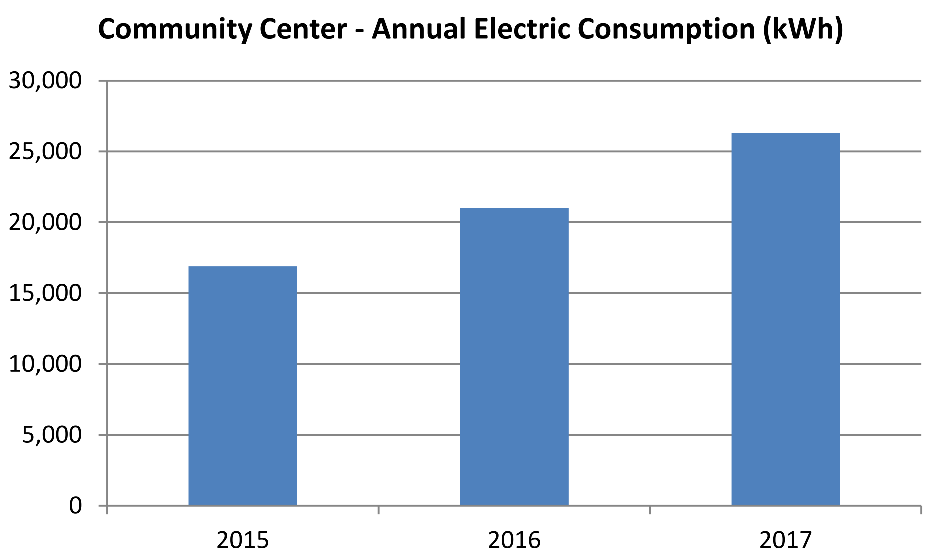
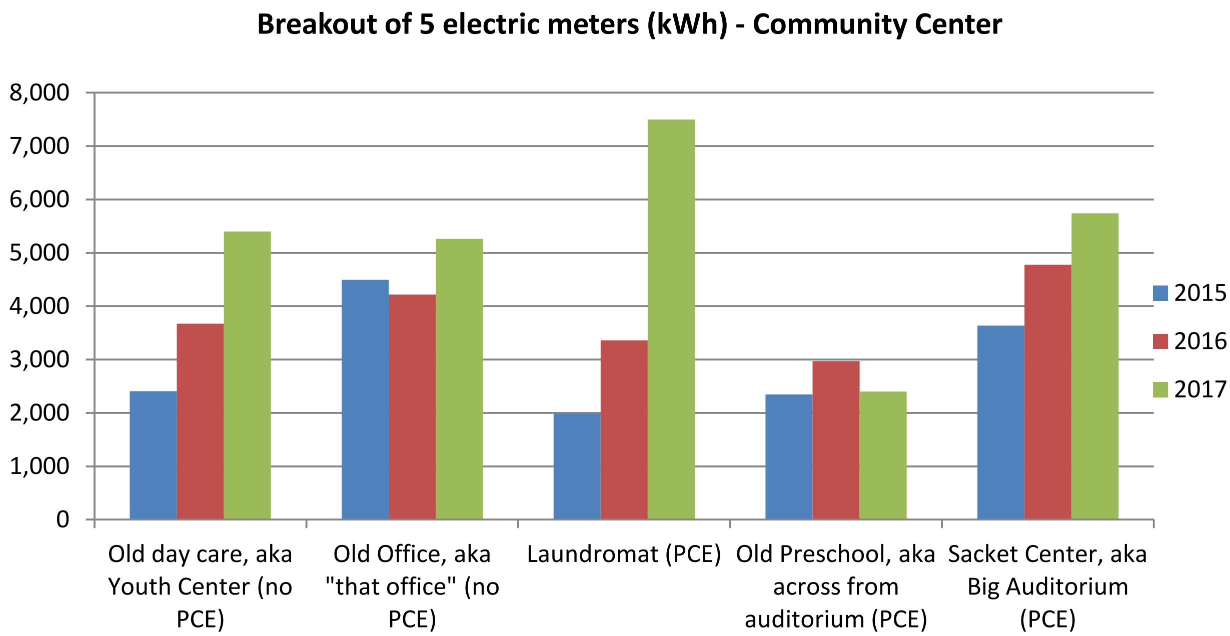


Figure B.5 – Breakdown by Electric Meter

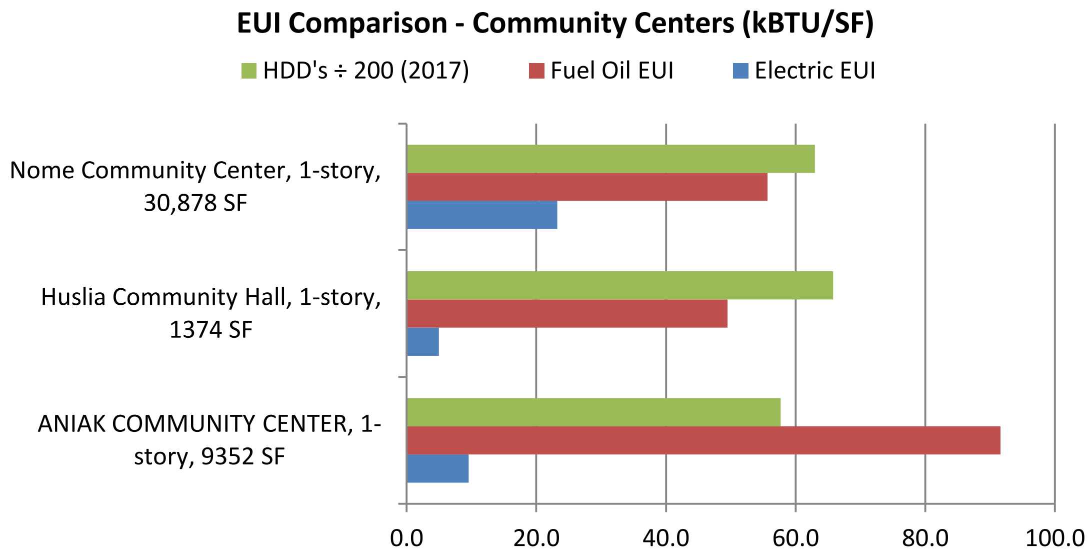


Fuel Oil: Because no oil delivery data was provided, no benchmarking can be performed on this building.

Comparing EUIs: Figure B.6 and the discussion in Section 1.5 indicate that this building's heating EUI is 50% higher than the next closest building, the Nome Community center. This is despite the fact that Nome has nearly 10% more HDDs than Aniak. The auditor attributes this to the poor condition of the building's envelope and its high infiltration rate of outside air (or exfiltration of heated inside air).

Electric EUIs are typically related to occupancy; more occupants (and therefore more plug and other electric loads) in the building for longer hours use more electricity. The Nome Community center has longer operating hours than the subject building, as well as a bowling alley, gymnasium, sauna, and mechanical ventilation, all of which use more electricity. The Huslia Community hall has only lighting and a bingo display. Given this information, the electric EUI of the subject building falls squarely within the range of expectations.

Figure B.6 – EUIs



After performing the historical analysis in Section 1.5 and above, a baseline period is selected as a benchmark. This is based on factors including the consistency of the data, periods for which data was available, and the current use and occupancy of the building versus its historical use and occupancy. The benchmark baseline periods selected for this building are 2017 for electricity and the predicted AkWarm-C consumption for fuel oil. The shaded 2017 electric consumption figures below were used to calibrate the electric side of the AkWarm© model.

Figure B.7 – Benchmark Utility Data

	Community Hall (5 meters, 3 with PCE)			
	2015	**2016**	**2017**	**Costs**
Jan	1,559	1,572	2,151	$911.57
Feb	1,306	1,603	2,165	$837.72
Mar	1,309	1,539	2,034	$827.95
Apr	1,279	1,506	2,301	$911.91
May	1,189	1,568	2,233	$959.37
Jun	1,399	1,073	1,998	$845.69
Jul	987	1,226	2,227	$865.61
Aug	1,084	1,367	2,163	$857.00
Sep	1,021	1,505	2,234	$898.20
Oct	1,212	1,841	2,232	$844.49
Nov	1,244	1,910	2,242	$852.13
Dec	1,283	2,279	2,324	$977.88
TOTALS	**16,887**	**21,005**	**26,304**	**$10,589.52**

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering and construction management costs (if required) are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit, and are derived from and one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified Electrician **$125/hr**

This level of work includes changing street light heads and light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work **$ 45/hr**

Includes installing switch-mounted occupancy sensors, which do not require re-wire or pulling additional wires, weather-stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work **$125/hr**

Work includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities **$45/hr**

Includes maintaining light fixtures, door and window weather-stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

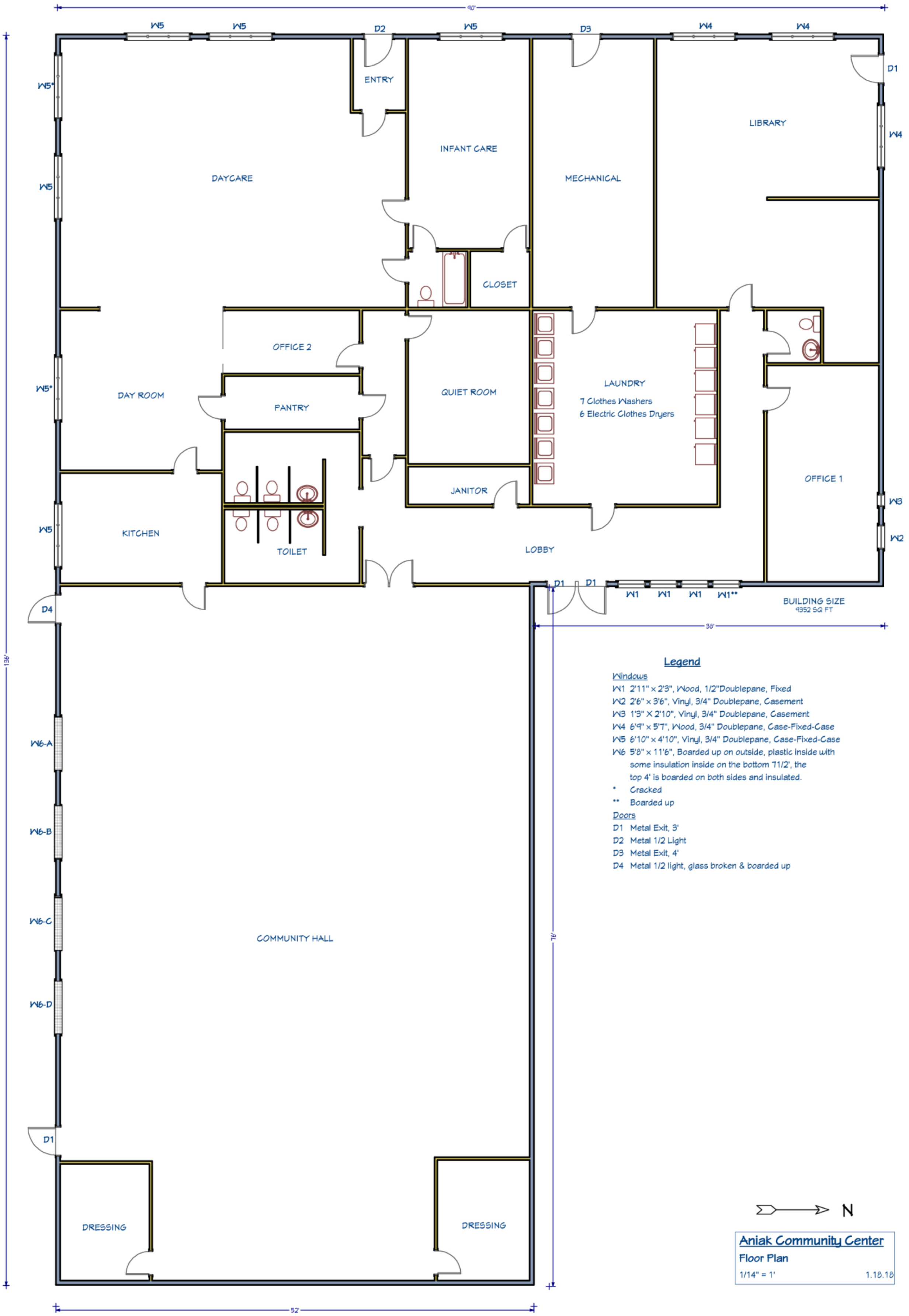
ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Community Center	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Laura Simeon	
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 675-4349	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 9,352 square feet	**Design Space Heating Load:** Design Loss at Space: 268,748 Btu/hour with Distribution Losses: 268,748 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 409,677 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 101 people	**Design Indoor Temperature:** 64.7 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days
Utility Information	
Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.380/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$36,038	$0	$1,034	$475	$1,996	$5,347	$886	$1,134	$0	**$46,910**
With Proposed Retrofits	$26,297	$0	$437	$475	$1,996	$2,274	$886	$1,134	$0	**$33,497**
Savings	$9,741	$0	$598	$0	$0	$3,074	$0	$0	$0	**$13,412**

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	99.8	7.78	$5.02
With Proposed Retrofits	71.6	5.58	$3.58

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.

BUILDING SCHEMATICS




ENTRY
INFANT CARE
MECHANICAL
LIBRARY
(10 b.o. total)
DAYCARE
CLOSET
OFFICE 2
DAY ROOM
PANTRY
QUIET ROOM
LAUNDRY
(11 b.o. total)
(2 b.o.)
OFFICE 1
(6 b.o. total)
JANITOR
KITCHEN
(2 b.o)
TOILET
LOBBY
COMMUNITY HALL
STAGE
DRESSING
DRESSING
Legend
A T8-2E Strip
B T8-4E LED, 16 x 48, 22w
C T8-4E, 24 x 48 Recessed Troffer
D T12-2M, Strip
E T12-4M, Wrap
F T12-2M, 24 x 48, Recessed Troffer
G T12-2U, 24 x 24, Recessed Troffer
H Incandencant, A-type, 40w, Recessed Can
J T12-2M Surface Mount
K T12-2M, Wrap
L T12-3M, 24 x 48, Recessed Troffer
M HPS Wall pack, 70w
N Wall pack, A-type, LED
O Wall Pack disconnected
P Soffit LED A-type can
Q Single Socket, No Bulb
R Pole Light, Broken
EF Exhaust Fan
b.o. bulbs or lamps burned out
N
Aniak Community Center
Lighting Plan
1/14" = 1'
1.18.18


ENTRY
INFANT CARE
T1
F2
F1
MECHANICAL
HWH
LIBRARY
T2
DAYCARE
CLOSET
EF
M
OFFICE 2
QUIET ROOM
LAUNDRY
7 Clothes Washers
6 Electric Clothes Dryers
DAY ROOM
PANTRY
JANITOR
OFFICE 1
KITCHEN
TOILET
LOBBY
BUILDING SIZE
9352 SQ FT
Legend
HWH Hot Water Heater, oil fired
M Moniter Stove 2200
T1 Toyo Laser 30
T2 Toyo Laser 73
F1 Furnace, Nonfunctional
F2 Furnace, Nonfunctional
EF Exhaust Fan
T2
T2
COMMUNITY HALL
T2
DRESSING
DRESSING
N
Aniak Community Center
HVAC Plan
1/14" = 1'
1.18.18

Appendix E – Photographs & IR Images

Broken windowpanes create heat loss and should be repaired

Fire damaged siding should be replaced

Auditorium with new LED lighting

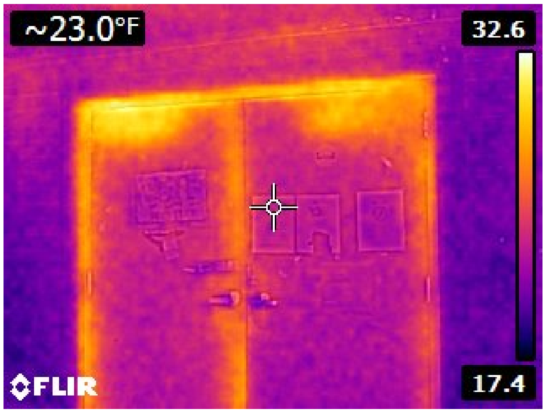
Auditorium door should be replaced

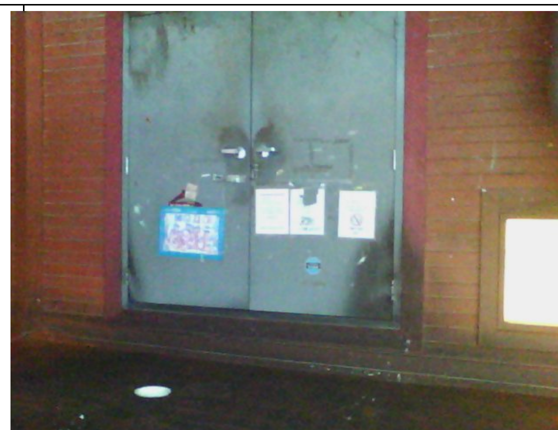
Seven Top loading clothes washers, estimated by on-site staff to run 25 loads/week

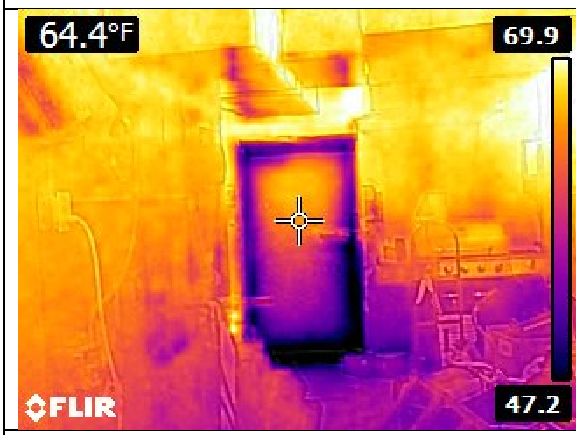
Oil-fired storage hot water heater and potable water pressure tank

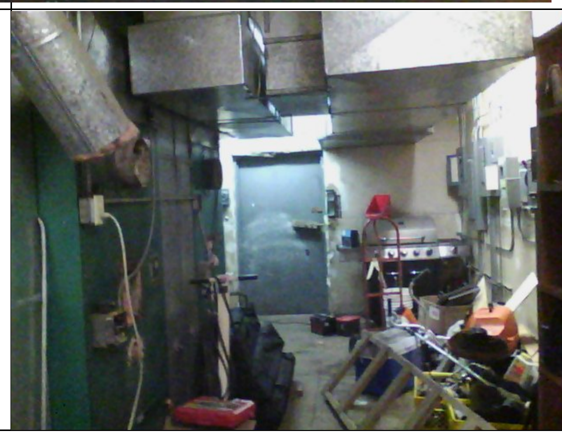
Library/music room – wood window frames

The wood frame windows are in poor condition

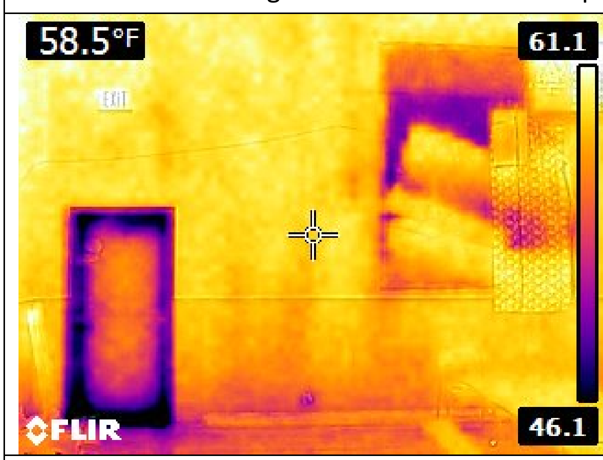


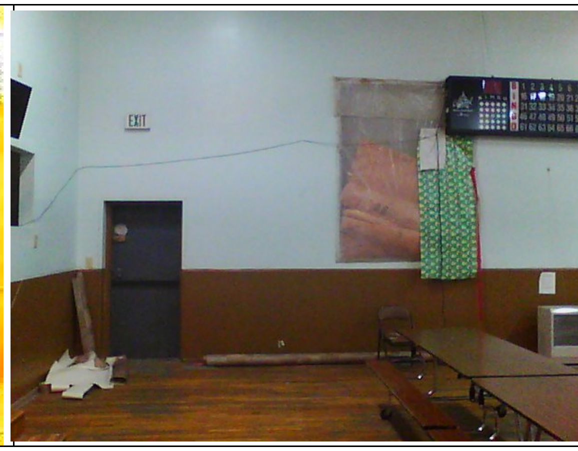




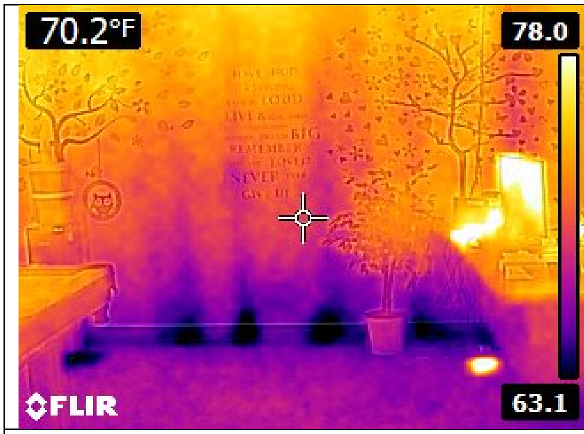


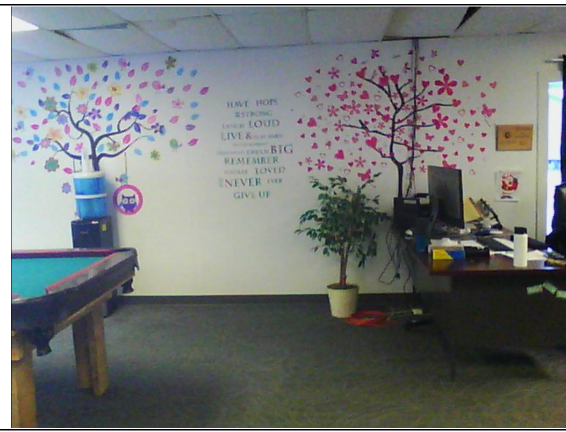
1. All doors show significant heat loss around periphery and bases



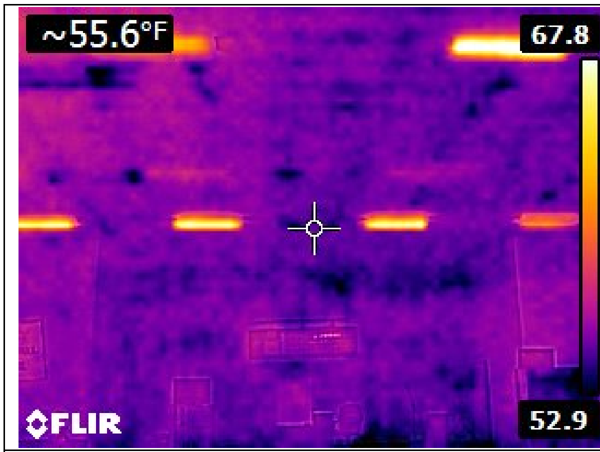


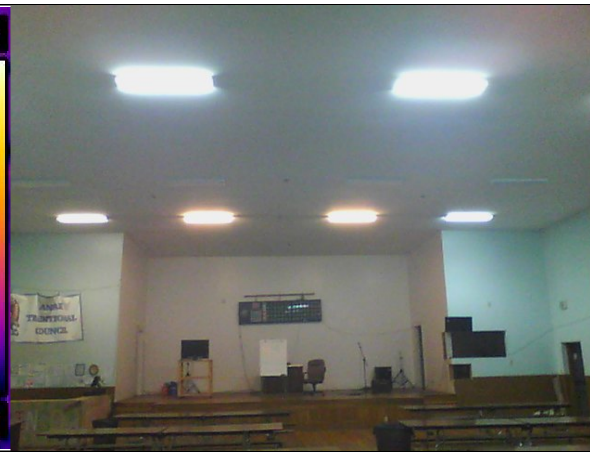
2. The old window openings should be repaired immediately, they are the source of great heat loss



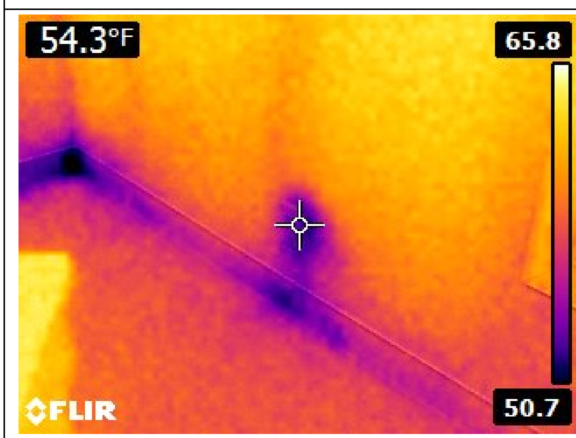


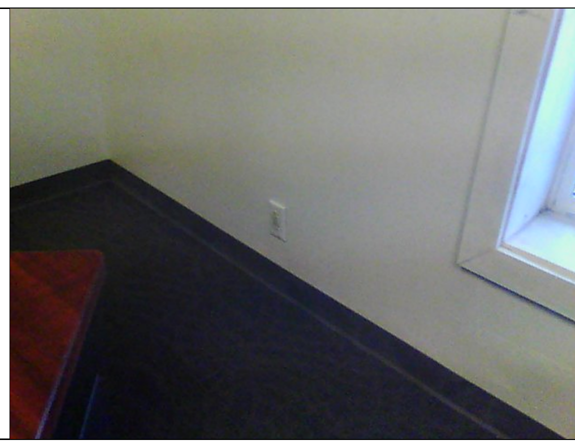
3. Poorly installed or damaged insulation is evident here



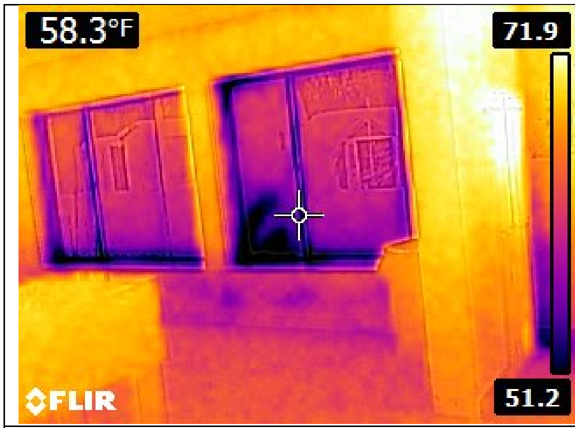


4. Missing or damaged ceiling insulation is very evident throughout the entire auditorium ceiling





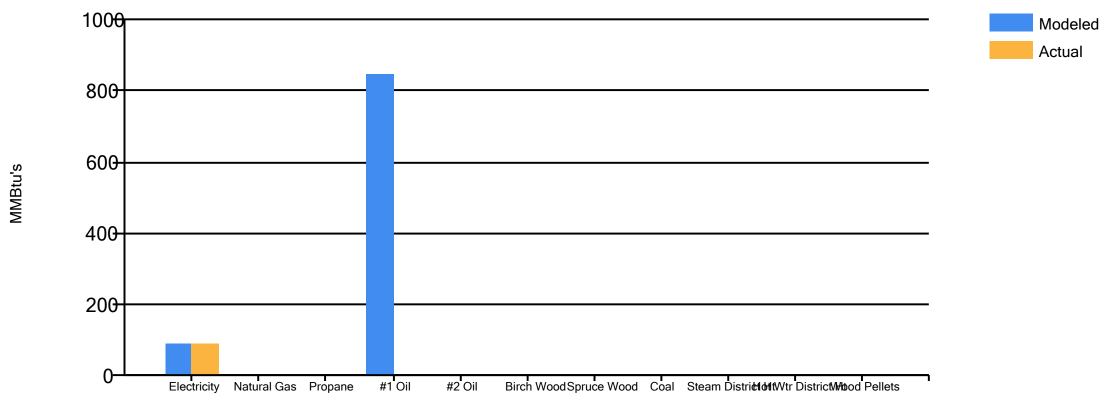
5. Air sealing of the building will prevent heat loss through wall, ceiling, and floor penetrations like this electric outlet

	
6. Broken window pane should be replaced	

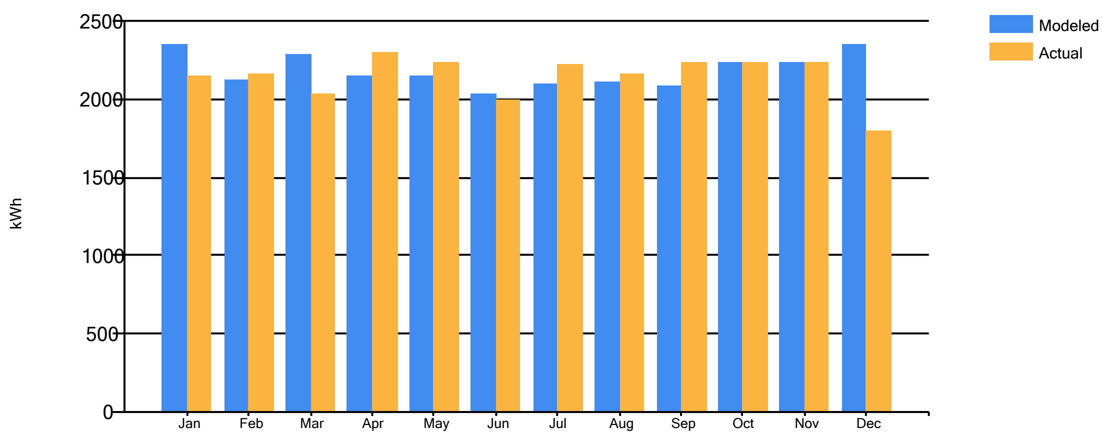
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

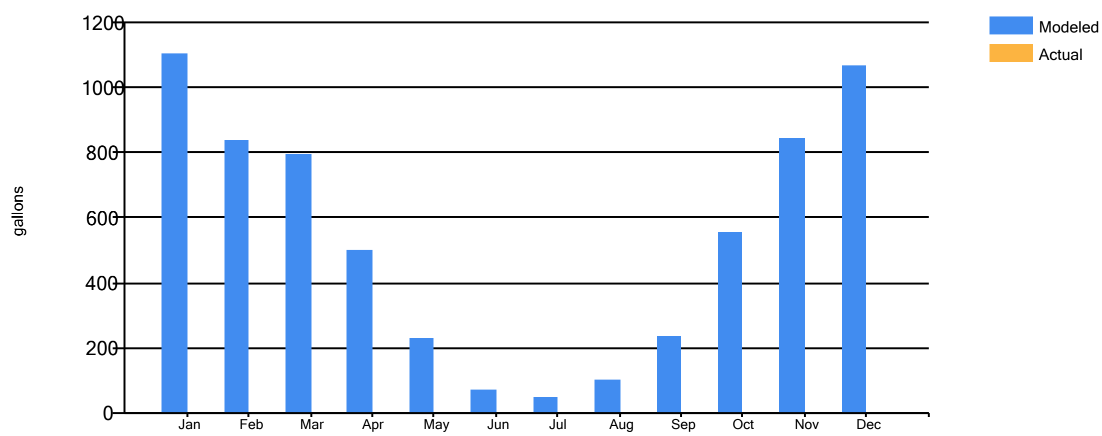
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
CFM	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OC	On Center
OSA	Outside Air
PCE	Power Cost Equalization
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECMs, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

Comprehensive Energy Audit
For the Aniak Duplex (aka ATC Building #4)

Prepared For

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Site Survey Date:
January 18, 2018

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Energy Audits of Alaska

Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 21, 2018
New Release – September 13, 2018

Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (energy efficiency measures, or EEMs), estimate the value of the savings and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that the recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of heating, ventilation, and air conditioning (HVAC) systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

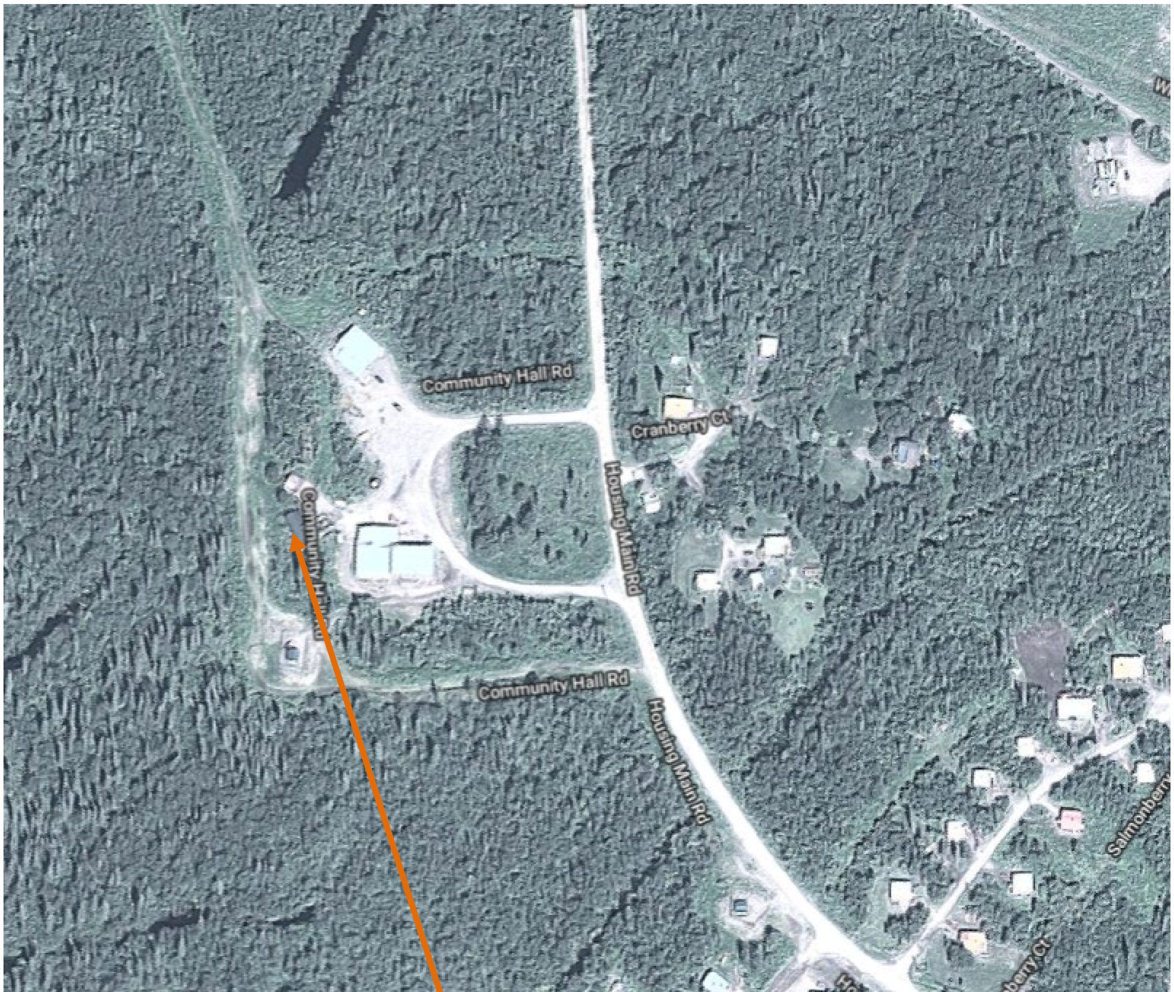
This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the ASHRAE definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy, and electric usage, and the U.S. Department of Energy Office of Indian Energy, who provided funding.

Project Location



NORTH

Subject Building

Building contact:
Laura Simeon
Tribal Administrator
907-675-4349
aniaktribe@gmail.com

1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the Duplex (aka ATC Building #4). The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and any process and plug loads. There are no charges for water and wastewater and these systems were not evaluated in this analysis.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy consuming equipment, identify technically and economically feasible EEMs for existing equipment and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The energy conservation measures (ECMs) identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The "avoided costs" resulting from ECMs are discussed in Section 1.7, but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 9 page summary is designed to contain all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost, and their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

Sections 2, 3 and 4 of this report and the Appendices, are back-up and provide much more detailed information should the owner/operator, or staff, desire to investigate further. Sections 4.3 through 4.5 include additional auditor's notes for many EEMs. Due to their length, Appendices H, I, and J, which contain additional ECM detail, lighting information and manufacturer's "cut sheets" of samples of recommended retrofit products, are included as a separate document.

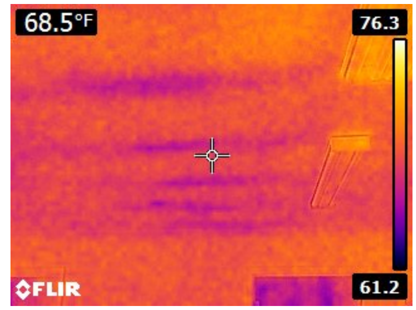
<u>Issues that the auditor feels are of particular importance to the reader are underlined</u> and all abbreviations and acronyms used in this document are listed in Appendix G.

1.2 Noteworthy Points & Immediate Action

a. ECMs are no cost or low cost energy conservation measures typically implemented by the building owner or the owner's staff. The following ECMs and maintenance issues should be rectified immediately:

    - If not already taking place, turn the boiler off during the summer months.
    - When the bunkhouse is unoccupied, turn off the refrigerator

- The IR image at right (and in Appendix E) indicates that the attic insulation has been moved or improperly replaced. Investigate the insulation and properly place the two layers of batt to maximize their insulation value.
- Given the relatively high plug loads in the State Patrol office, the use of plug load management devices is recommended. See Section 1.7, #5 for additional information.
- If the Toyo stoves in each wing of the building are used, the set-back feature should be programmed.



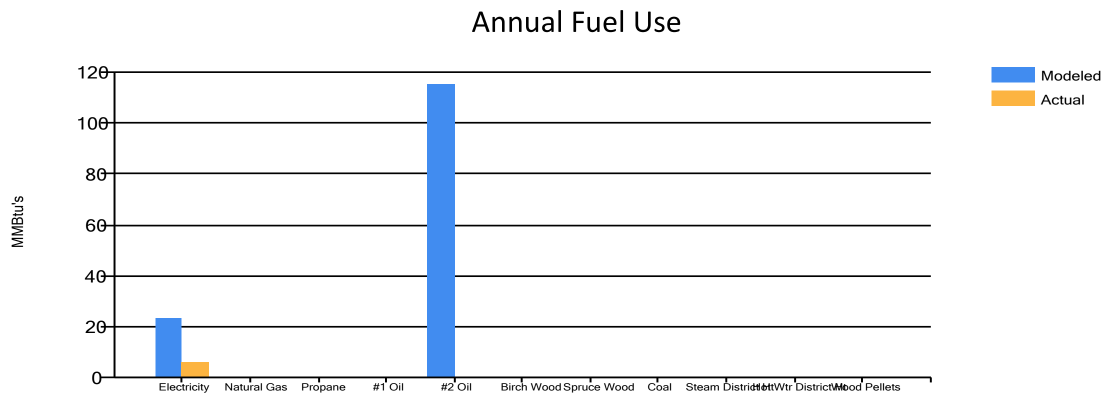
b. If all the recommended EEMs are incorporated in this building, there will be a 24% reduction in energy costs, totaling $2,836, with a simple payback of 1 year on the $2,883 implementation cost.

c. The east wing of this building was unoccupied or only partially occupied during 2017, was undergoing a renovation in late 2017 and early 2018, and the west wing is used intermittently during the summer months. So, there is no baseline period of energy consumption that represents a fully utilized building. Furthermore, no fuel oil use data was provided by the owner. In order to provide the owner with realistic estimates of energy savings for a fully utilized building, the AkWarm-C model was created using the following assumptions:

   East Wing (State Patrol Offices):
   - Occupied from 9:00am until 5:00pm Monday through Friday
   - 4 occupants including visitors
   - Typical plug and electric loads for an office environment

   West Wing (Bunkhouse):
   - Occupied from 4:00pm until 10:00am, 7 days per week from mid-May through mid-September
   - Typical plug and electric loads for a residence

   As a result of these assumptions, and as seen in the bar chart below (from Appendix F), neither the electrical or fuel oil consumption figures in the AkWarm-C model are calibrated to actual figures. The electric and fuel oil use figures predicted by the AkWarm-C model are used in this analysis unless specifically stated otherwise.



d. It was assumed in this analysis, that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity. It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician.

1.3 Current Cost and Breakdown of Energy

Based on electricity and fuel oil prices in effect at the time of the audit, and using the uncalibrated AkWarm-C© energy model[1] with the assumptions stated in Section 1.2.c. above, the total predicted energy costs are $11,793 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$5,319 for Electricity
$6,474 for #2 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	8,865 kWh	5,021 kWh
#2 Oil	1,138 gallons	1,045 gallons

The table below shows the relative costs per 1,000,000 BTU (MMBTU) for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.60	$175.80
Fuel Oil	$5.69	$43.10

[1] Neither electric or oil data represent a fully occupied building, see 1.2.c. above for the assumptions used in creating the AkWarm-C simulation model.

Figure 1.1

Distribution of Electric Consumption (kWh)

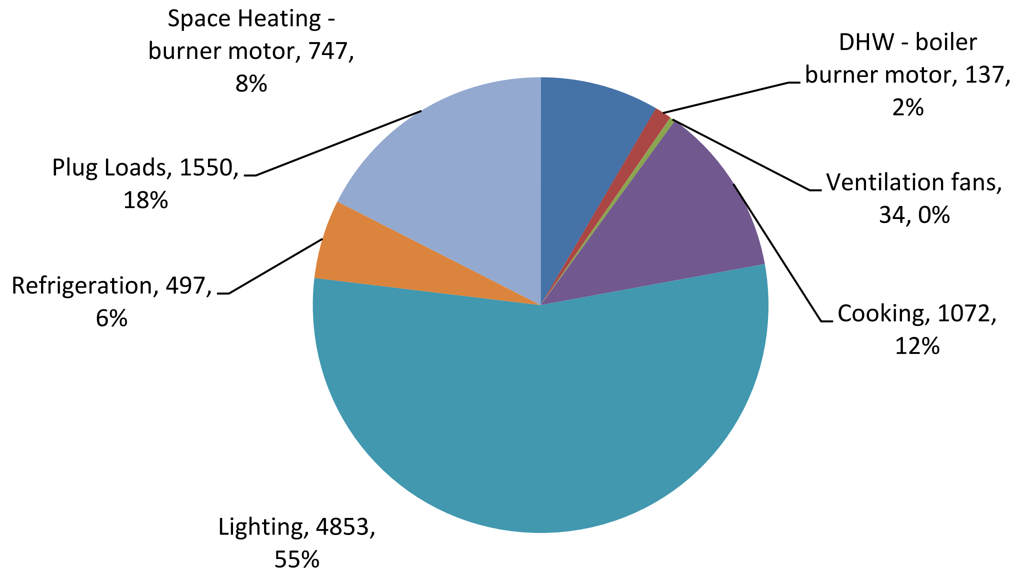
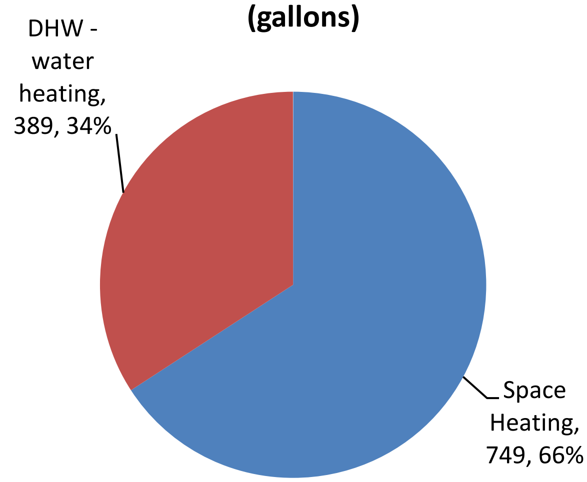


Figure 1.2

Distribution of Fuel Oil Consumption (gallons)



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on lighting and space heating building-wide, and plug loads in the East wing.

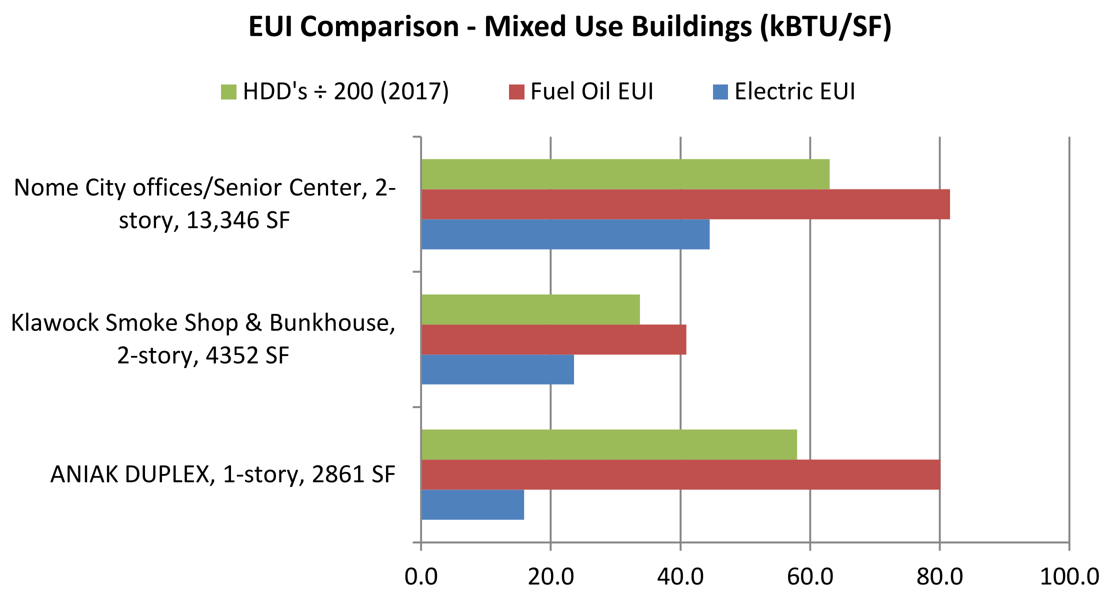
1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	98.4	7.67	$6.19
With Proposed Retrofits	84.7	6.60	$4.70
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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric EUI's are compared to similar use buildings in and out of the region in the bar chart below. The Heating Degree Days[2] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart, the heating energy utilization (or use) Index (EUI) of all three buildings closely tracks the number of HDD's, as it should. So, the heating EUI of the subject building falls where expected. The electric EUI is lower than the other two buildings, most likely because the bunkhouse is used for only a part of the year. Because the electric and heating EUI in the bar chart below represent a theoretical building, issues like a malfunctioning heating or excessive electric loads will not be evident in the EUI's below. This bar chart shows how this building compares to similar use buildings in the region if it is operating properly. Additional discussion is provided in Appendix B.



[2] HDD's are a measure of the severity of cold weather; higher HDD's indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDD's.

1.6 Energy Efficiency Measures(EEMs)

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3, and Figure 1.4 shows the reduction in cost, consumption and BTU's of electricity and fuel oil if all recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
Setback Thermostats & Bath fan controls	$1,662	$864	1.9
Lighting	$1,221	$2,017	0.6
Totals	**$2,883**	**$2,881**	**1.0**

Figure 1.4

<table>
<tr><th rowspan="2"></th><th colspan="2">Existing (modeled) conditions</th><th colspan="2">Proposed Conditions</th><th rowspan="2">Effective reduction in building energy consumption and costs</th></tr>
<tr><th></th><th>kBTU of consumption</th><th></th><th>kBTU of consumption</th></tr>
<tr><td>kWh Electric</td><td>8,865</td><td>30,256</td><td>5,021</td><td>17,137</td><td>43.4%</td></tr>
<tr><td>Gallons Oil</td><td>1,138</td><td>150,216</td><td>1,045</td><td>137,940</td><td>8.2%</td></tr>
<tr><td>Energy Cost</td><td colspan="2">$11,793</td><td colspan="2">$8,957</td><td>24.0%</td></tr>
</table>

Table 1.1 below summarizes the energy efficiency measures analyzed for the Duplex (aka ATC Building #4). Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM. Table 4.1 shows an additional measure of financial return on investment as well as CO_2 savings. The $1 Installed cost indicates that the owner or their staff will implement the EEM at little or no cost; AkWarm-C does not allow a $0 cost entry.

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	HVAC And DHW	Turn boiler off during the summer months, if not already doing so.	$226 / 4.9 MMBTU	$1	3837.75	0.0	841.0
2	Lighting - Power Retrofit: Outdoors Incan A-type 60w	Replace with 2 LED 9W Module StdElectronic	$258 / 1.5 MMBTU	$10	217.03	0.0	730.2
3	Lighting - Power Retrofit: Hall, Bath Incan A-type 60w	Replace with 2 LED 9W Module StdElectronic	$131 / 0.6 MMBTU	$10	127.13	0.1	362.8

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
4	Lighting - Power Retrofit: Entry Incan A-type 60w	Replace with LED 9W Module StdElectronic	$50 / 0.1 MMBTU	$5	81.62	0.1	128.5
5	Lighting - Power Retrofit: Offices (3) Incan A-type 2bulb 60w	Replace with 3 LED (2) 9W Module StdElectronic	$297 / 0.4 MMBTU	$30	81.20	0.1	766.1
6	Lighting - Power Retrofit: Bedrooms, Entry Incan A-Type 60w	Replace with 4 LED (2) 9W Module StdElectronic	$259 / 1.2 MMBTU	$40	63.05	0.2	718.4
7	Setback Thermostat: State Patrol Offices (east wing)	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the State Patrol Offices (east wing) space.	$247 / 6.0 MMBTU	$301	11.14	1.2	957.9
8	Lighting - Power Retrofit: Open Office T12-4lamp wrap	Replace with 3 LED (4) 15W Module (2) StdElectronic	$396 + $15 Maint. Savings / 0.4 MMBTU	$342	9.88	0.8	1,020.0
9	Lighting - Power Retrofit: Open Office T12-2lamp strip	Replace with 3 LED (2) 15W Module StdElectronic	$243 + $15 Maint. Savings / 0.2 MMBTU	$222	9.54	0.9	621.3
10	Lighting - Power Retrofit: Bedroom CFL A-type 2-bulbs 11w	Replace with LED (2) 7W Module StdElectronic	$8 / 0.0 MMBTU	$10	7.66	1.3	21.8
11	Setback Thermostat: Bunkhouse (west wing)	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Bunkhouse (west wing) space.	$324 / 7.8 MMBTU	$600	7.33	1.8	1,257.0
12	Lighting - Combined Retrofit: Kitchen Hall T12-2lamps strip	Replace with 3 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$324 + $15 Maint. Savings / 1.5 MMBTU	$522	5.88	1.5	895.8
13	Lighting - Power Retrofit: Boiler Rm Incan A-type	Replace with LED 7W Module StdElectronic	$1 / 0.0 MMBTU	$5	2.88	3.9	3.3
14	Lighting - Power Retrofit: Storage Incan A-type 60w	Replace with LED (2) 9W Module StdElectronic	$2 / 0.0 MMBTU	$10	2.72	4.1	6.2
15	Lighting - Power Retrofit: Bathroom CFL A-type 2bulbs	Replace with LED (2) 7W Module StdElectronic	$3 / 0.0 MMBTU	$10	2.42	3.4	7.6
16	Ventilation	Replace (2) bath exhaust fans with models with integral humidistat and occupancy sensor @ $200 parts each + 8 hrs total labor @ $45/hr	$67 / 1.4 MMBTU	$760	1.17	11.3	249.8

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
	TOTAL, cost-effective measures		**\$2,835 + \$45 Maint. Savings / 26.0 MMBTU**	**\$2,878**	**10.42**	**1.0**	**8,587.7**
The following measures were *not* found to be cost-effective from a financial perspective, but are still recommended:							
17	Lighting - Power Retrofit: Boiler Rm CFL A-type	Replace with LED 7W Module StdElectronic	\$0 / 0.0 MMBTU	\$5	0.17	68.3	0.2
	TOTAL, all measures		**\$2,836 + \$45 Maint. Savings / 26.0 MMBTU**	**\$2,883**	**10.40**	**1.0**	**8,587.9**

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.

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 existing building. 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. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Cooking**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	\$4,710	\$0	\$2,276	\$19	\$646	\$2,910	\$300	\$930	\$0	**\$11,793**
With Proposed Retrofits	\$4,147	\$0	\$2,276	\$10	\$646	\$648	\$300	\$930	\$0	**\$8,957**
Savings	\$564	\$0	\$0	\$10	\$0	\$2,262	\$0	\$0	\$0	**\$2,836**

1.7 Energy Conservation Measures (ECMs)

No and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called "avoided costs" rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring.** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC "performance drift" is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.

   There is a range of simple to very complex building monitoring systems commercially available, and most utilize a user-friendly internet or network-based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

   ARIS - The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owner's track and manage energy use and costs. For more information contact Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us)

   BMON - AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings, and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

   Monnit – "product model" sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPTION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures, is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas and/or oil	
Re-program Toyo stoves after a power outage	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.
4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Weather-stripping should be maintained if it exists or added if it does not.
5) **Turn off plug loads** including computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves their desk, add an occupancy sensing plug load management device (PLMD) like the "Isole IDP 3050" power strip produced by Wattstopper. (See Appendix J).
6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans and thermostats in this building. An unmaintained HVAC component like a boiler can reduce operating efficiency by 3% or more.
7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone, and turn down the heat and lighting in that zone.
8) **Additional ECM recommendations**:
   a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.
   b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.

c. At their end of useful life (EOL), replace refrigeration equipment and commercial cooking equipment with Energy Star versions.

d. Keep refrigeration coils clean and turn off if not in use.

e. Repair attic insulation.

f. Turn off the boiler during summer months.

g. Maintain set back temperature programming on all Toyo and Monitor stoves, especially after a power outage.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Duplex (aka ATC Building #4). 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 including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager, if possible, to understand their objectives and ownership strategy and to gather other information the auditor could use to make the audit most useful. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment including refrigeration equipment
- Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and energy management programs (if they exist) provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from Duplex (aka ATC Building #4) enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building." The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model

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, adding any HVAC systems, ventilation, and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat) and the hours of operation of the building.

Duplex (aka ATC Building #4) is classified as being made up of the following activity areas:

1) State Patrol Offices (east wing): 888 square feet
2) Boiler & storage: 127 square feet
3) Bunkhouse (west wing): 889 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model was calibrated to actual fuel consumption and was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions.

Limitations of AkWarm© Models

The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly, on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis
Our analysis provides a number of tools for assessing the cost effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions, and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the projected life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIR's and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR>=1 to be considered financially viable on a stand-alone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. <u>Costs are considered to be accurate within +/-30% in this level of audit;</u> they are derived from Means Cost Data, industry publications, the auditors experience and/or local contractors and equipment suppliers.

Interactive effects of EEMs:
It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases, lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in others, negatively. If all EEMs are implemented, their order of implementation is irrelevant, because the total savings after full implementation will be unchanged. If an EEM is calculated outside of the AkWarm© model, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:
The underlying assumptions used in the calculations made in this audit follow:

- 3,413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs, or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline, shall accept full responsibility and liability for the design, engineering and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects is not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. DUPLEX (aka ATC Building #4) EXISTING CONDITIONS

3.1. Building Description

The 1,904 square foot Duplex was constructed in 1995. The West wing has been used on an intermittent basis, primarily during summer months, to house groups such as the Campfire Girls, construction crews, etc. The East wing was under construction during the site survey, and is being renovated to house the State Patrol Regional office. The building was modeled in AkWarm-C using the following occupancy schedules:

East Wing:
- Occupied from 9:00am until 5:00pm Monday through Friday
- 4 occupants including visitors
- Typical plug and electric loads for an office environment

West Wing:
- Occupied from 4:00pm until 10:00am, 7 days per week from mid-May through mid-September
- 10 occupants including visitors
- Typical plug and electric loads for a residence

Description of Building Shell

This building is constructed on 6" x 18" glue lam beams supported by wood pads in ground contact. The beams support the floor joists on a 12' span so they are assumed to be 2" x 12" and have R-38 fiberglass batt in the joist cavities.

The walls are constructed with 2" x 6" studs, presumed to be 16" OC, and the stud cavities are filled with R-19 batt. The interior walls are finished with gypsum and the exterior walls are finished with horizontal vinyl siding. There are several areas where the siding is missing, these should be repaired. The windows utilize double glazing in vinyl frames, presumed to have low-E coatings. A single window has a U=0.32 sticker stating argon filled, low-E, but it appears to be a replacement and not the norm for the rest of the building's windows. The windows are in good condition and the doors are metal skinned, 6-panel, also in good condition.

The painted metal roof is supported by wood trusses over a vented attic. The portion of the attic over the boiler room was accessible, it has two layers of R-38 fiberglass batt, and it is presumed that this is the same throughout the rest of the attic. The roof had a thin layer of snow on it during the site survey, indicating that the attic insulation is functional.

Description of Heating and Cooling Plants

Toyotomi Domestic Hot Water Heater

Nameplate Information: Toyotomi OM-148

Fuel Type:	#2 Oil
Input Rating:	148,000 BTU/hr
Steady State Efficiency:	83 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	148 MBH input, 130 MBH output, nominal thermal efficiency when new 88%, de-rated to 83% for age

Boiler

Nameplate Information:	Burnham PV8H4WK
Fuel Type:	#2 Oil
Input Rating:	141,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	162 MBH input, 141 MBH output, nominal 87% thermal efficiency when new, de-rated to 84% for age. Manufactured in 2011.

Toyo Stove Laser 72

Nameplate Information:	Toyo Laser 72
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	40 MBH input, nominal thermal efficiency when new is 88%; de-rated to 84% for age and condition

Toyo Stove Laser 56

Nameplate Information:	Toyo Laser 56
Fuel Type:	#1 Oil
Input Rating:	22,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	22 MBH input, nominal thermal efficiency when new 88%, de-rated to 84% for age and condition

<u>Space Heating and Cooling Distribution Systems</u>

Heat is distributed to fintube baseboard radiators throughout this building by a hydronic system using a single, constant speed circulation pump, There is no cooling in the building. Two secondary heat plants, (Toyo Stoves) are located in each wing. They do not appear to be used very often and both were turned off during the site survey

Building Ventilation System

There is no mechanical ventilation in this building and outside air is provided by operable windows.

HVAC Controls

This is a 3-zone system using (3) Taco zone valves and a Taco ZVC406 controller. The three zones are the East wing, West wing and the bathroom in the bunkhouse. The controller receives input from the (3) manual thermostats located in the zone. There is no heat in the State Patrol bathroom.

Each Toyo stove has its own remote bulb thermostat and internal controls.

Domestic Hot Water System

DHW is provided by an oil fired, Toyotomi, tank-less hot water heater located in the boiler room. There does not appear to be a DHW re-circulation pump in use.

Lighting

The interior lighting consists of a mixture of 2 and 4-lamp, 48” fixtures utilizing T12 florescent lamps and magnetic ballasts and surface mount A-type fixtures utilizing CFL and incandescent bulbs. No lighting controls appear to be in use. Exterior lighting consists of what appears to be a 70w HPS wall pack and wall mounted fixtures utilizing incandescent A-type bulbs. There does not appear to be any controls on the exterior lighting.

Major Equipment and Plug Loads

A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis, to match the actual, baseline electric data and after calibration, the AkWarm© model predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

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 as predicted by the AkWarm-C model. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The utility companies providing energy to the subject building, and the class of service provided by each, are listed below:

Electricity: Aniak Light & Power - 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	$ 0.6000/kWh
#2 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or from invoices, which also included customer charges, service charges, energy costs and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically gallons delivered, not gallons consumed. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $11,793 annually for electricity and other fuel costs for the Duplex.

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

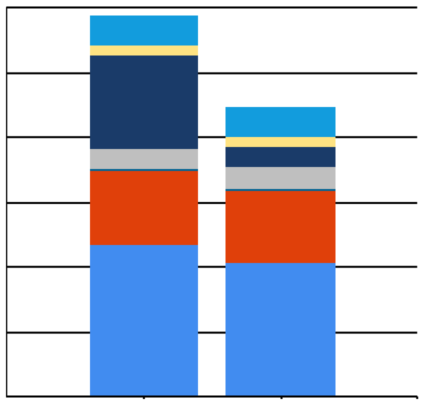


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

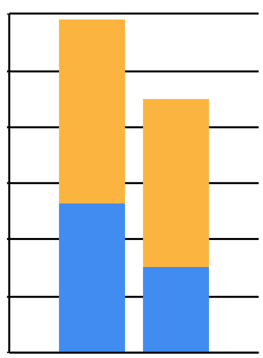
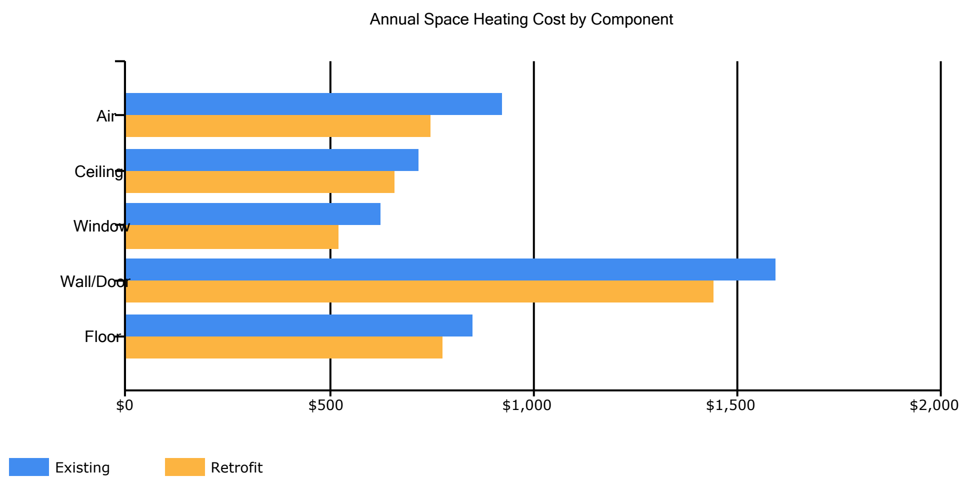


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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 the model'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	67	60	65	61	61	59	61	61	59	64	63	66
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	9	8	9	9	9	9	9	9	9	9	9	9
Ventilation_Fans	2	2	2	2	3	5	5	5	3	2	2	1
Cooking	91	83	91	88	91	88	91	91	88	91	88	91
Lighting	278	253	278	269	483	654	676	676	461	278	269	278
Refrigeration	42	39	42	41	42	41	42	42	41	42	41	42
Other_Electrical	84	77	84	82	157	217	225	225	149	84	82	84

Fuel Oil #2 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	136	99	91	55	14	11	11	11	17	69	104	131
DHW	33	30	33	32	33	32	33	33	32	33	32	33

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building.
It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUI's are calculated by converting all the energy consumed by a building in one year to BTU's and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy". Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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, and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

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 + Gas Usage in kBtu + similar for other fuels)*
Building Square Footage

Building Source EUI = *(Electric Usage in kBtu X SS Ratio + Gas 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
Duplex (aka ATC Building #4) 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	8,865 kWh	30,256	3.340	101,054
#2 Oil	1,138 gallons	157,009	1.010	158,579
Total		**187,264**		**259,633**
BUILDING AREA		1,904	Square Feet	
BUILDING SITE EUI		98	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		136	**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	**98.4**	**7.67**	**$6.19**
With Proposed Retrofits	**84.7**	**6.60**	**$4.70**
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.			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C. The $1 Installed cost indicates that the owner or their staff will implement the EEM at little or no cost; AkWarm-C does not allow a $0 cost entry.

Table 4.1
Duplex (aka ATC Building #4), Aniak, 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	HVAC And DHW	Turn boiler off during the summer months, if not already doing so.	$226 / 4.9 MMBTU	$1	3837.75	0.0	841.0
2	Lighting - Power Retrofit: Outdoors Incan A-type 60w	Replace with 2 LED 9W Module StdElectronic	$258 / 1.5 MMBTU	$10	217.03	0.0	730.2
3	Lighting - Power Retrofit: Hall, Bath Incan A-type 60w	Replace with 2 LED 9W Module StdElectronic	$131 / 0.6 MMBTU	$10	127.13	0.1	362.8
4	Lighting - Power Retrofit: Entry Incan A-type 60w	Replace with LED 9W Module StdElectronic	$50 / 0.1 MMBTU	$5	81.62	0.1	128.5
5	Lighting - Power Retrofit: Offices (3) Incan A-type 2bulb 60w	Replace with 3 LED (2) 9W Module StdElectronic	$297 / 0.4 MMBTU	$30	81.20	0.1	766.1
6	Lighting - Power Retrofit: Bedrooms, Entry Incan A-Type 60w	Replace with 4 LED (2) 9W Module StdElectronic	$259 / 1.2 MMBTU	$40	63.05	0.2	718.4
7	Setback Thermostat: State Patrol Offices (east wing)	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the State Patrol Offices (east wing) space.	$247 / 6.0 MMBTU	$301	11.14	1.2	957.9
8	Lighting - Power Retrofit: Open Office T12-4lamp wrap	Replace with 3 LED (4) 15W Module (2) StdElectronic	$396 + $15 Maint. Savings / 0.4 MMBTU	$342	9.88	0.8	1,020.0
9	Lighting - Power Retrofit: Open Office T12-2lamp strip	Replace with 3 LED (2) 15W Module StdElectronic	$243 + $15 Maint. Savings / 0.2 MMBTU	$222	9.54	0.9	621.3
10	Lighting - Power Retrofit: Bedroom CFL A-type 2-bulbs 11w	Replace with LED (2) 7W Module StdElectronic	$8 / 0.0 MMBTU	$10	7.66	1.3	21.8

Table 4.1 Duplex (aka ATC Building #4), Aniak, 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**
11	Setback Thermostat: Bunkhouse (west wing)	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Bunkhouse (west wing) space.	$324 / 7.8 MMBTU	$600	7.33	1.8	1,257.0
12	Lighting - Combined Retrofit: Kitchen Hall T12-2lamps strip	Replace with 3 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$324 + $15 Maint. Savings / 1.5 MMBTU	$522	5.88	1.5	895.8
13	Lighting - Power Retrofit: Boiler Rm Incan A-type	Replace with LED 7W Module StdElectronic	$1 / 0.0 MMBTU	$5	2.88	3.9	3.3
14	Lighting - Power Retrofit: Storage Incan A-type 60w	Replace with LED (2) 9W Module StdElectronic	$2 / 0.0 MMBTU	$10	2.72	4.1	6.2
15	Lighting - Power Retrofit: Bathroom CFL A-type 2bulbs	Replace with LED (2) 7W Module StdElectronic	$3 / 0.0 MMBTU	$10	2.42	3.4	7.6
16	Ventilation	Replace (2) bath exhaust fans with models with integral humidistat and occupancy sensor @ $200 parts each + 8 hrs total labor @ $45/hr	$67 / 1.4 MMBTU	$760	1.17	11.3	249.8
	TOTAL, cost-effective measures		**$2,835 + $45 Maint. Savings / 26.0 MMBTU**	**$2,878**	**10.42**	**1.0**	**8,587.7**
The following measures were *not* found to be cost-effective from a financial perspective, but are still recommended:							
17	Lighting - Power Retrofit: Boiler Rm CFL A-type	Replace with LED 7W Module StdElectronic	$0 / 0.0 MMBTU	$5	0.17	68.3	0.2
	TOTAL, all measures		**$2,836 + $45 Maint. Savings / 26.0 MMBTU**	**$2,883**	**10.40**	**1.0**	**8,587.9**

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 effects 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 Insulation Measures (There were no improvements in this category)

4.3.2 Window Measures (There were no improvements in this category)

4.3.3 Door Measures (There were no improvements in this category)

4.3.4 Air Sealing Measures (There were no improvements in this category)

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation				
1	Turn boiler off during the summer months, if not already doing so.				
Installation Cost	$1	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$226
Breakeven Cost	$3,838	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	4.9 MMBTU
		Savings-to-Investment Ratio	3,837.8		
Auditors Notes:					

4.4.2 Ventilation System Measures

Rank	Description			Recommendation	
16				Replace (2) bath exhaust fans with models with integral humidistat and occupancy sensor @ $200 parts each + 8 hrs total labor @ $45/hr	
Installation Cost	$760	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$67
Breakeven Cost	$892	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	1.4 MMBTU
		Savings-to-Investment Ratio	1.2		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
7	State Patrol Offices (east wing)			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the State Patrol Offices (east wing) space.	
Installation Cost	$301	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$247
Breakeven Cost	$3,352	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	6.0 MMBTU
		Savings-to-Investment Ratio	11.1		
Auditors Notes:					

Rank	Building Space			Recommendation	
11	Bunkhouse (west wing)			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Bunkhouse (west wing) space.	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$324
Breakeven Cost	$4,398	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	7.8 MMBTU
		Savings-to-Investment Ratio	7.3		
Auditors Notes:					

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	Outdoors Incan A-type 60w	2 INCAN A Lamp, Std 60W with Manual Switching		Replace with 2 LED 9W Module StdElectronic	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$258
Breakeven Cost	$2,170	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.5 MMBTU
		Savings-to-Investment Ratio	217.0		
Auditors Notes: Replace (2) A-type incandescent bulbs with (7 or 9)w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
3	Hall, Bath Incan A-type 60w	2 INCAN A Lamp, Std 60W with Manual Switching		Replace with 2 LED 9W Module StdElectronic	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$131
Breakeven Cost	$1,271	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
		Savings-to-Investment Ratio	127.1		
Auditors Notes: Replace (2) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
4	Entry Incan A-type 60w	INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 9W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$50
Breakeven Cost	$408	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	81.6		
Auditors Notes: Replace (1) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
5	Offices (3) Incan A-type 2bulb 60w	3 INCAN (2) A Lamp, Std 60W with Manual Switching		Replace with 3 LED (2) 9W Module StdElectronic	
Installation Cost	$30	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$297
Breakeven Cost	$2,436	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
		Savings-to-Investment Ratio	81.2		
Auditors Notes: Replace (6) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
6	Bedrooms, Entry Incan A-Type 60w	4 INCAN (2) A Lamp, Std 60W with Manual Switching		Replace with 4 LED (2) 9W Module StdElectronic	
Installation Cost	$40	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$259
Breakeven Cost	$2,522	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.2 MMBTU
		Savings-to-Investment Ratio	63.1		
Auditors Notes: Replace (8) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
8	Open Office T12-4lamp wrap	3 FLUOR (4) T12 4' F40T12 40W Standard (2) Magnetic with Manual Switching		Replace with 3 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$342	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$396
Breakeven Cost	$3,378	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.4 MMBTU
		Savings-to-Investment Ratio	9.9	**Maintenance Savings ($/yr)**	$15
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (3) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (12) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
9	Open Office T12-2lamp strip	3 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic	
Installation Cost	$222	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$243
Breakeven Cost	$2,118	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	9.5	**Maintenance Savings ($/yr)**	$15
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (3) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (6) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
10	Bedroom CFL A-type 2-bulbs 11w	FLUOR (2) CFL, A Lamp 11W with Manual Switching		Replace with LED (2) 7W Module StdElectronic	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$8
Breakeven Cost	$77	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	7.7		
Auditors Notes: Replace (2) 11w A-type CFL bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location		Existing Condition		Recommendation	
12	Kitchen Hall T12-2lamps strip		3 FLUOR (2) T12 4' F40T12 40W Standard Magnetic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost		$522	**Estimated Life of Measure (yrs)**	11	**Energy Savings ($/yr)**	$324
Breakeven Cost		$3,070	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	1.5 MMBTU
			Savings-to-Investment Ratio	5.9	**Maintenance Savings ($/yr)**	$15
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (3) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (6) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add ceiling mounted occupancy sensor @ $175 parts + 1 hr labor @ $125/hr						

Rank	Location		Existing Condition		Recommendation	
13	Boiler Rm Incan A-type		INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 7W Module StdElectronic	
Installation Cost		$5	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1
Breakeven Cost		$14	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	2.9		
Auditors Notes: Replace (1) 60w A-type Incandescent bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.						

Rank	Location		Existing Condition		Recommendation	
14	Storage Incan A-type 60w		INCAN (2) A Lamp, Std 60W with Manual Switching		Replace with LED (2) 9W Module StdElectronic	
Installation Cost		$10	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$2
Breakeven Cost		$27	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	2.7		
Auditors Notes: Replace (2) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.						

Rank	Location		Existing Condition		Recommendation	
15	Bathroom CFL A-type 2bulbs		FLUOR (2) CFL, A Lamp 11W with Manual Switching		Replace with LED (2) 7W Module StdElectronic	
Installation Cost		$10	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$3
Breakeven Cost		$24	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	2.4		
Auditors Notes: Replace (2) 11w A-type CFL bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.						

Rank	Location		Existing Condition		Recommendation	
17	Boiler Rm CFL A-type		FLUOR CFL, A Lamp 11W with Manual Switching		Replace with LED 7W Module StdElectronic	
Installation Cost		$5	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$
Breakeven Cost		$1	**Simple Payback (yrs)**	68	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.2		
Auditors Notes: Replace (1) 11w A-type CFL bulbs with 7w A-type LED bulbs @ $5 ea. No labor, owner to install.						

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

ALL SCHEDULES COMPILED FROM PLANS OR ON-SITE NAMEPLATE OBSERVATION, WHERE ACCESSIBLE e= estimated

EXHAUST FAN SCHEDULE

SYMBOL	MOTOR MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
EF-1	unknown	e100	e60w/115/1	exhaust fan in west unit bathroom
EF-2	unknown	e100	e60w/115/1	exhaust fan in east unit bathroom
EF-3	unknown	e100	e60w/115/1	exhaust fan in west unit storage room (does not appear to be in use)

HEAT PLANT SCHEDULE

SYMBOL	MFGR/MODEL	NOMINAL EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
B-1	Burnham, model RV8H4WC	87%	unknown	162 MBH input, 162 output, nominal efficiency when new 87%; manufactured 2010/2011
	Toyo Laser 56	93%	225w/120/1	located in west unit; 22 MBH input
	Toyo Laser 72	92%	285w/120/1	located in east unit; 40 MBH input

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
CP-1	Grundfos UPS 15-58 FC	12 @ 8'	87w/115/1	Main building circ pump

INSTANTANEOUS WATER HEATER SCHEDULE

SYMBOL	MFGR/MODEL	GALLONS	NUMBER OF ELEMENTS	REMARKS
HWH-1	Toyotomi OM-148	5.1	n/a	Input 148 MBH, 120w power usage

PLUMBING FIXTURES				
SYMBOL	**FIXTURE**	**GPF**	**QUANTITY**	**REMARKS**
	W.C.	1.1/1.6	2	manually operated dual-flush
	Shower	e3.0	1	located in west unit
	Lavatory	1.5	1	manually operated, located in east unit (office)
	Lavatory	3.0	1	manually operated, located in west unit

PLUG LOAD SUMMARY				
SYMBOL	**FIXTURE**	**QUANTITY**	**ESTIMATED CONSUMPTION**	**REMARKS**
	Toaster oven	1	1200w	
	Stereo System	1	200w	
	Microwaves	1	1000w	
	GE full size refrigerator, model GTS18FBRERWW	1	800 kWh/yr	1/4 full
	GE electric range/oven, model RB757BH1WH	1	11.7kW@240V	

Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies and irregularities which may provide insight regarding the building's function and efficiency. Thirty-six months of historical data is usually a sufficient period of time to gain an understanding of the building operation. Electric consumption data from 2015 through 2017 was available, but no fuel oil delivery or consumption data was provided. As previously mentioned, the use and occupancy of this building will change significantly from the 2015-2017 period, so both the actual and AkWarm-C predicted figures are shown in this Appendix. Figures B.1, B.2 and B.3 show the known and predicted 3-year summary of consumption and costs for this facility. The shaded cells represent the data used in (or provided by) the AkWarm-C model.

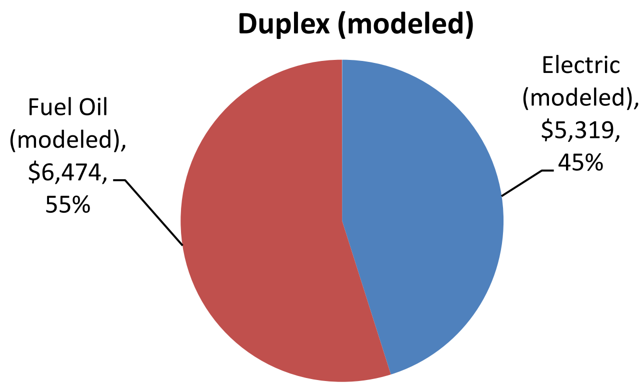
Figure B.1 – Total ACTUAL, known Building Electric Consumption and Costs

DUPLEX (no PCE)						
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use (gallons)	Fuel oil Cost	Total kBTU's of Energy	Total Utility Cost
2015	150	$87	Not provided by owner			
2016	780	$455				
2017	1415	$848				

Figure B.2 – Total Building Electric Consumption and Costs as PREDICTED by the AkWarm-C model

DUPLEX (no PCE)						
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use (predicted by AkWarm-C) - gallons	Fuel oil Cost	Total kBTU's of Energy	Total Utility Cost
			1,138	$6,474	180,472	$11,793
Predicted	8,865	$5,319				

Figure B.3 – Distribution of PREDICTED Energy Costs



Electricity: Because the use and occupancy of this building has changed and will change when the State Patrol staff move in, little can be concluded from historical data. Nonetheless, monthly and annual electric consumption figures are provided below.

Figure B.4 – 2 Years of monthly Electric Consumption

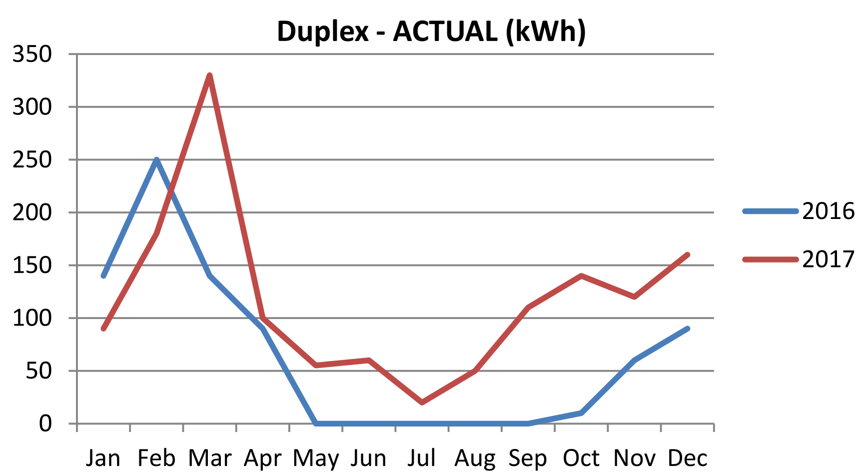
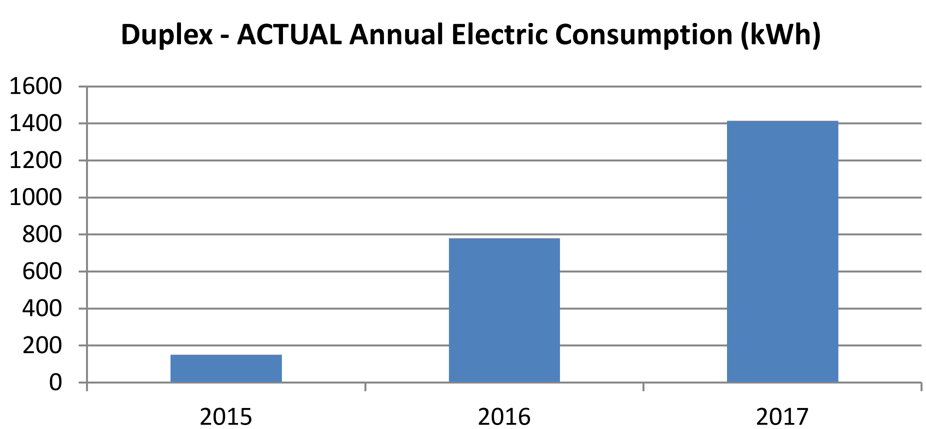


Figure B.5 – 3 years of Annual Electric Consumption

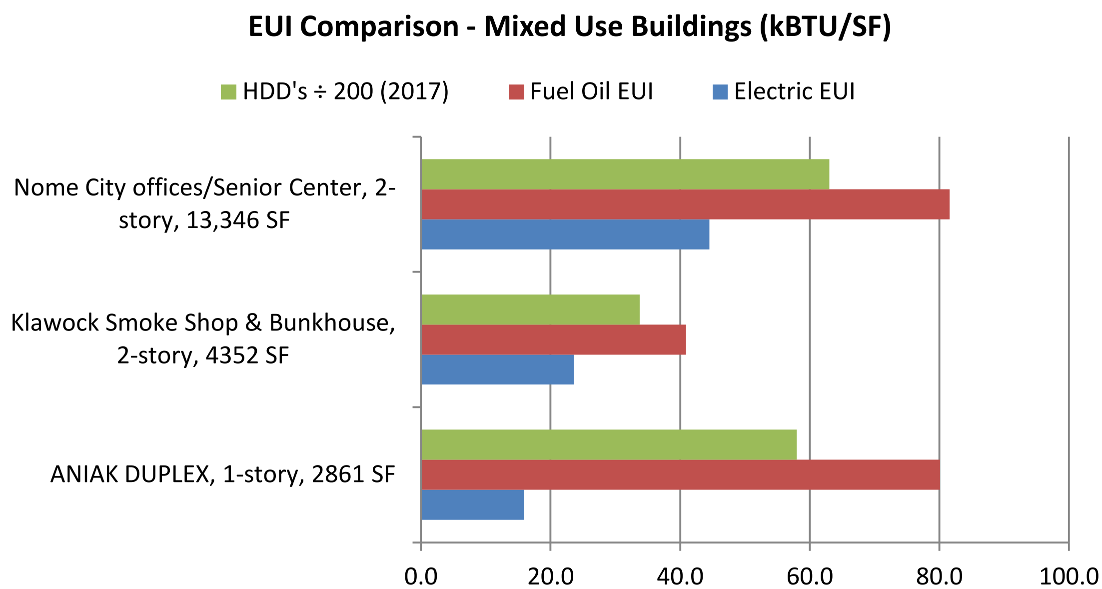


Fuel Oil: Because no oil delivery data was provided, no benchmarking can be performed on this building.

Comparing EUI's: Figure B.6 and the discussion in Section 1.5 above, show that this building's heating EUI falls within expectations as does its electric EUI.

A noteworthy point is that this building, as modeled, has a heating EUI 52% higher than it would if DHW was used only for hand washing. As seen in Figure 1.2, 34% of the fuel oil used in this building is for DHW, and 98% of that is used for showers in the bunkhouse. The Nome Senior center also has a high DHW usage due to the use of a commercial kitchen in the facility but the Klawock Bunkhouse has a fairly low DHW use.

Figure B.6 – EUI's



After performing the historical analysis in Section 1.5 and above, a baseline period is typically selected as a benchmark, based on factors including the consistency of the data, the periods for which data was available and the current use and occupancy of the building versus its historical use and occupancy. But since its use and occupancy are in flux, the benchmark baseline selected for this building is the electric and fuel oil predictions made by the AkWarm-C model shown in Figure B.2 above.

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering (if required) and construction management costs are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit, and are derived from and one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- Local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified Electrician $125/hr

This level of work includes changing street light heads, light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work $ 45/hr

Includes installing switch mounted occupancy sensors which do not require re-wire or pulling additional wires, weather stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work $125/hr

Work includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities $45/hr

Includes maintaining light fixtures, door and window weather stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

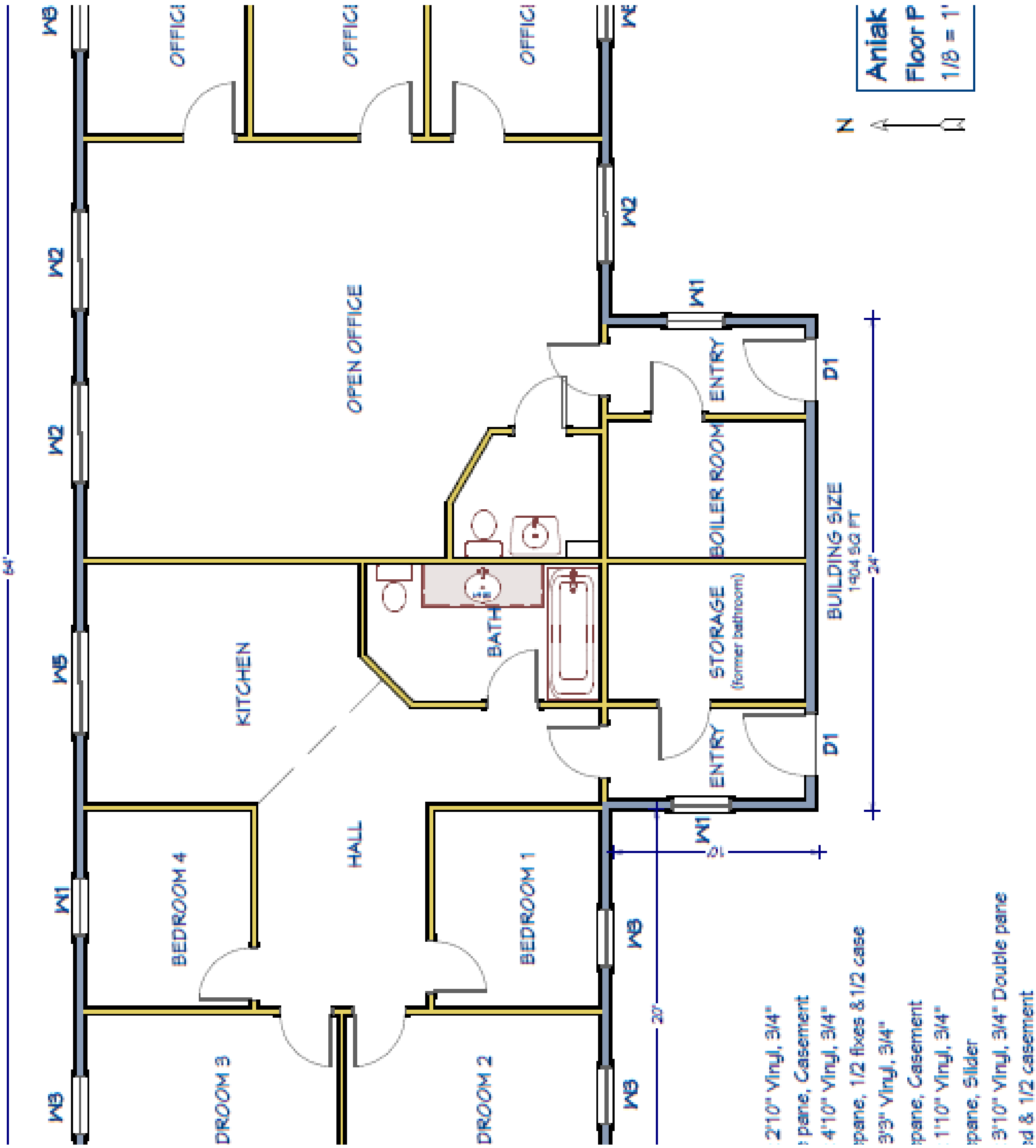
ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Duplex (aka ATC Building #4)	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Laura Simeon	
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 675-4349	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,904 square feet	**Design Space Heating Load:** Design Loss at Space: 28,971 Btu/hour with Distribution Losses: 32,190 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 49,070 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 14 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days
Utility Information	
Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.600/kWh	**Average Annual Cost/ccf:** $0.000/ccf

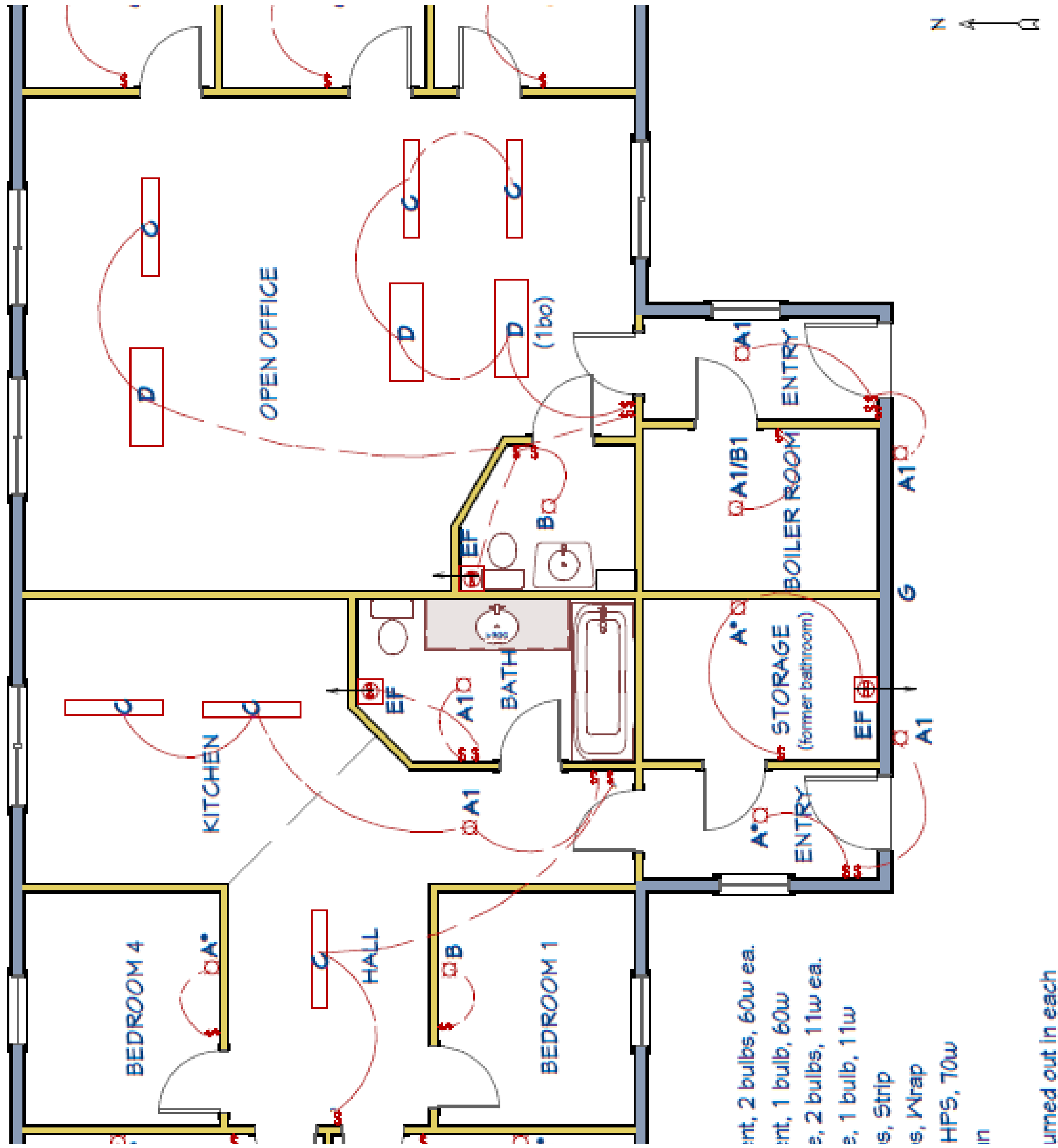
Annual Energy Cost Estimate										
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Cooking**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$4,710	$0	$2,276	$19	$646	$2,910	$300	$930	$0	**$11,793**
With Proposed Retrofits	$4,147	$0	$2,276	$10	$646	$648	$300	$930	$0	**$8,957**
Savings	$564	$0	$0	$10	$0	$2,262	$0	$0	$0	**$2,836**

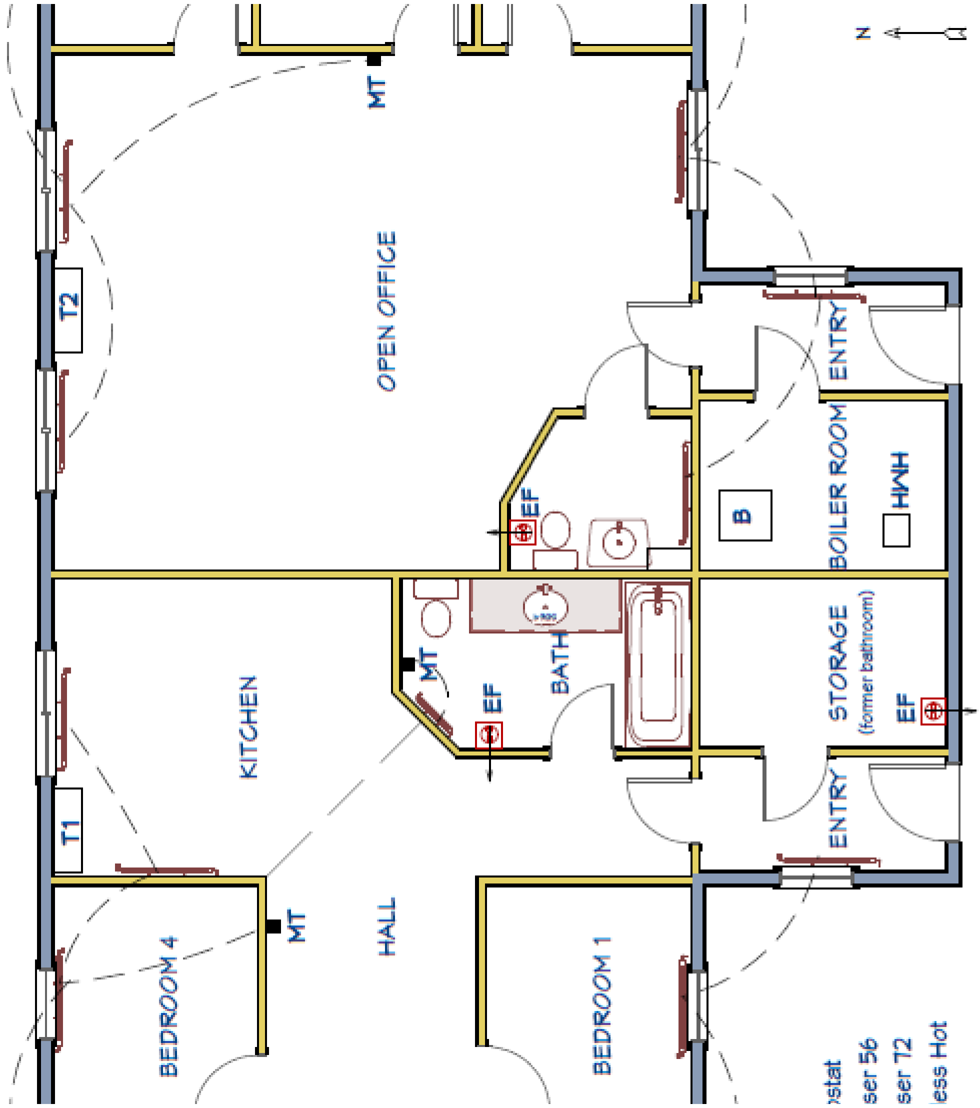
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	98.4	7.67	$6.19
With Proposed Retrofits	84.7	6.60	$4.70

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.

BUILDING SCHEMATICS




OPEN OFFICE
(1bo)
ENTRY
BOILER ROOM
STORAGE
(former bathroom)
BATH
KITCHEN
HALL
BEDROOM 4
BEDROOM 1


N
MT
OPEN OFFICE
T2
ENTRY
BOILER ROOM
B
HWH
EF
KITCHEN
T1
BATH
MT
EF
STORAGE
(former bathroom)
EF
ENTRY
MT
HALL
BEDROOM 4
BEDROOM 1

Appendix E – Photographs & IR Images

Several areas of missing siding should be repaired

Attic above boiler room: batts have been moved and have not been properly replaced to maximize insulation value

Boiler and potable water pressure tank in the boiler room

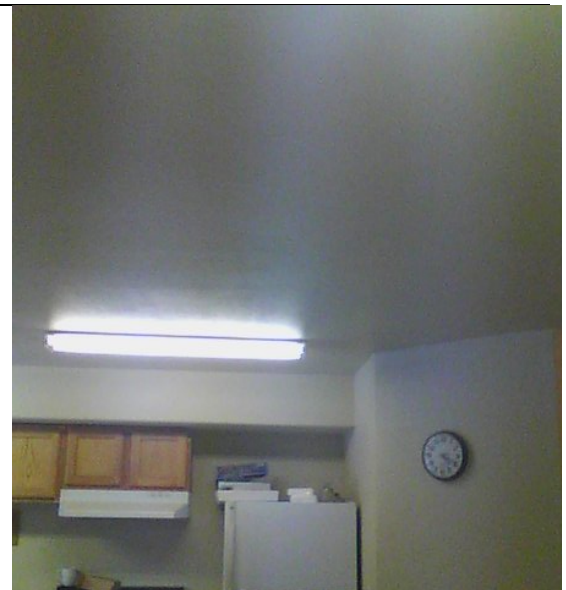
Taco controller and 3 zone valves

Bunkhouse kitchen

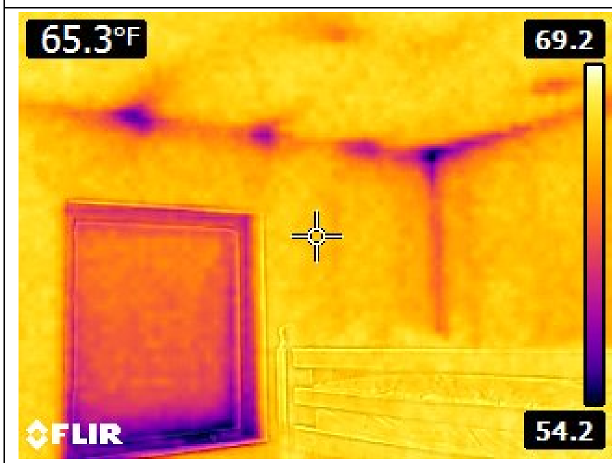
One of the bunkhouse bedrooms

State Patrol common area office

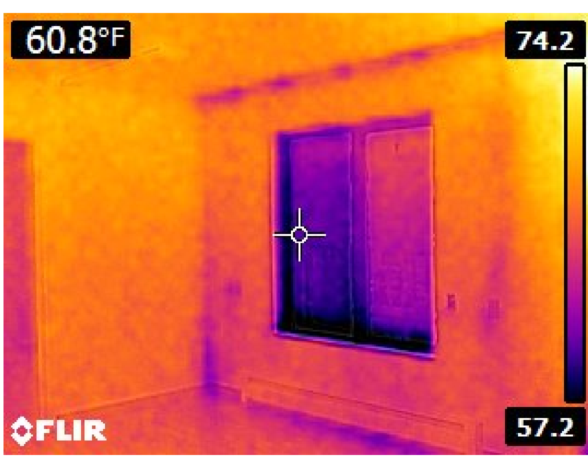
One of the offices in State Patrol wing

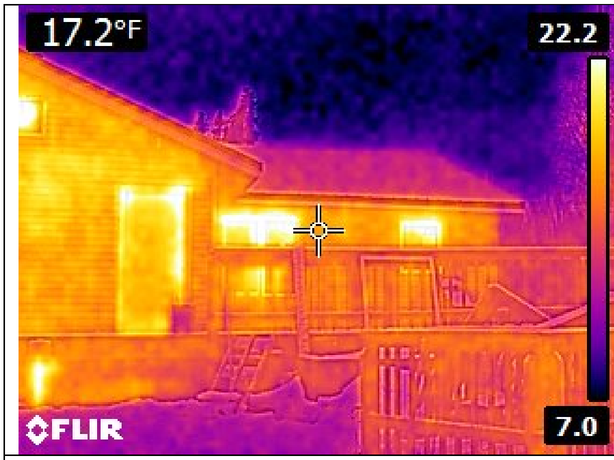
1. Attic insulation appears to have been moved out of place; it should be carefully replaced to reduce heat loss



2. Window heat loss is minimal, heat loss through the corners is typical when standard trusses are used



3. Again, fairly typical heat loss in corners

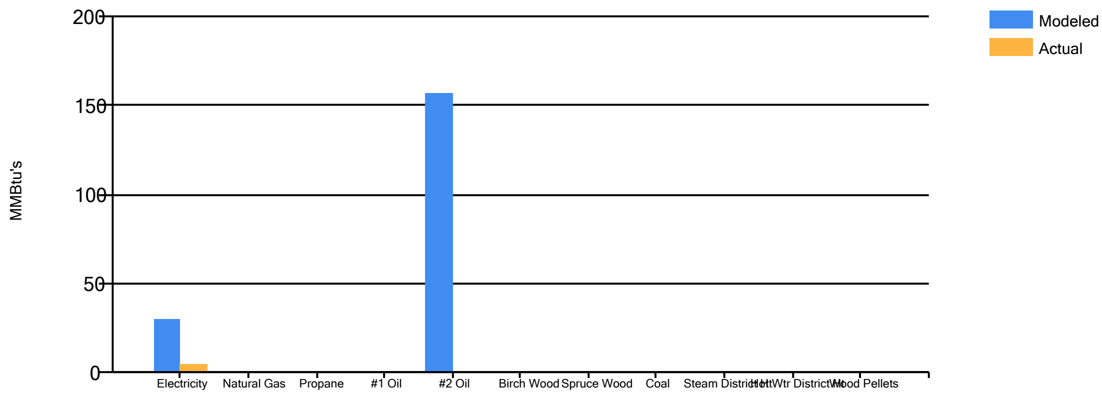


4. Standby boiler heat losses are evident around periphery of entry door. The attic vent in upper left corner if image should be replaced

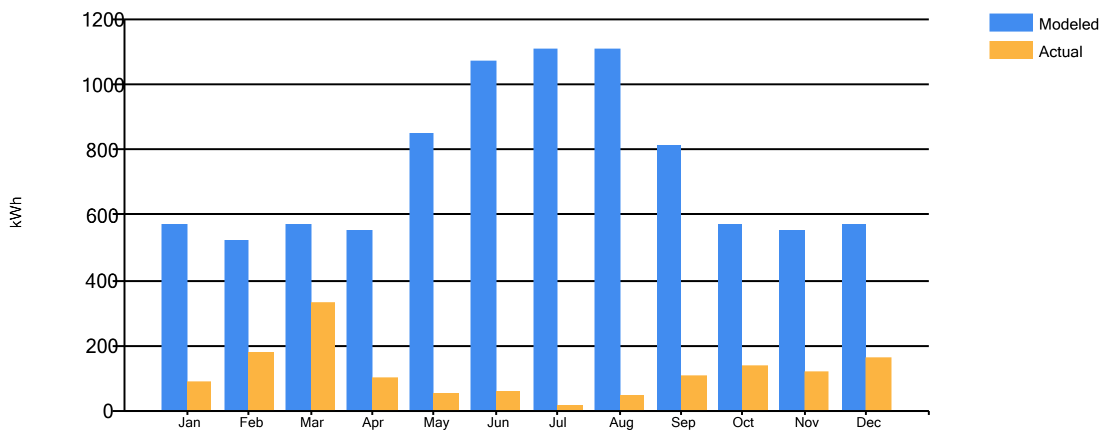
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

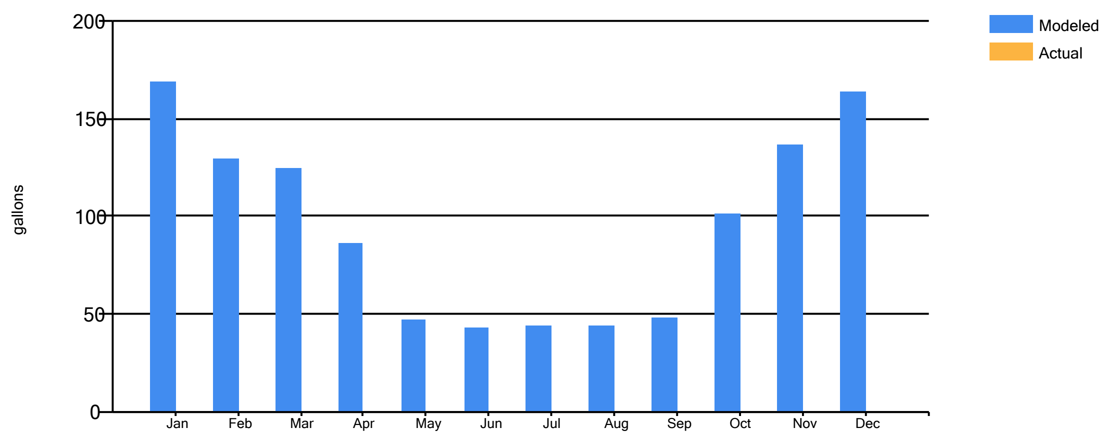
Annual Fuel Use



Electricity Fuel Use



#2 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
CFM	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OSA	Outside Air
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECMs, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

Comprehensive Energy Audit
For the Aniak Large Farm Building

Prepared For:
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Site Survey Date:
January 18, 2018

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Energy Audits of Alaska

Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 21, 2018
New Release – September 14, 2018

Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (energy efficiency measures, or EEMs), estimate the value of the savings and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that the recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of heating, ventilation and air-conditioning (HVAC) systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the ASHRAE definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy and electric usage, and the US Department of Energy Office of Indian Energy who provided funding.

Project Location

NORTH

Subject Building

Building contact:
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Tribal Administrator
907-675-4349
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1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the Large Farm Building. The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and any process and plug loads. There are no charges for water and wastewater and these systems were not evaluated in this analysis.

The site survey took place on January 18, 2018. The outside temperature varied between 20F and 28F and there was snow on the ground and on rooftops.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy consuming equipment, identify technically and economically feasible energy efficiency measures (EEMs) for existing equipment and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The energy conservation measures (ECMs) identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The "avoided costs" resulting from energy conservation measures (ECMs) are discussed in Section 1.7, but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 8-page summary is designed to contain all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost, and their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

Sections 2, 3, and 4 of this report and the Appendices, are back-up and provide much more detailed information should the owner/operator, or staff, desire to investigate further. Sections 4.3 through 4.5 include additional auditor's notes for many EEMs. Due to their length, Appendices H, I, and J, which contain additional ECM detail, lighting information and manufacturer's "cut sheets" of samples of recommended retrofit products, are included as a separate document.

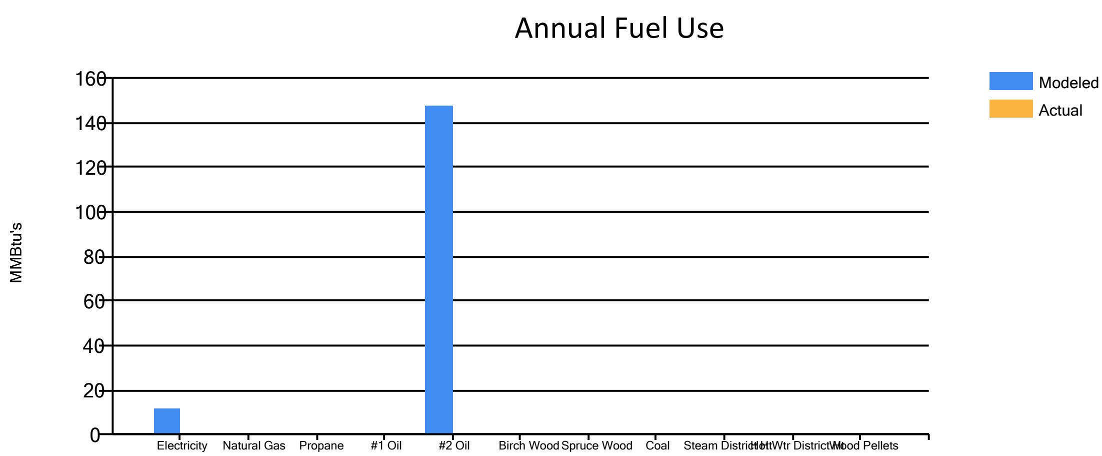
Issues that the auditor feels are of particular importance to the reader are underlined and all abbreviations and acronyms used in this document are listed in Appendix G.

1.2 Noteworthy Points & Immediate Action

a. This building is currently used for cold storage and has no heat or electrical service. At some time in the near future, the owner is considering using the partially insulated west portion as a shop and retaining the uninsulated east portion as cold storage. Consequently, there is no historical baseline period of energy consumption representing this building in its future use and occupancy. Furthermore, with no current electric service or heat, no electric or fuel oil use data could be provided by the owner. In order to provide the owner with realistic estimates of energy savings for this building used as a shop and cold storage, the AkWarm-C model was created using the following assumptions:

- Occupied for 4 hours/day Monday through Friday
- 2 occupants in the west wing and 1 occupant in the east wing
- Typical plug and electric loads for a low-use shop and warehouse building

As a result of these assumptions, and as seen in the bar chart below (from Appendix F), neither the electrical or fuel oil consumption figures in the AkWarm-C model are calibrated to actual figures. The electric and fuel oil use figures predicted by the AkWarm-C model are used in this analysis unless specifically stated otherwise.



b. If all the recommended EEMs are incorporated in this building, there will be a 52.1% reduction in energy costs, totaling $4,281, with a simple payback of 2.9 years on the $12,340 implementation cost.

c. It was assumed in this analysis, that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity. It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician.

d. It was also assumed that envelope improvements such as adding insulation, installing windows and replacing doors would be performed by Tribal Staff members, a labor rate of $45/hr was also used for these activities.

1.3 Current Cost and Breakdown of Energy

Based on electricity and fuel oil prices in effect at the time of the audit, and using the uncalibrated AkWarm-C© energy model[1], the total predicted energy costs are $8,222 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$2,119 for Electricity
$6,103 for #2 Oil

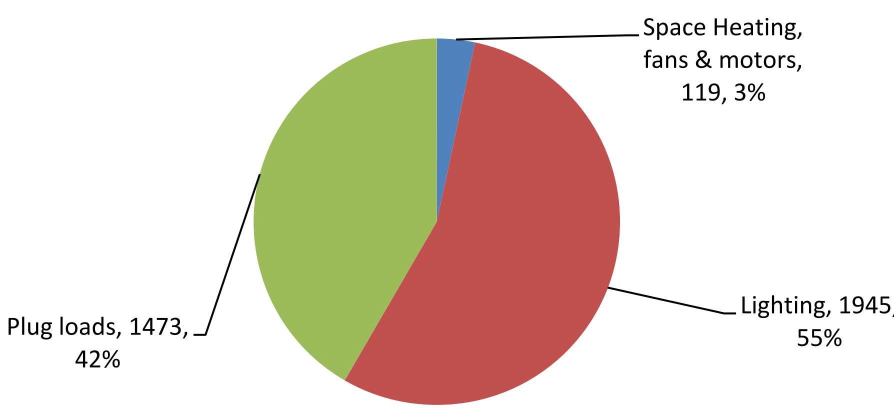
Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	3,532 kWh	2,151 kWh
#2 Oil	1,073 gallons	466 gallons

The table below shows the relative costs per MMBTU for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.60	$175.80
Fuel Oil	$5.69	$43.10

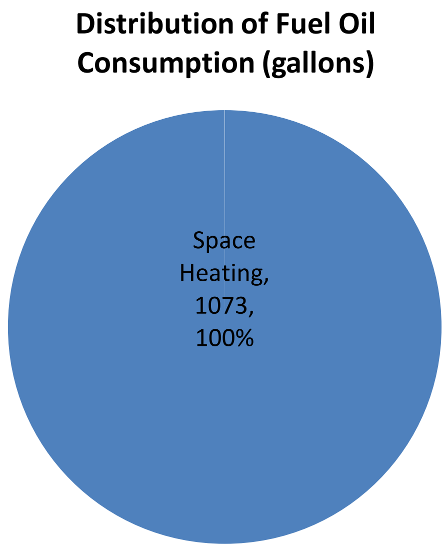
Figure 1.1

Distribution of Electric Consumption (kWh)



[1] If both electric and oil consumption data were available, the AkWarm-C model would normally be calibrated to these figures resulting in more accurate savings projections.

Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on space heating and lighting. Plug loads are primarily shop equipment, and no related EEMs are anticipated.

1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

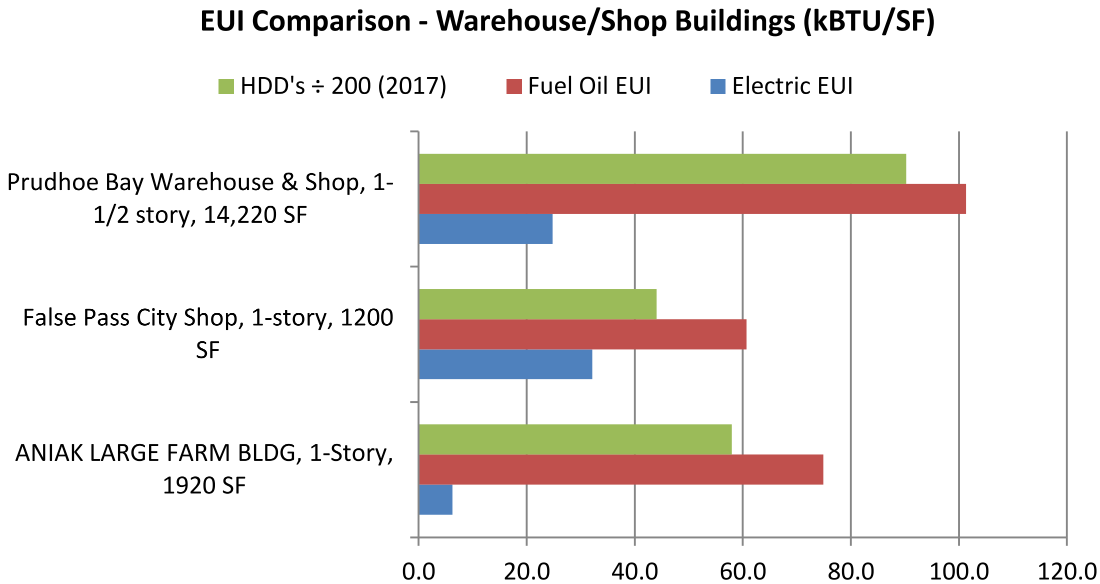
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	83.4	6.50	$4.28
With Proposed Retrofits	37.3	2.91	$2.05
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy 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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric energy utilization indexes (EUIs) are compared to similar use buildings in the region in the bar chart below. The Heating Degree Days[2] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart the heating EUI of all three buildings closely parallel the number of HDDs in their region, as they should, so the heating EUI of this building - as it is modeled in AkWarm-C - is as expected. The Electric EUI of this building is considerably lower than the other two comparison buildings. This

[2] HDD's are a measure of the severity of cold weather; higher HDD's indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDD's.

is also expected given that 60% of it is used as cold storage with no electric consumption and the shop portion has low use and occupancy. Additional discussion is provided in Appendix B.



1.6 Energy Efficiency Measures

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3, and Figure 1.4 shows the reduction in cost, consumption and BTUs of electricity and fuel oil if all recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
Envelope	$10,189	$2,793	3.6
Setback Thermostat	$300	$767	0.4
Lighting	$1,850	$741	2.5
Totals	**$12,339**	**$4,301**	**2.9**

Figure 1.4

	Existing conditions - modeled		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	3,532	12,055	2,451	8,365	30.6%
Gallons Oil	1,073	141,636	466	61,512	56.6%
Energy Cost	$8,222		$3,942		52.1%

Table 1.1 below and Table 4.1 later in this document, summarize the energy efficiency measures analyzed for the Small Farm Building. Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM.

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	Lighting - Power Retrofit: Exterior Incan A-type	Replace with 2 LED 9W Module StdElectronic	$258 / 1.5 MMBTU	$10	217.03	0.0	730.2
2	Setback Thermostat: West side, Insulated	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the West side, Insulated space.	$767 / 18.4 MMBTU	$300	34.62	0.4	2,965.1
3	West side wall bordering the uninsulated east side	Install R-19 insulation	$1,421 / 34.2 MMBTU	$2,480	13.56	1.7	5,497.2
4	Lighting - Power Retrofit: East wing T12-2 96"	Replace with 2 LED (2) 15W Module StdElectronic	$132 + $5 Maint. Savings / 0.8 MMBTU	$200	5.79	1.5	375.0
5	Air Tightening	Perform air sealing to reduce air leakage by 50%.	$807 / 19.4 MMBTU	$2,000	3.75	2.5	3,120.2
6	West side insulated walls	Add R-19 insulation to existing insulation	$365 / 8.8 MMBTU	$3,210	2.69	8.8	1,412.6
7	West side ceiling	Add R-19 to existing insulation.	$200 / 4.8 MMBTU	$2,499	1.89	12.5	772.9
8	Lighting - Power Retrofit: West wing T12-2 96"	Replace with 6 LED (2) 15W Module StdElectronic	$331 + $15 Maint. Savings / 0.7 MMBTU	$1,640	1.74	4.7	870.5
	TOTAL, all measures		**$4,281 + $20 Maint. Savings / 88.4 MMBTU**	**$12,340**	**5.76**	**2.9**	**15,743.7**

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.

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 existing building. 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. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate								
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$6,174	$0	$0	$0	$1,166	$883	$0	**$8,222**
With Proposed Retrofits	$2,680	$0	$0	$0	$378	$883	$0	**$3,942**
Savings	$3,494	$0	$0	$0	$787	$0	$0	**$4,281**

1.7 Energy Conservation Measures (ECMs)

No and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called “avoided costs” rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring.** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC “performance drift” is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.

   There is a range of simple to very complex building monitoring systems commercially available, and most utilize a user-friendly internet or network-based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

ARIS - The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owner's track and manage energy use and costs. For more information contact Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us)

BMON - AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings, and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

Monnit – "product model" sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPTION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures, is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas and/or oil	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.

4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Weather-stripping should be maintained if it exists or added if it does not.

5) **Turn off plug loads** including shop equipment, computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves their desk, add

an occupancy sensing plug load management device (PLMD) like the "Isole IDP 3050" power strip produced by Wattstopper. (See Appendix J)

6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans and thermostats in this building. An unmaintained HVAC component like a boiler can reduce operating efficiency by 3% or more.

7) **Additional ECM recommendations**:
    a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.
    b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.
    c. Keep heating coils in air handlers, unit heaters and fan coil units clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Large Farm Building. 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 including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager, if possible, to understand their objectives and ownership strategy and to gather other information the auditor could use to make the audit most useful. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment including refrigeration equipment
- Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and energy management programs (if they exist) provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from Large Farm Building enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building". The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model
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, adding any HVAC systems, ventilation and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat) and the hours of operation of the building.

Large Farm Building is classified as being made up of the following activity areas:

1) West side, Insulated: 705 square feet
2) East side, Uninsulated: 1,215 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model was calibrated to actual fuel consumption and was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions.

Limitations of AkWarm© Models
The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly, on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis
Our analysis provides a number of tools for assessing the cost effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions, and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the projected life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIRs and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR>=1 to be considered financially viable on a stand-alone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. <u>Costs are considered to be accurate within +/-30% in this level of audit;</u> they are derived from Means

Cost Data, industry publications, the auditor's experience, and/or local contractors and equipment suppliers.

Interactive effects of EEMs:
It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases, lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in others, negatively. If all EEMs are implemented, their order of implementation is irrelevant, because the total savings after full implementation will be unchanged. If an EEM is calculated outside of the AkWarm© model, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:
The underlying assumptions used in the calculations made in this audit follow:

- 3,413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs, or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline, shall accept full responsibility and liability for the design, engineering and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects is not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. LARGE FARM BUILDING EXISTING CONDITIONS

3.1. Building Description

The 1,920 square foot Large Farm Building was constructed around the year 2000. The east 2/3 of the building is used as cold storage and the west 1/3 was used as a shop at one time, but is also now used as cold storage. The owner would like to re-consider using the west 1/3 as a shop in the future. In light of this, the building was modeled in AkWarm-C as operating for 4 hours per day Monday through Friday, with the west portion having 2 occupants and the east portion having 1 occupant.

Description of Building Shell

The walls and roof of this building are fabricated steel constructed over a dirt floor. The walls and ceiling of the west portion of the building has “bag insulation” with an estimated insulation value of R-11. The bag insulation, as is typical, is pinched between the steel structural members and the exterior siding, reducing its insulation value. The east wall of the west wing is a metal divider and is uninsulated. The interior walls are unfinished and the exterior siding is painted metal. There are no windows but there are four panels of clear plastic siding providing ambient light in the east wing, two metal exit doors, both in poor condition, and two overhead sectional doors also in poor condition. The overhead doors had a layer of rigid foam installed on their inside surface (photo at right), but it is in very poor condition and provides little or no insulation value. The painted metal roof is supported by the structural steel beams and also has bag insulation in the west wing. In general, the building’s envelope is in poor condition.

Description of Heating and Cooling Plants

There is currently no heat in the building, this heat plant is proposed in order to utilize the west wing as a shop.

Oil fired unit heater

Nameplate Information:	Modine POR100 or equivalent
Fuel Type:	#2 Oil
Input Rating:	119,000 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	There is currently no heat. The Modine heater specified here should suffice.

Space Heating and Cooling Distribution Systems

There is no existing or proposed distribution system.

Building Ventilation System
There is no existing or proposed mechanical ventilation.

Domestic Hot Water System
There is no plumbing in this building.

Lighting
The interior lighting consists of 96" fixtures utilizing T12 lamps and magnetic ballasts. Exterior lighting consists of surface mounted fixtures utilizing A-type incandescent bulbs.

Major Equipment and Plug Loads
A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis to match the actual, baseline electric data and after calibration, the AkWarm© model predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

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 as predicted by the AkWarm-C model. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The utility companies providing energy to the subject building, and the class of service provided by each, are listed below:

Electricity: Aniak Light & Power - 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	$ 0.6000/kWh
#2 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or from invoices, which also included customer charges, service charges, energy costs, and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically gallons delivered, not gallons consumed. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $8,222 annually for electricity and other fuel costs for the Large Farm Building.

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

Figure 3.1
Annual Energy Costs by End Use

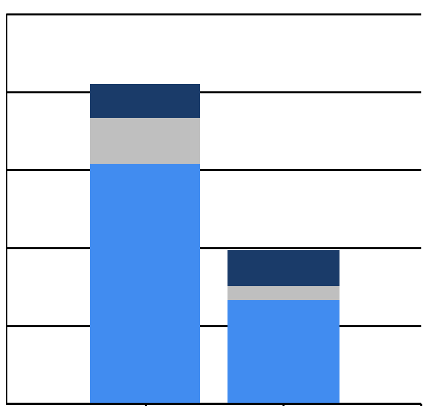


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

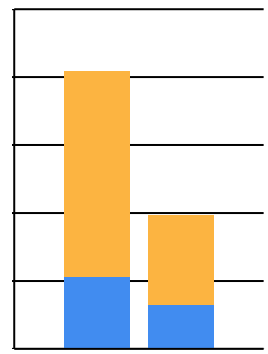
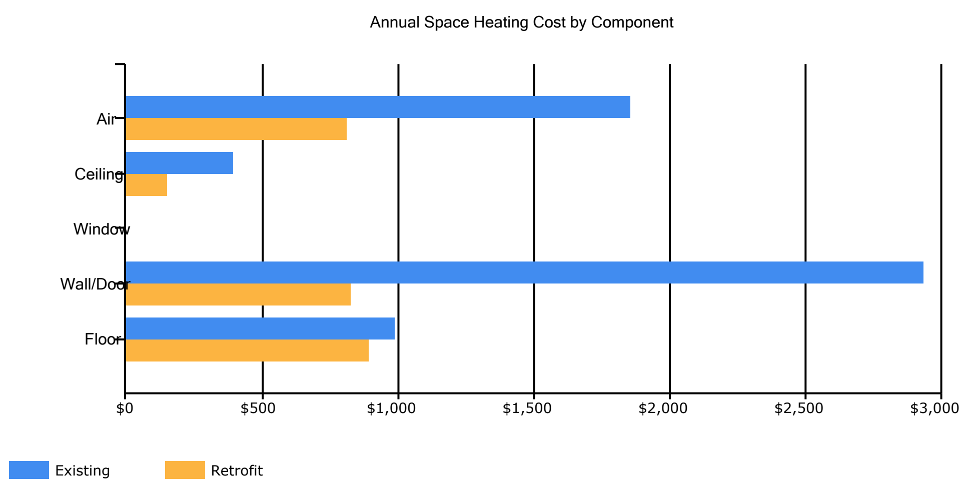


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Figure 3.3
Annual Space Heating Cost by Component



The tables below show the model'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	27	19	16	6	0	0	0	0	0	7	18	26
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	165	150	165	160	165	160	165	165	160	165	160	165
Other_Electrical	125	114	125	121	125	121	125	125	121	125	121	125

Fuel Oil #2 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	241	165	141	53	4	3	3	3	4	68	159	229
DHW	0	0	0	0	0	0	0	0	0	0	0	0

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building.
It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUIs are calculated by converting all the energy consumed by a building in one year to BTUs and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy." Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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, and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{\text{Electric Usage in kBtu + Gas Usage in kBtu + similar for other fuels}}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{\text{Electric Usage in kBtu X SS Ratio + Gas Usage in kBtu X SS Ratio + similar for other fuels}}{\text{Building Square Footage}}$$

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

Table 3.4
Large Farm Building EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	3,532 kWh	12,056	3.340	40,266
#2 Oil	1,073 gallons	148,019	1.010	149,499
Total		**160,075**		**189,765**
BUILDING AREA		1,920	Square Feet	
BUILDING SITE EUI		83	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		99	**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	**83.4**	**6.50**	**$4.28**
With Proposed Retrofits	**37.3**	**2.91**	**$2.05**
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.**			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C.

Table 4.1
Large Farm Building, Aniak, 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	Lighting - Power Retrofit: Exterior Incan A-type	Replace with 2 LED 9W Module StdElectronic	$258 / 1.5 MMBTU	$10	217.03	0.0	730.2
2	Setback Thermostat: West side, Insulated	Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the West side, Insulated space.	$767 / 18.4 MMBTU	$300	34.62	0.4	2,965.1
3	West side wall bordering the uninsulated east side	Install R-19 insulation	$1,421 / 34.2 MMBTU	$2,480	13.56	1.7	5,497.2
4	Lighting - Power Retrofit: East wing T12-2 96"	Replace with 2 LED (2) 15W Module StdElectronic	$132 + $5 Maint. Savings / 0.8 MMBTU	$200	5.79	1.5	375.0
5	Air Tightening	Perform air sealing to reduce air leakage by 50%.	$807 / 19.4 MMBTU	$2,000	3.75	2.5	3,120.2
6	West side insulated walls	Add R-19 insulation to existing insulation	$365 / 8.8 MMBTU	$3,210	2.69	8.8	1,412.6
7	West side ceiling	Add R-19 to existing insulation.	$200 / 4.8 MMBTU	$2,499	1.89	12.5	772.9
8	Lighting - Power Retrofit: West wing T12-2 96"	Replace with 6 LED (2) 15W Module StdElectronic	$331 + $15 Maint. Savings / 0.7 MMBTU	$1,640	1.74	4.7	870.5
	TOTAL, all measures		**$4,281 + $20 Maint. Savings / 88.4 MMBTU**	**$12,340**	**5.76**	**2.9**	**15,743.7**

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 effects 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 Insulation Measures

Rank	Location	Existing Type/R-Value	Recommendation Type/R-Value
3	West side wall bordering the uninsulated east side	Wall Type: Stressed Skin Panel Siding Configuration: Just Siding Panel Insulation: None Insulation Quality: Very Damaged Modeled R-Value: 1.8	Install R-19 insulation

Installation Cost	$2,480	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$1,421
Breakeven Cost	$33,622	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	34.2 MMBTU
		Savings-to-Investment Ratio	13.6		

Auditors Notes: Add R-19 insulation

Rank	Location	Existing Type/R-Value	Recommendation Type/R-Value
6	West side insulated walls	Wall Type: Single Stud Siding Configuration: Just Siding Insul. Sheathing: None Structural Wall: 2 x 4, 16 inches on center R-11 Batt:FG or RW, 3.5 inches Window and door headers: Not Insulated Modeled R-Value: 10.6	Add R-19 insulation to existing insulation

Installation Cost	$3,210	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$365
Breakeven Cost	$8,640	**Simple Payback (yrs)**	9	**Energy Savings (MMBTU/yr)**	8.8 MMBTU
		Savings-to-Investment Ratio	2.7		

Auditors Notes: Install additional R-19 insulation

Rank	Location	Existing Type/R-Value	Recommendation Type/R-Value
7	West side ceiling	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: R-11 Batt:FG or RW, 3.5 inches Bottom Insulation Layer: None Top Insulation Layer: None Insulation Quality: Damaged Modeled R-Value: 13.2	Add R-19 insulation to existing insulation.

Installation Cost	$2,499	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$200
Breakeven Cost	$4,727	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	4.8 MMBTU
		Savings-to-Investment Ratio	1.9		

Auditors Notes: Install additional insulation, R-19 minimum.

4.3.2 Window Measures (There were no improvements in this category)

4.3.3 Door Measures (There were no improvements in this category)

4.3.4 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
5			Air Tightness estimated as: 4000 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 50%.	
Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	10		**Energy Savings ($/yr)**	$807
Breakeven Cost	$7,492	**Simple Payback (yrs)**	2		**Energy Savings (MMBTU/yr)**	19.4 MMBTU
		Savings-to-Investment Ratio	3.7			
Auditors Notes:						

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure (There were no improvements in this category)

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

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
2	West side, Insulated			Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the West side, Insulated space.	
Installation Cost	$300	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$767
Breakeven Cost	$10,385	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	18.4 MMBTU
		Savings-to-Investment Ratio	34.6		
Auditors Notes:					

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	
1	Exterior Incan A-type	2 INCAN A Lamp, Std 60W with Manual Switching		Replace with 2 LED 9W Module StdElectronic	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$258
Breakeven Cost	$2,170	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.5 MMBTU
		Savings-to-Investment Ratio	217.0		
Auditors Notes: Replace (2) 60w A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
4	East wing T12-2 96"	FLUOR (2) T12 8' F96T12 75W Standard Magnetic with Manual Switching		Replace with 2 LED (2) 15W Module StdElectronic	
Installation Cost	$200	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$132
Breakeven Cost	$1,157	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	5.8	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Replace (1) 96" T12 fixtures with (2) 48" LED fixtures, estimate $100/fixture; labor included in west side EEM. $5/fixture maintenance savings.					

Rank	Location	Existing Condition		Recommendation	
8	West wing T12-2 96"	6 FLUOR (2) T12 8' F96T12 75W Standard Magnetic with Manual Switching		Replace with 6 LED (2) 15W Module StdElectronic	
Installation Cost	$1,640	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$331
Breakeven Cost	$2,861	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.7 MMBTU
		Savings-to-Investment Ratio	1.7	**Maintenance Savings ($/yr)**	$15
Auditors Notes: Replace (3) 96" T12 fixtures with (6) 48" LED fixtures, estimate $100/fixture plus 12 hrs total labor @ $45/hr plus $500 man-lift rental. Maintenance savings of $5/fixture.					

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

There is no functional equipment in this building, other than what is stored.

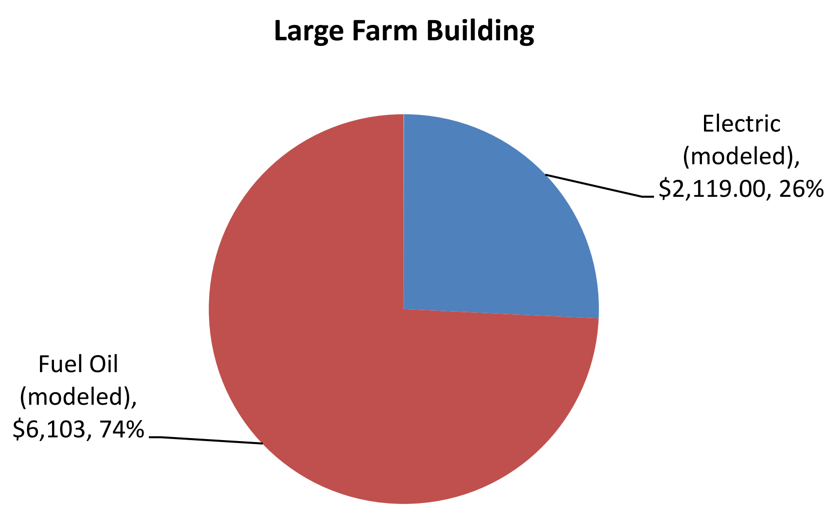
Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies and irregularities which may provide insight regarding the building's function and efficiency. 36 months of historical data is usually a sufficient period of time to gain an understanding of the building operation. As previously mentioned, no electric or fuel oil consumption or delivery data was provided for this building and its use and occupancy is expected to change. Consequently, the AkWarm-C predicted figures become the baseline and only they are shown in this Appendix. Figures B.1 and B.2 show the predicted electric and fuel oil consumption and costs for this facility.

Figure B.1 – Total PREDICTED Building Energy Consumption and Costs

LARGE FARM BUILDING - (no PCE)							
	Elec. Consumption (kWh) predicted by AkWarm-C	Electric Cost	Fuel Oil use (predicted by AkWarm-C) - gallons	Fuel oil Cost	Total kBTUs of Energy	Total Utility Cost
Modeled	3,532	$2,119.00	1,073	$6,103	141,636	$8,222

Figure B.2 – PREDICTED Costs

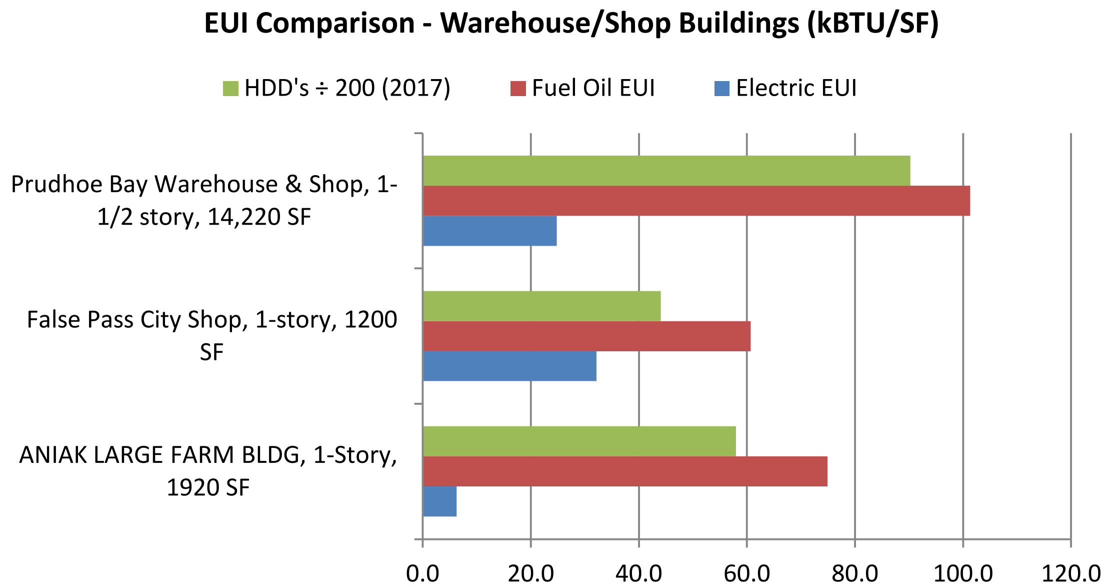


Electricity: Because no oil electric consumption data was provided, no benchmarking can be performed on this building.

Fuel Oil: Because no oil delivery data was provided, no benchmarking can be performed on this building.

Comparing EUIs: Figure B.3 and the discussion in Section 1.5 above show that this building, as modeled in AkWarm-C, falls within expectations with regards to its existing heating efficiency and very low with its electric EUI. As mentioned in Section 1.5, the low electric EUI is attributed to the modeled buildings low use and occupancy and the fact that only 1/3 of it has electric loads other than basic lighting.

Figure B.3 – EUIs



There is no historical baseline period for this building. As stated, its use and occupancy are in flux, so the benchmark baseline selected for this building is the electric and fuel oil predictions made by the AkWarm-C model shown in Figure B.1 above.

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering (if required) and construction management costs are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit, and are derived from and one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- Local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified Electrician $125/hr

This level of work includes changing street light heads, light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work $ 45/hr

Includes installing switch-mounted occupancy sensors which do not require re-wire or pulling additional wires, weather-stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work $125/hr

Work includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities $45/hr

Includes maintaining light fixtures, door and window weather-stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

ENERGY AUDIT REPORT – PROJECT SUMMARY

General Project Information

PROJECT INFORMATION	AUDITOR INFORMATION
Building: Large Farm Building	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak **Client Name:** Laura Simeon	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350 **Auditor FAX:**
Client Phone: (907) 675-4349 **Client FAX:**	**Auditor Comment:**

Design Data

Building Area: 1,920 square feet	**Design Space Heating Load:** Design Loss at Space: 63,938 Btu/hour with Distribution Losses: 63,938 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 97,467 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 3 people	**Design Indoor Temperature:** 42.3 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days

Utility Information

Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.600/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

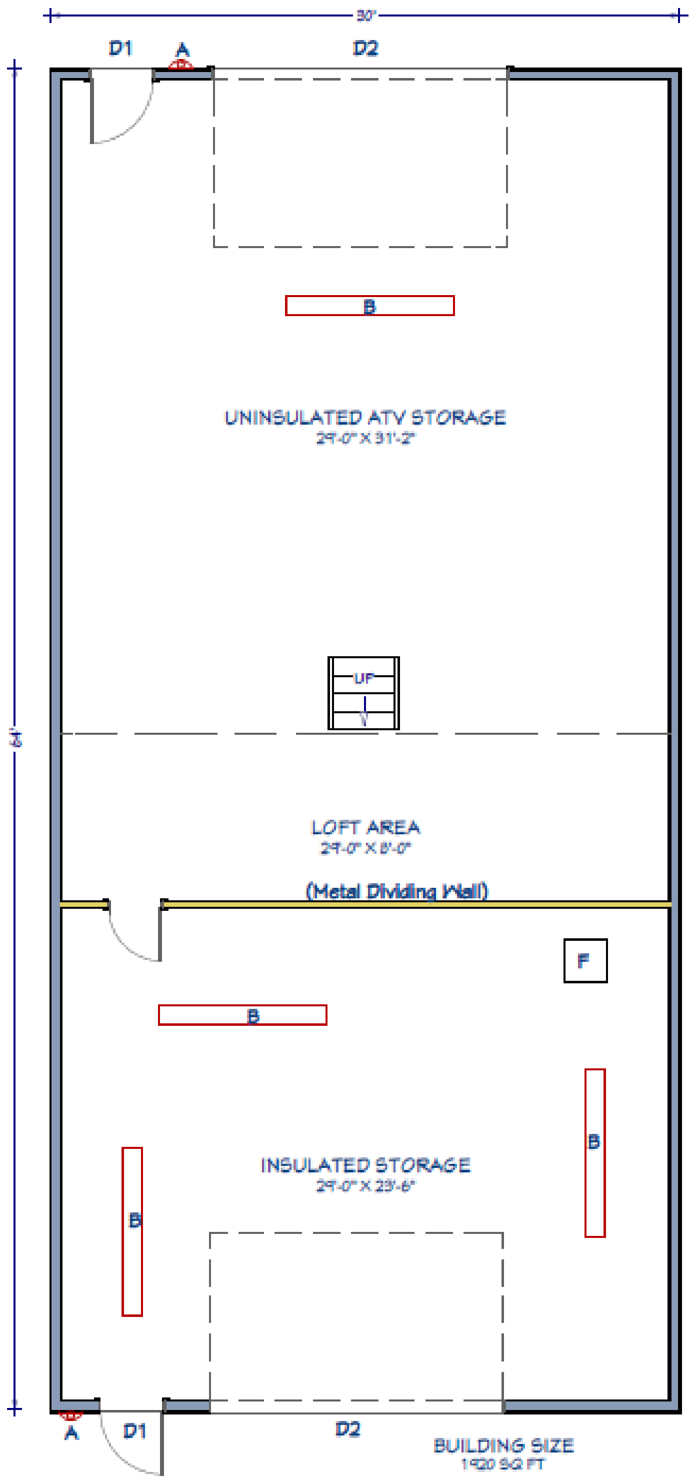
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Service Fees	Total Cost
Existing Building	$6,174	$0	$0	$0	$1,166	$883	$0	**$8,222**
With Proposed Retrofits	$2,680	$0	$0	$0	$378	$883	$0	**$3,942**
Savings	$3,494	$0	$0	$0	$787	$0	$0	**$4,281**

Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	83.4	6.50	$4.28
With Proposed Retrofits	37.3	2.91	$2.05

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.

BUILDING SCHEMATICS



Legend

Doors	
D1	Metal Exit
D2	14' Metal Overhead Rollup (Insulated)
Lighting	
A	Incandescant, A-type, 1 bulb
B	T12-2 lamps x 96" Strip
HVAC	
F	Furnace (not in use)
Other	
Foundation	none, Dirt Floor
Siding	Metal
Walls	Structural Steel Shell
Roof	Metal
Ceiling	Outside 15' on side, 17.5' at peak

N

Aniak KNA Large Farm Building (Tan)
Floor, Lighting & HVAC Plan
1/8" = 1' 1.18.18

Appendix E – Photographs & IR Images

East entry

West portion of the building, bag insulation on walls and ceiling are shown

Shop bench area in west wing

Overhead door in east wing, and clear plastic siding allowing ambient light into the building

Overhead door insulation in very poor condition

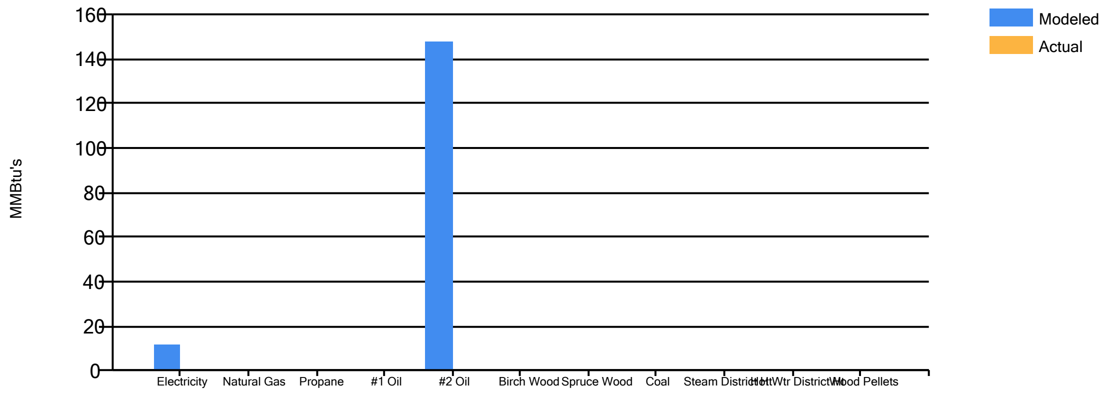
Mezzanine in east wing

WHEN A BUILDING IS NOT HEATED THERE IS INSUFFICIENT TEMPERATURE DIFFERENCE BETWEEN INTERIOR AND EXTERIOR SPACES AND THERE IS NO VALUE TO BE OBTAINED FROM IR IMAGES.

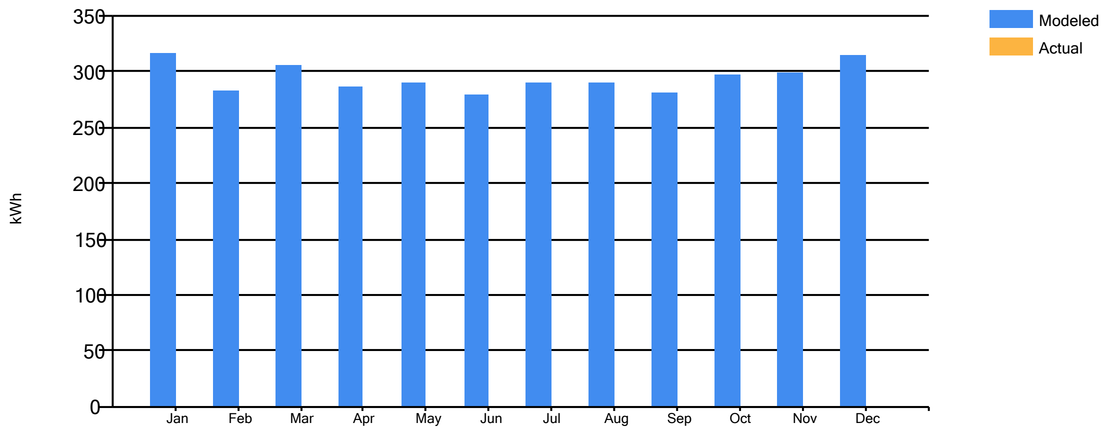
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

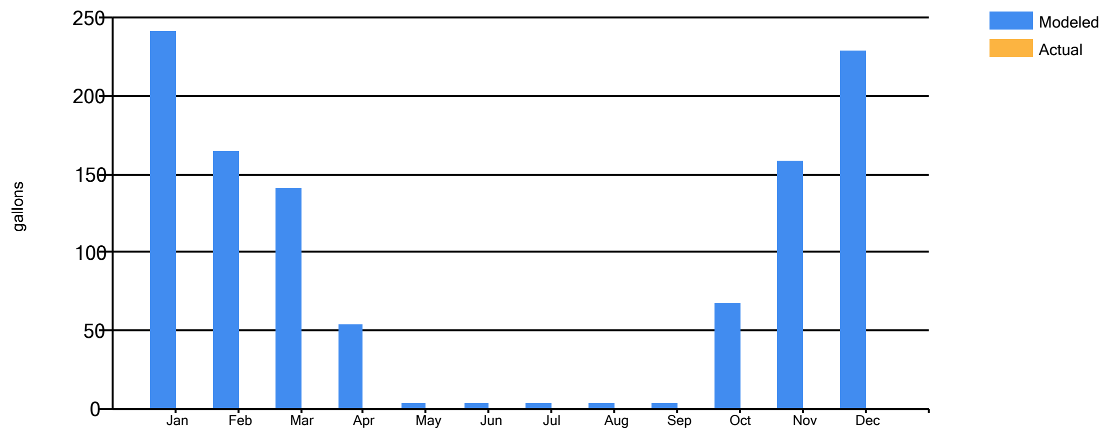
Annual Fuel Use



Electricity Fuel Use



#2 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
CFM	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OSA	Outside Air
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECMs, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

Comprehensive Energy Audit
For the Aniak Small Farm building

Prepared For

Native Village of Aniak
Laura Simeon, Tribal Administrator
P.O. Box 349
Aniak, AK 99557
aniaktribe@gmail.com
907-675-4349

Site Survey Date:

January 18, 2018

Prepared By:
James Fowler, PE, CEM
Energy Audits of Alaska
200 W 34th Ave, Suite 1018
Anchorage, AK 99503
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Energy Audits of Alaska

Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 24, 2018
New Release – September 15, 2018

Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (EEMs), estimate the value of the savings, and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that the recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of heating, ventilation and air-conditioning (HVAC) systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the ASHRAE definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy and electric usage, and the U.S. Department of Energy Office of Indian Energy who provided funding.

Project Location

NORTH

Subject Building

Building contact:
Laura Simeon
Tribal Administrator
907-675-4349
aniaktribe@gmail.com

1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the Small Farm building. The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and any process and plug loads. There are no charges for water and wastewater and these systems were not evaluated in this analysis.

The site survey took place on January 18, 2018. The outside temperature ranged from 20F and 28F and there was snow on the ground and on rooftops.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy consuming equipment, identify technically and economically feasible energy efficiency measures (EEMs) for existing equipment, and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The ECMs identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The "avoided costs" resulting from energy conservation measures (ECMs) are discussed in Section 1.7, but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 13-page summary contains all the information the building owner/operator should need to determine which energy improvements should be implemented and approximately how much they will cost and their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

Sections 2, 3, and 4 of this report and the Appendices, are back-up and provide much more detailed information should the owner/operator or staff desire to investigate further. Sections 4.3 through 4.5 include additional auditor's notes for many EEMs. Due to their length, Appendices H, I, and J, which contain additional ECM detail, lighting information and manufacturer's "cut sheets" of samples of recommended retrofit products, are included as a separate document.

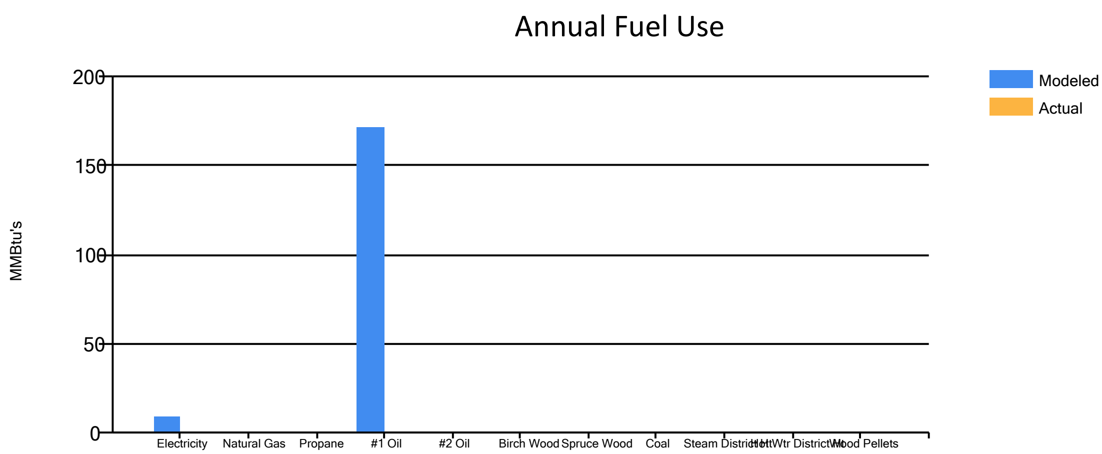
<u>Issues that the auditor feels are of particular importance to the reader are underlined</u> and all abbreviations and acronyms used in this document are listed in Appendix G.

1.2 Noteworthy Points & Immediate Action

a. This building is currently vacant and does not have heat or electric service. At some time in the near future, the owner is considering renovating it for use as a shop. Consequently, there is no historical baseline period of energy consumption representing this building in its future use and occupancy. Furthermore, with no electric service or heat, no electric or fuel oil use data could be provided by the owner. In order to provide the owner with realistic estimates of energy savings for this building used as a shop, the AkWarm-C model was created using the following assumptions:

- Occupied for 4 hours/day Monday through Friday
- 1 occupants
- Typical plug and electric loads for a low-use shop building

As a result of these assumptions, and as seen in the bar chart below (from Appendix F), neither the electrical or fuel oil consumption figures in the AkWarm-C model are calibrated to actual figures. The electric and fuel oil use figures predicted by the AkWarm-C model are used in this analysis unless specifically stated otherwise.



b. If all the recommended EEMs are incorporated in this building, there will be a 65.2% reduction in energy costs, totaling $5,829, with a simple payback of 2.2 years on the $12,814 implementation cost.

c. It was assumed in this analysis that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity. It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician.

d. It was also assumed that envelope improvements such as adding insulation, installing windows, and replacing doors would be performed by Tribal Staff members. A labor rate of $45/hr was also used for these activities.

1.3 Current Cost and Breakdown of Energy

Based on electricity and fuel oil prices in effect at the time of the audit, and using the uncalibrated AkWarm-C© energy model[1], the total predicted energy costs are $8,941 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

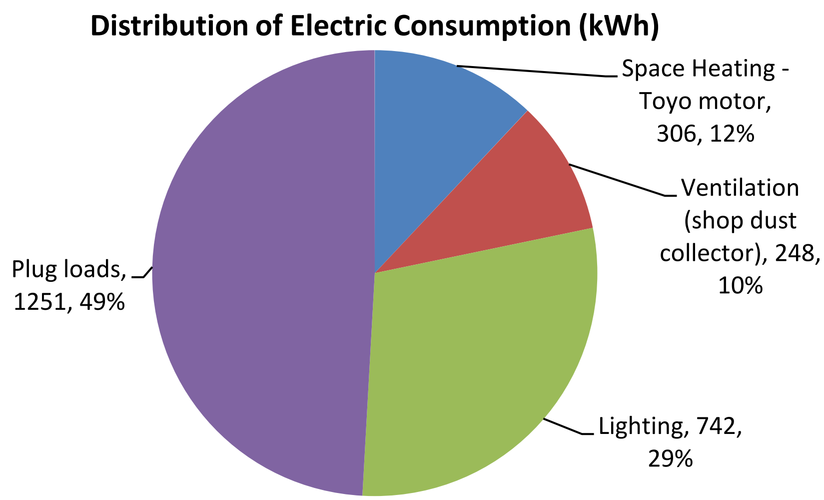
$1,548 for Electricity
$7,393 for #1 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	2,580 kWh	1,919 kWh
#1 Oil	1,299 gallons	344 gallons

The table below shows the relative costs per MMBTU for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

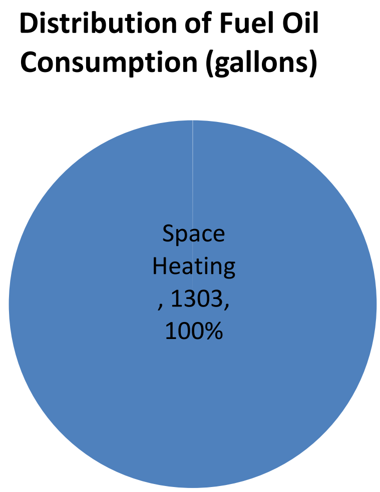
	Unit Cost	Cost/MMBTU
Electricity	$0.60	$175.80
Fuel Oil	$5.69	$43.10

Figure 1.1



[1] If both electric and oil consumption data were available, the AkWarm-C model would normally be calibrated to these figures resulting in more accurate savings projections.

Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on space heating and lighting. Plug loads are primarily shop equipment, and no related EEMs are anticipated.

1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

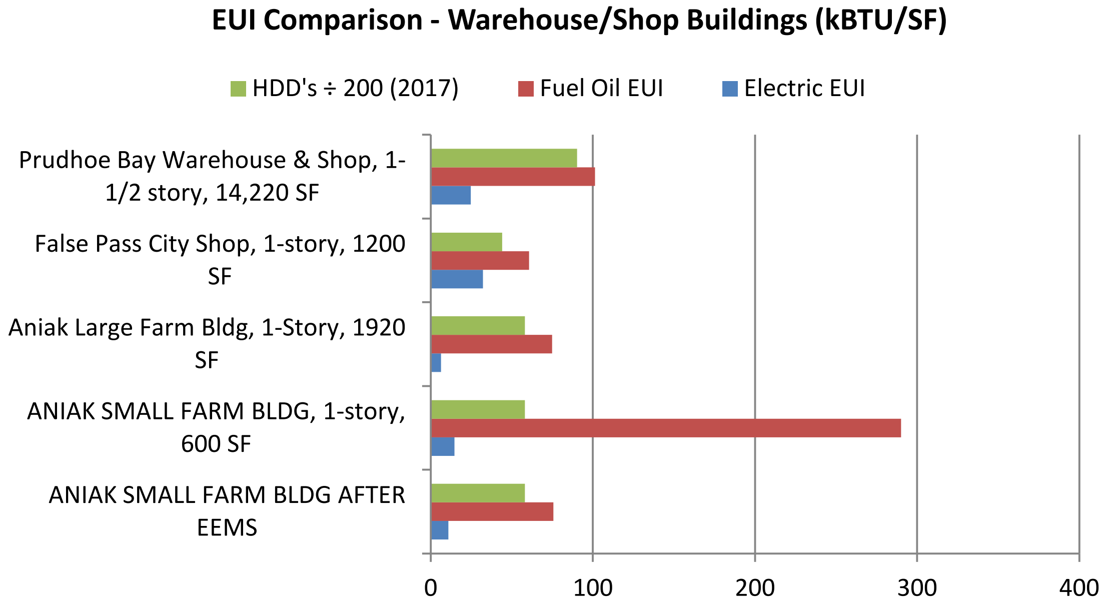
Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	300.5	23.42	$14.90
With Proposed Retrofits	86.7	6.76	$5.19
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy 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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric energy utilization indexes (EUIs) are compared to similar use buildings in the region in the bar chart below. The Heating Degree Days[2] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart the heating EUI of the three comparison buildings closely parallel the number of HDDs in their region, as they should, while the heating EUI of the subject building is four times higher than expected. This is attributed to the very poor condition of the envelope and its lack of insulation. After implementation of the envelope EEMs, the subject building's heating EUI falls into line with the other buildings and the HDDs in its region. The Electric EUI of this building

[2] HDDs are a measure of the severity of cold weather; higher HDDs indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDDs.

falls within expectations considering its use and occupancy. Additional discussion is provided in Appendix B.



1.6 Energy Efficiency Measures

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3, and Figure 1.4 shows the reduction in cost, consumption and BTUs of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
Envelope Improvements	$10,617	$4,681	2.3
Setback Thermostat	$1	$914	0.0
Lighting	$2,196	$233	9.4
Totals	**$12,814**	**$5,828**	**2.2**

Figure 1.4

	Existing conditions - modeled		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	2,580	8,806	1,919	6,550	25.6%
Gallons Oil	1,299	171,468	344	45,408	73.5%
Energy Cost	$8,941		$3,112		65.2%

Table 1.1 below and Table 4.1 later in this document summarize the energy efficiency measures analyzed for the Small Farm building. Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM. The $1 cost in Tables 1.1 and 4.1 represent the owner or staff performing the programming at no cost; AkWarm-C does not allow a $0 dollar cost entry.

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	Setback Thermostat: Small Farm Bldg	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Small Farm Bldg space.	$914 / 20.8 MMBTU	$1	12366.65	0.0	3,374.4
2	Attic insulation	Install insulation in 2x12 stud cavity with R-38 fiberglass batts	$2,728 / 62.1 MMBTU	$3,441	18.71	1.3	10,068.4
3	Walls	Install R-21 fiberglass batts in 2x6 wall, install vapor barrier, finish interior walls	$1,322 / 30.1 MMBTU	$2,067	15.10	1.6	4,878.3
4	Lighting - Combined Retrofit: Exterior CFL lighting	Replace with 2 LED (2) 12W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	$133 / 0.8 MMBTU	$236	4.75	1.8	377.4
5	Entry doors	Install standard pre-hung U-0.16 insulated door.	$300 / 6.8 MMBTU	$1,519	4.66	5.1	1,106.3
6	2 windows	Install window with triple pane, 2 low-E, argon window.	$331 / 7.5 MMBTU	$3,590	1.60	10.8	1,223.3
	TOTAL, cost-effective measures		**$5,729 / 128.2 MMBTU**	**$10,854**	**11.23**	**1.9**	**21,028.1**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
7	Lighting - Power Retrofit: 48" T8 Florescent fixtures	Replace with 8 LED (2) 15W Module StdElectronic	$100 / 0.1 MMBTU	$1,960	0.48	19.6	259.4
	TOTAL, all measures		**$5,829 / 128.3 MMBTU**	**$12,814**	**9.59**	**2.2**	**21,287.4**

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.

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 existing building. The second row shows the expected breakdown of energy cost for the building assuming all the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate								
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$7,595	$0	$0	$148	$446	$751	$0	**$8,941**
With Proposed Retrofits	$2,027	$0	$0	$148	$185	$751	$0	**$3,112**
Savings	$5,568	$0	$0	$0	$261	$0	$0	**$5,829**

1.7 Energy Conservation Measures (ECMs)

No and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called <u>“avoided costs”</u> rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring-** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC “performance drift” is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. <u>It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.</u>

   There is a range of simple to very complex building monitoring systems commercially available, and most utilize a user-friendly internet or network-based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

   ARIS–The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owner’s track and manage energy use and costs. For more information contact

Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us).

BMON–AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

Monnit–These "product model" sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures, is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas and/or oil	
Re-program Toyo stoves after a power outage	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.

4) **Air Infiltration:** All entry and roll-up doors and windows should be properly maintained and adjusted to close and function properly. Weather-stripping should be maintained if it exists or added if it does not.

5) **Turn off plug loads** including shop equipment, computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves the desk, add

an occupancy sensing plug load management device (PLMD) like the “Isole IDP 3050” power strip produced by Wattstopper. (See Appendix J)

6) **HVAC Maintenance** should be performed annually to ensure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans, and thermostats in this building. An unmaintained HVAC component like a boiler can reduce operating efficiency by 3% or more.

7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone and turn down the heat and turn off lighting in that zone.

8) **Additional ECM recommendations**:

    a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes, and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.

    b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.

    c. Keep heating coils in air handlers, unit heaters, and fan coil units clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Small Farm building. 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 including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager–if possible–to understand their objectives and ownership strategy and gather other information to make the audit most useful. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)

• Lighting systems and controls
• Building-specific equipment including refrigeration equipment
• Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and energy management programs (if they exist) provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from the Small Farm building enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building." The analysis involves distinguishing the different fuels used on site and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model

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, adding any HVAC systems, ventilation and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat), and the hours of operation of the building.

The Small Farm building is made up of the following activity areas:

1) Small Farm Bldg: 600 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model was calibrated to actual fuel consumption and was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions.

Limitations of AkWarm© Models

The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis

Our analysis provides a number of tools for assessing the cost effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the projected life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIRs and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR>=1 to be considered financially viable on a stand-alone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. <u>Costs are</u>

considered to be accurate within +/-30% in this level of audit; they are derived from Means Cost Data, industry publications, the auditor's experience and/or local contractors and equipment suppliers.

Interactive effects of EEMs:

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in others negatively. If all EEMs are implemented, their order of implementation is irrelevant, because the total savings after full implementation will be unchanged. If an EEM is calculated outside of the AkWarm© model, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:

The underlying assumptions used in the calculations made in this audit follow:

- 3413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs, or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline, shall accept full responsibility and liability for the design, engineering, and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects is not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. SMALL FARM BUILDING EXISTING CONDITIONS

3.1. Building Description

The 600-square-foot Small Farm building was constructed around the year 1990. The building is currently vacant and unused. The owner would like to consider using the building as a shop in the future, so the building was modeled in AkWarm-C as having an occupancy of 1 person for 4 hours per day Monday through Friday.

Description of Building Shell

This building is constructed on a concrete slab poured on grade. The walls are constructed with 2” x 6” wood studs 16” OC. There is no insulation, vapor barrier, or interior wall finishes and the exterior walls are finished with painted T1-11 plywood siding. There are no windows. The doors consist of T1-11 plywood and part of one is missing. The galvanized metal roof and plywood sheathing are supported by site-fabricated trusses utilizing 2” x 6” lumber (photo at right). It is questionable if the roof trusses will continue to support snow loads after the addition of gypsum or plywood ceiling finishes and insulation; they should be evaluated structurally. At minimum, collar ties should be added to the roof joists to provide some additional structural integrity. In general the building envelope is in very poor condition.

Description of Heating and Cooling Plants

There is currently no heat in the building, this heat plant is proposed in order to utilize the facility as a shop.

Toyotomi Laser 730

Nameplate Information:	Toyotomi Laser 730 or equivalent
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	88 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	40 MBH

Space Heating and Cooling Distribution Systems

There is no existing or proposed distribution system.

Building Ventilation System

There is no existing or proposed mechanical ventilation.

Domestic Hot Water System
There is no plumbing in this building.

Lighting
There is no lighting in the building. The proposed baseline is 48" linear florescent fixtures utilizing 32w T8 lamps. The upgrade is 48" fixtures utilizing 15w LED lamps. The proposed exterior lighting baseline is (2) 2-lamp CFL floods and the upgrade is (2) 2-lamp LED floods with a motion and photocell sensor.

Major Equipment and Plug Loads
A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis to match the actual baseline electric data and after calibration, the AkWarm© model predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

The electric usage profile charts (below) represent 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 as predicted by the AkWarm-C model. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The utility companies providing energy to the subject building and the class of service provided by each are listed below:

Electricity: Aniak Light & Power - 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	$ 0.6000/kWh
#1 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or from invoices, which also included customer charges, service charges, energy costs, and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically gallons delivered, not gallons consumed. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $8,941 annually for electricity and other fuel costs for the Small Farm building.

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

Figure 3.1
Annual Energy Costs by End Use

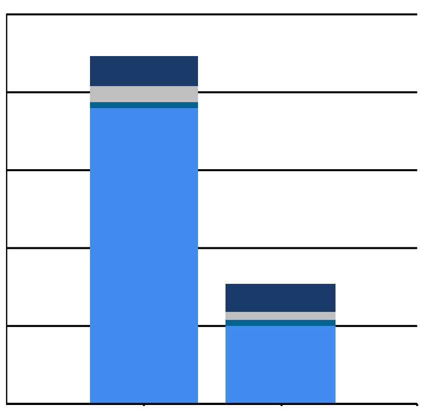


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

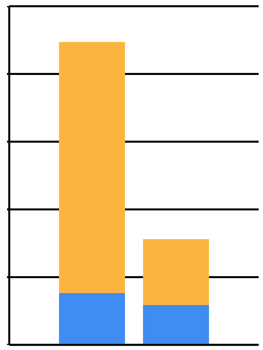
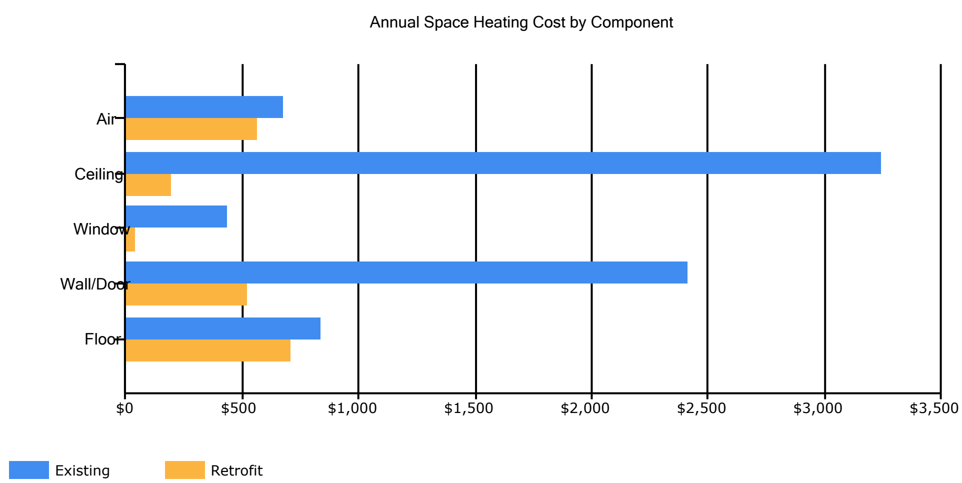


Figure 3.3 below addresses only space heating costs. The figure shows how each heat loss component contributes to those costs; for example, how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the existing building is shown (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 the model'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	53	42	41	28	17	6	4	7	17	31	42	51
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	22	20	22	21	22	21	22	22	21	22	21	12
Lighting	63	57	63	61	63	61	63	63	61	63	61	63
Other_Electrical	106	97	106	103	106	103	106	106	103	106	103	106

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	210	164	158	105	56	23	15	28	57	116	166	200
DHW	0	0	0	0	0	0	0	0	0	0	0	0

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building. It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUIs are calculated by converting all the energy consumed by a building in one year to BTUs and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy." Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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 and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{(\text{Electric Usage in kBtu} + \text{Gas Usage in kBtu} + \text{similar for other fuels})}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{(\text{Electric Usage in kBtu X SS Ratio} + \text{Gas Usage in kBtu X SS Ratio} + \text{similar for other fuels})}{\text{Building Square Footage}}$$

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

Table 3.4
Small Farm building EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	2,580 kWh	8,805	3.340	29,410
#1 Oil	1,299 gallons	171,498	1.010	173,213
Total		**180,303**		**202,622**
BUILDING AREA		600	Square Feet	
BUILDING SITE EUI		301	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		338	**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	**300.5**	**23.42**	**$14.90**
With Proposed Retrofits	**86.7**	**6.76**	**$5.19**
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.**			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C. The $1 cost for EEM #1 represents the owner or staff performing the programming at no cost; AkWarm-C does not allow a $0 dollar cost entry.

Table 4.1
Small Farm building, Aniak, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Setback Thermostat: Small Farm Bldg	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Small Farm Bldg space.	$914 / 20.8 MMBTU	$1	12366.65	0.0	3,374.4
2	Attic insulation	Install insulation in 2x12 stud cavity with R-38 fiberglass batts	$2,728 / 62.1 MMBTU	$3,441	18.71	1.3	10,068.4
3	Walls	Install R-21 fiberglass batts in 2x6 wall, install vapor barrier, finish interior walls	$1,322 / 30.1 MMBTU	$2,067	15.10	1.6	4,878.3
4	Lighting - Combined Retrofit: Exterior CFL lighting	Replace with 2 LED (2) 12W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	$133 / 0.8 MMBTU	$236	4.75	1.8	377.4
5	Entry doors	Install standard pre-hung U-0.16 insulated door.	$300 / 6.8 MMBTU	$1,519	4.66	5.1	1,106.3
6	2 windows	Install window with triple pane, 2 low-E, argon window.	$331 / 7.5 MMBTU	$3,590	1.60	10.8	1,223.3
	TOTAL, cost-effective measures		**$5,729 / 128.2 MMBTU**	**$10,854**	**11.23**	**1.9**	**21,028.1**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
7	Lighting - Power Retrofit: 48" T8 Florescent fixtures	Replace with 8 LED (2) 15W Module StdElectronic	$100 / 0.1 MMBTU	$1,960	0.48	19.6	259.4
	TOTAL, all measures		**$5,829 / 128.3 MMBTU**	**$12,814**	**9.59**	**2.2**	**21,287.4**

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 effects 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 Insulation Measures

Rank	Location	Existing Type/R-Value		Recommendation Type/R-Value	
2	Attic insulation	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: None Bottom Insulation Layer: None Top Insulation Layer: None Modeled R-Value: 2.7		Install insulation in 2x12 stud cavity with R-38 fiberglass batts	
Installation Cost	$3,441	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$2,728
Breakeven Cost	$64,391	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	62.1 MMBTU
		Savings-to-Investment Ratio	18.7		
Auditors Notes: Add R-38 Batt					

Rank	Location	Existing Type/R-Value		Recommendation Type/R-Value	
3	Walls	Wall Type: Single Stud Siding Configuration: Siding and Sheathing Insul. Sheathing: None Structural Wall: 2 x 6, 16 inches on center None Window and door headers: Not Insulated Modeled R-Value: 4.2		Install R-21 fiberglass batts in 2x6 wall, install vapor barrier, finish interior walls	
Installation Cost	$2,067	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$1,322
Breakeven Cost	$31,198	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	30.1 MMBTU
		Savings-to-Investment Ratio	15.1		
Auditors Notes: Add R-21 batt					

4.3.2 Window Measures

Rank	Location	Size/Type, Condition		Recommendation	
6	2 windows	Glass: No glazing - broken, missing Frame: Aluminum, No Thermal Break Spacing Between Layers: Half Inch Gas Fill Type: Air Modeled U-Value: 1.30 Solar Heat Gain Coefficient including Window Coverings: 0.11		Install window with triple pane, 2 low-E, argon window.	
Installation Cost	$3,590	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$331
Breakeven Cost	$5,751	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	7.5 MMBTU
		Savings-to-Investment Ratio	1.6		
Auditors Notes: Frame up openings and fill with 2 windows					

4.3.3 Door Measures

Rank	Location	Size/Type, Condition		Recommendation	
5	Entry doors	Door Type: Entrance, Wood, paneled, 1-3/8" Modeled R-Value: 0.7		Install standard pre-hung U-0.16 insulated door.	
Installation Cost	$1,519	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$300
Breakeven Cost	$7,075	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	6.8 MMBTU
		Savings-to-Investment Ratio	4.7		
Auditors Notes: Replace existing doors with higher insulation value doors					

4.3.4 Air Sealing Measures (There were no improvements in this category)

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure (There were no improvements in this category)

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

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Small Farm Bldg			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Small Farm Bldg space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$914
Breakeven Cost	$12,367	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	20.8 MMBTU
		Savings-to-Investment Ratio	12,366.7		
Auditors Notes:					

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	
4	Exterior CFL lighting	2 FLUOR (2) CFL, Reflector 15W R30 with Manual Switching		Replace with 2 LED (2) 12W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	
Installation Cost	$236	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$133
Breakeven Cost	$1,122	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	4.8		
Auditors Notes: Replace with LED fixtures @ $50/fixture + 3 hrs labor @ $45/hr					

Rank	Location	Existing Condition		Recommendation	
7	48" T8 Florescent fixtures	8 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 8 LED (2) 15W Module StdElectronic	
Installation Cost	$1,960	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$100
Breakeven Cost	$946	**Simple Payback (yrs)**	20	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.5		
Auditors Notes: Replace with LED fixtures @ $200 ea. + 8 hrs labor @ $45/hr					

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

There is no equipment in this building, other than what is stored.

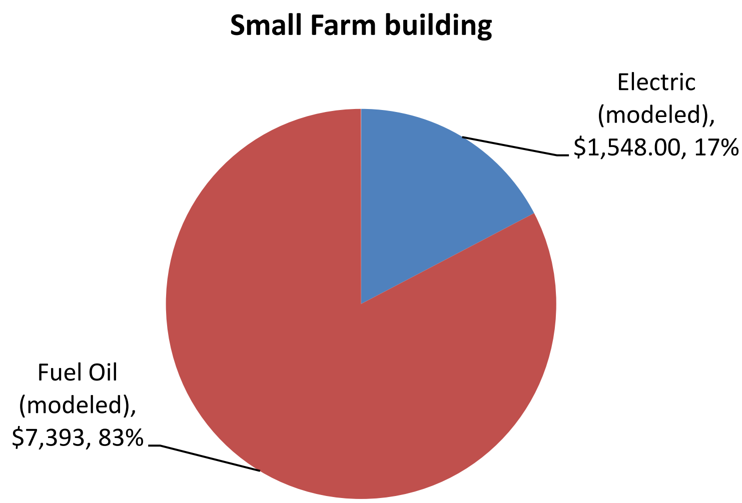
Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies, and irregularities which may provide insight regarding the building's function and efficiency. Thirty-six months of historical data is usually sufficient to gain an understanding of the building operation. As previously mentioned, no electric or fuel oil consumption or delivery data was provided for this building and its use and occupancy is expected to change. Consequently, the AkWarm-C predicted figures become the baseline and only they are shown in this Appendix. Figures B.1 and B.2 show the predicted electric and fuel oil consumption and costs for this facility.

Figure B.1 – Total PREDICTED Building Energy Consumption and Costs

SMALL FARM BUILDING (no electricity)							
	Elec. Consumption (kWh) predicted by AkWarm-C	Electric Cost	Fuel Oil use (predicted by AkWarm-C) - gallons	Fuel oil Cost	Total kBTUs of Energy	Total Utility Cost
Modeled	2,580	$1,548.00	1,299	$7,393	171,468	$8,941

Figure B.2 – PREDICTED Costs

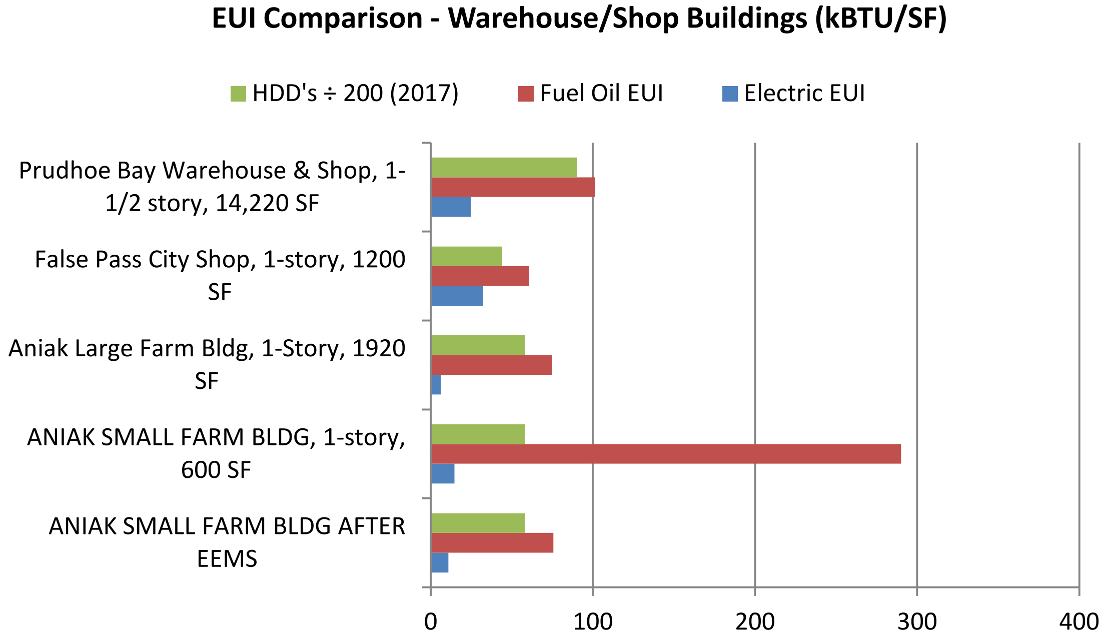


Electricity: Because no oil electric consumption data was provided, no benchmarking can be performed on this building.

Fuel Oil: Because no oil delivery data was provided, no benchmarking can be performed on this building.

Comparing EUIs: Figure B.3 and the discussion in Section 1.5 above show that because it has no envelope insulation, this building - as modeled in AkWarm-C - has an extremely high heating EUI. After implementation of the recommended EEMs, this building's heating EUI falls within expectations and into alignment with the comparison buildings. As mentioned in Section 1.5, the low electric EUI is attributed to the modeled building's low use and occupancy.

Figure B.3 – EUI's



There is no historical baseline period for this building. As stated, its use and occupancy are in flux, so the benchmark baseline selected for this building is the electric and fuel oil predictions made by the AkWarm-C model shown in Figure B.1 above.

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering (if required) and construction management costs are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit, and are derived from and one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- Local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified Electrician **$125/hr**

This level of work includes changing street light heads, light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work **$ 45/hr**

Includes installing switch-mounted occupancy sensors which do not require re-wire or pulling additional wires, weather-stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work **$125/hr**

Work includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities **$45/hr**

Includes maintaining light fixtures, door and window weather-stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

ENERGY AUDIT REPORT – PROJECT SUMMARY

General Project Information

PROJECT INFORMATION	AUDITOR INFORMATION
Building: Small Farm building	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Laura Simeon	
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 675-4349	**Auditor Comment:**
Client FAX:	

Design Data

Building Area: 600 square feet	**Design Space Heating Load:** Design Loss at Space: 146,237 Btu/hour with Distribution Losses: 146,237 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 222,923 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 65 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days

Utility Information

Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.600/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

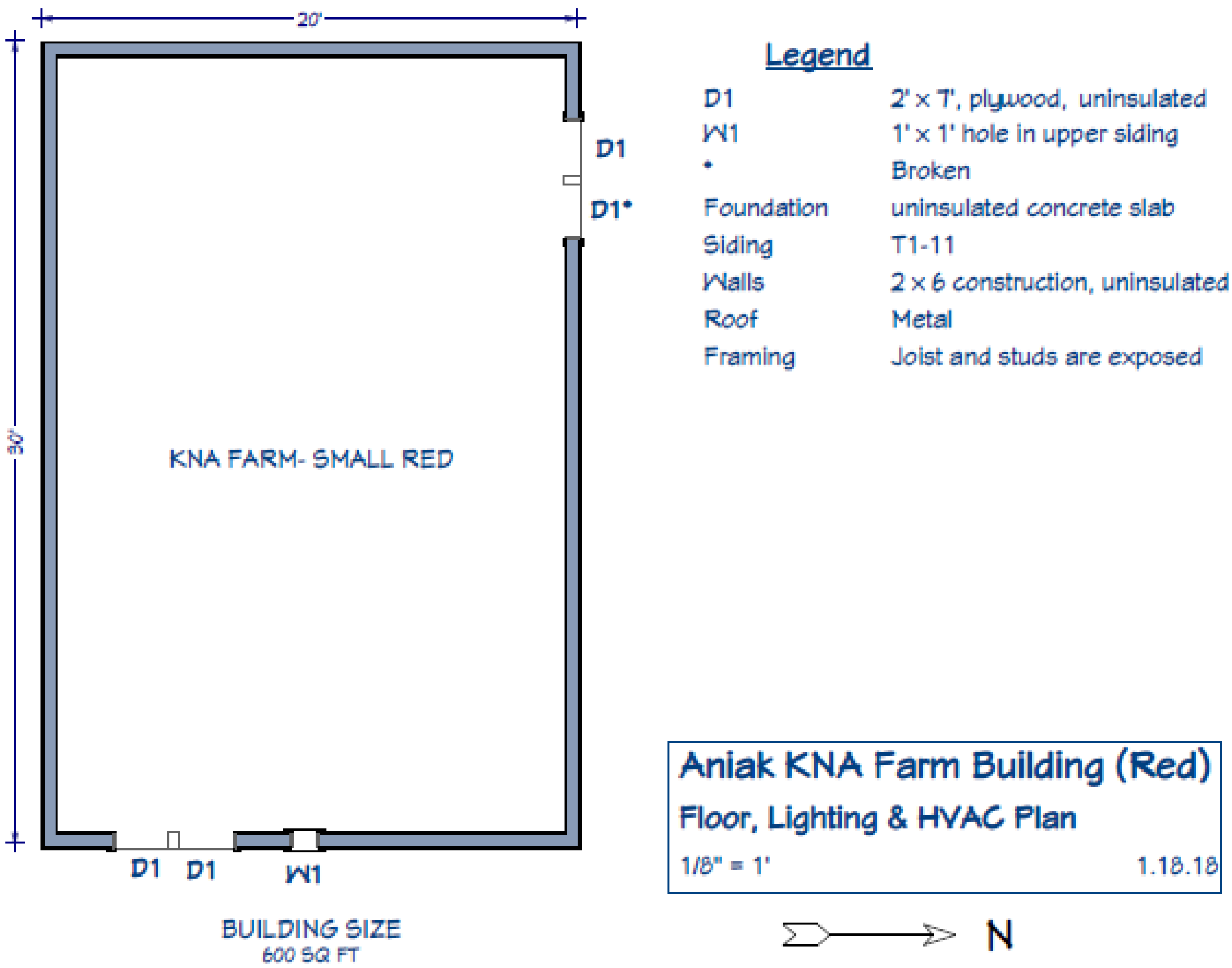
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Service Fees	Total Cost
Existing Building	$7,595	$0	$0	$148	$446	$751	$0	**$8,941**
With Proposed Retrofits	$2,027	$0	$0	$148	$185	$751	$0	**$3,112**
Savings	$5,568	$0	$0	$0	$261	$0	$0	**$5,829**

Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	300.5	23.42	$14.90
With Proposed Retrofits	86.7	6.76	$5.19

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.

BUILDING SCHEMATICS



Appendix E – Photographs & IR Images

Shop area on concrete slab

Walls are in fairly good condition

Most of rear door is missing

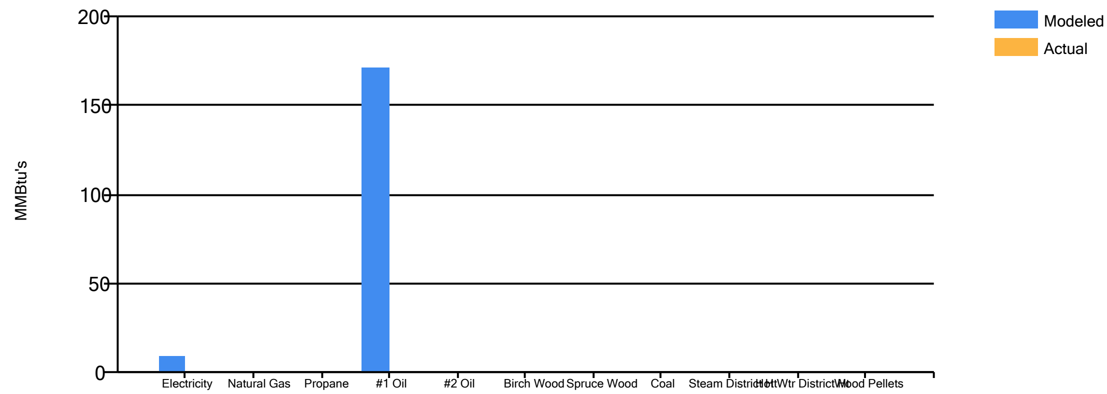
Roof support needs a structural evaluation if additional weight is to be added

WHEN A BUILDING IS NOT HEATED THERE IS INSUFFICIENT TEMPERATURE DIFFERENCE BETWEEN INTERIOR AND EXTERIOR SPACES AND THERE IS NO VALUE TO BE OBTAINED FROM IR IMAGES.

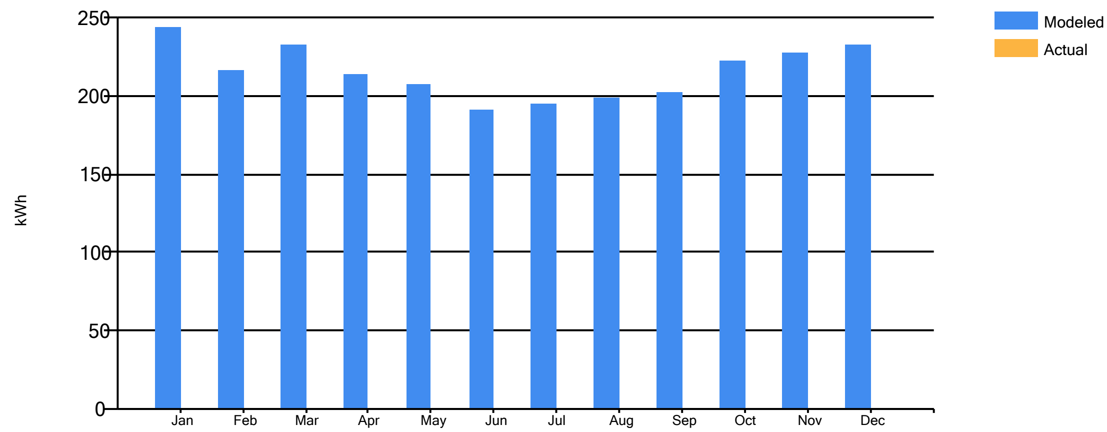
Appendix F – Actual Fuel Use versus Modeled Fuel Use

The orange bars show actual fuel use, and the blue bars are AkWarm's prediction of fuel use.

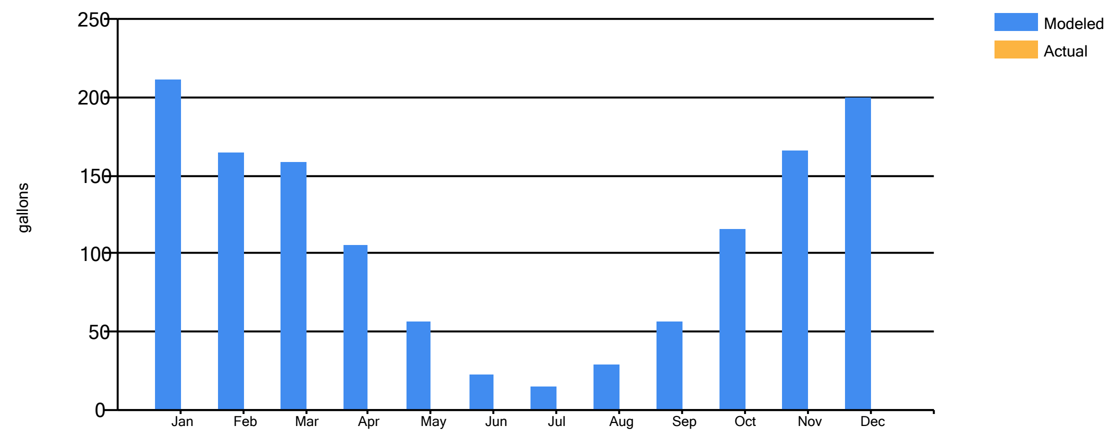
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
CFM	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OSA	Outside Air
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECMs, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

Comprehensive Energy Audit
For Aniak Tribal Office

Prepared For

Native Village of Aniak
Laura Simeon, Tribal Administrator
P.O. Box 349
Aniak, AK 99557
aniaktribe@gmail.com
907-675-4349

Site Survey Date:

January 16, 2018

Prepared By:
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Energy Audits of Alaska
200 W 34th Ave, Suite 1018
Anchorage, AK 99503
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Energy Audits of Alaska

Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 21, 2018
New Release – September 10, 2018

Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (energy efficiency measures, or EEMs), estimate the value of the savings, and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that the recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of heating, ventilation, and air-conditioning (HVAC) systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

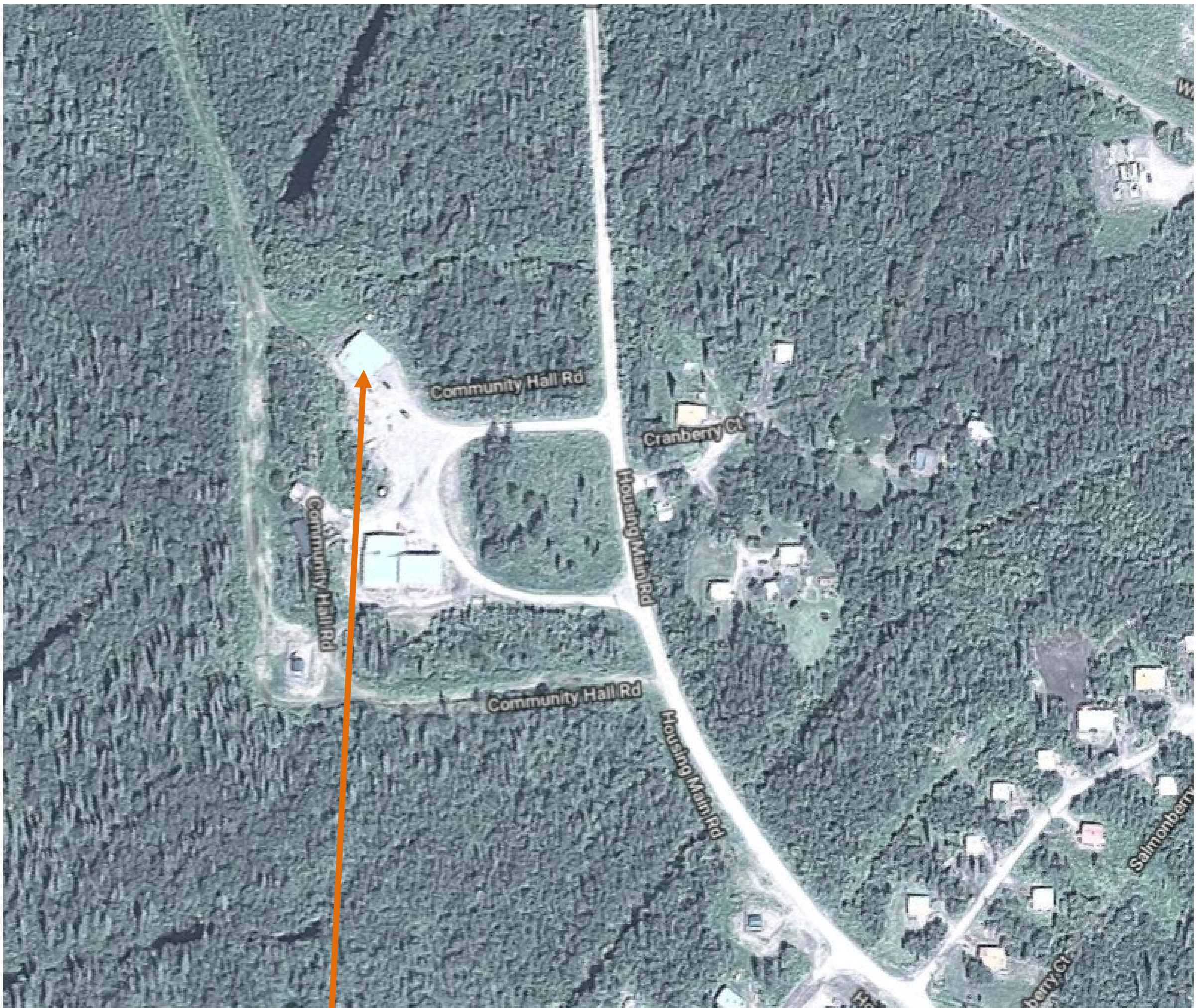
This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the ASHRAE definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips, and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy, and electric usage, and the U.S. Department of Energy Office of Indian Energy, who provided funding.

Project Location



NORTH

Subject Building

Building contact:
Laura Simeon
Tribal Administrator
907-675-4349
aniaktribe@gmail.com

1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the Anyaraqmuite Office Center, also known as the Aniak Tribal Office. The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and plug loads. There are no charges for water or wastewater and these systems were not evaluated in this analysis.

The site survey took place in January 2018. The outside temperature varied between 20F and 28F and there was snow on the ground and on rooftops.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy consuming equipment, identify technically and economically feasible EEMs for existing equipment, and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The energy conservation measures (ECMs) identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The "avoided costs" resulting from ECMs are discussed in Section 1.7 but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 10-page summary is designed to contain all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost, and their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

Sections 2, 3, and 4 of this report and the Appendices are back-up and provide much more detailed information should the owner/operator, or staff, desire to investigate further. Due to their length, Appendices H, I, and J, which contain additional ECM detail, lighting information and manufacturer's "cut sheets" of samples of recommended retrofit products, are included as a separate document.

<u>Issues that the auditor feels are of particular importance to the reader are underlined</u> and all abbreviations and acronyms used in this document are listed in Appendix G.

1.2 Noteworthy Points & Immediate action

a. The following ECMs and maintenance issues should be rectified immediately:
   - Re-set the corridor lights timer located in the boiler room to the correct time and confirm that it is working properly
   - Turn the AHU back on after cleaning the heating coil, replacing the filters, re-programing the timer to the correct building schedule, confirming that the thermostats, 3-way valve, and dampers are operating correctly

- Confirm that the thermostats and cabinet unit heaters in both of the south entries are operating correctly, as they were both running continually during the site survey
- Re-program the timer controlling the central bathroom exhaust fans and confirm that it is working properly

b. On-site staff indicated that the building space temperatures were controlled by modulating the boiler temperature in the boiler room. This indicates that either zone valves or thermostats or the boiler controller, or all three, are not functioning properly. The table below supports this conclusion, as do the EUI comparisons in Section 1.5 and Appendix B. The building's HVAC system should be retro-commissioned before the next heating season begins and the boiler temperature reset only twice per year, to 150F during the warmer months and 180F during the colder months. The table below shows that only 3 (green colored) of the 17 rooms sampled are maintaining proper temperatures and at least 8 (red colored) are clearly not functioning properly and wasting heating energy and at least 3 more rooms are significantly overheated with the heat off. See building schematics in Appendix D for the room names and locations used in the table below.

Location	Thermostat set point	Actual room temperature	Remarks
Office 1	off		heat is on
Finance Office	off		heat is on
Office 3	75	80	heat is off, room is overheated
Office 4	off		heat is on
Office 5	off		heat is on
East entry vestibule	off		heat is off
Office/Storage	68	75	heat is on
Conference room	75	75	proper operation
Janitor	65	75	heat is off, room is overheated
SW vestibule, Entry 1	65	70	CUH fan running continually
Gaming office	off		heat is on
Social Worker 1	off		heat is off
Reception area	70	70	proper operation
SE vestibule, entry 2	65	70	CUH fan running continually
Waiting room	72	72	proper operation
Social Worker 2	off		heat is off
FL2 TANF office	65	75	room is overheated

c. On-site staff indicated that the air-handling unit located in the attic was manually turned off, and remains off, because second-floor occupants were too hot. This is saving energy but it's also resulting in no outside air to the entire building, which is a code violation and could result in poor indoor air quality. It should be turned back on and the ventilation system retro-commissioned and re-balanced so it is operating properly. In the AkWarm-C energy simulation model, it is input as running from 7:30am until 5:00pm, Monday through Friday.

d. If all the recommended EEMs are incorporated in this building, there will be a 35.9% reduction in energy costs, totaling $12,573, with a simple payback of 5 years on the $61,727 implementation cost. The cost of retro-commissioning the HVAC system as a separate line item is not included in this figure. It is assumed that maintenance personnel will work their way through the HVAC system, retro-commissioning it as time allows.
e. Fuel oil delivery data for this building was not provided by the building owner, therefore the fuel oil consumption figures in this analysis had to be derived from the AkWarm-C energy simulation model. The modeled figures may not represent the actual consumption figures and therefore the energy savings lose accuracy. It is recommended to immediately add a cumulative oil meter to the fuel oil day tank and monitor monthly oil consumption in this building.
f. The Aniak Light and Power Company (the electric utility provider) has a 2-tier rate structure. The first 1600 kWh/month are charged at one rate and all kWh after that are charged at a slightly reduced rate. Electricity savings calculations in this analysis used the lower rate, as shown in Table 3.1.
g. It was assumed in this analysis that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity.
h. Most of the 48" light fixtures utilize T8 florescent lamps, but magnetic ballasts. When the T12s were replaced with T8s, the magnetic ballasts should have been replaced with electronic ballasts, and a savings of 27% would have been realized. All florescent lighting is recommended in this audit to be replaced with LED lighting.

1.3 Current Cost and Breakdown of Energy

Based on electricity and fuel oil prices in effect at the time of the audit, and the uncalibrated AkWarm-C© energy model[1], the total predicted energy costs are $34,183 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$15,862 for Electricity
$18,321 for #2 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	28,694 kWh	15,688 kWh
#2 Oil	3,220 gallons	2,416 gallons

[1] If both electric and oil consumption data were available, the AkWarm-C model would normally be calibrated to these figures which results in more accurate energy savings calculations.

The table below shows the relative costs per MMBTU for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.55	$161.15
Fuel Oil	$5.69	$43.10

Figure 1.1

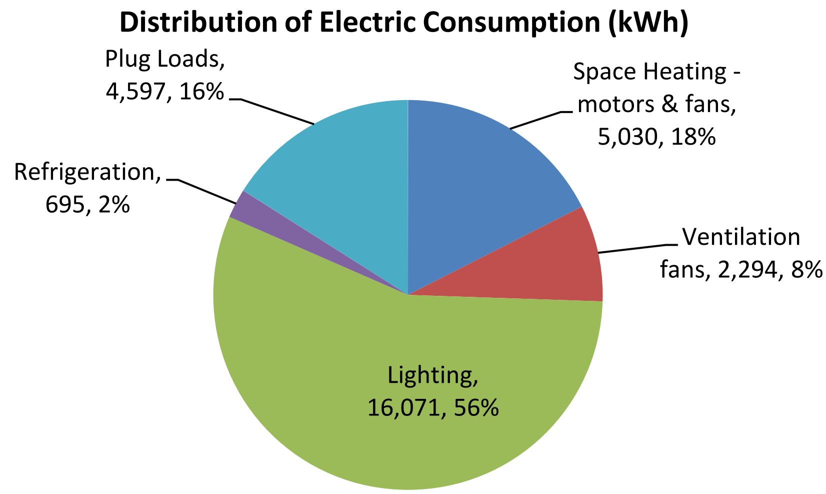
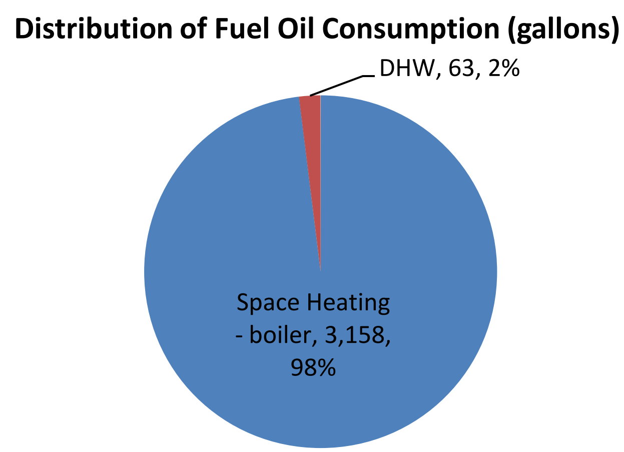


Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on space heating and lighting.

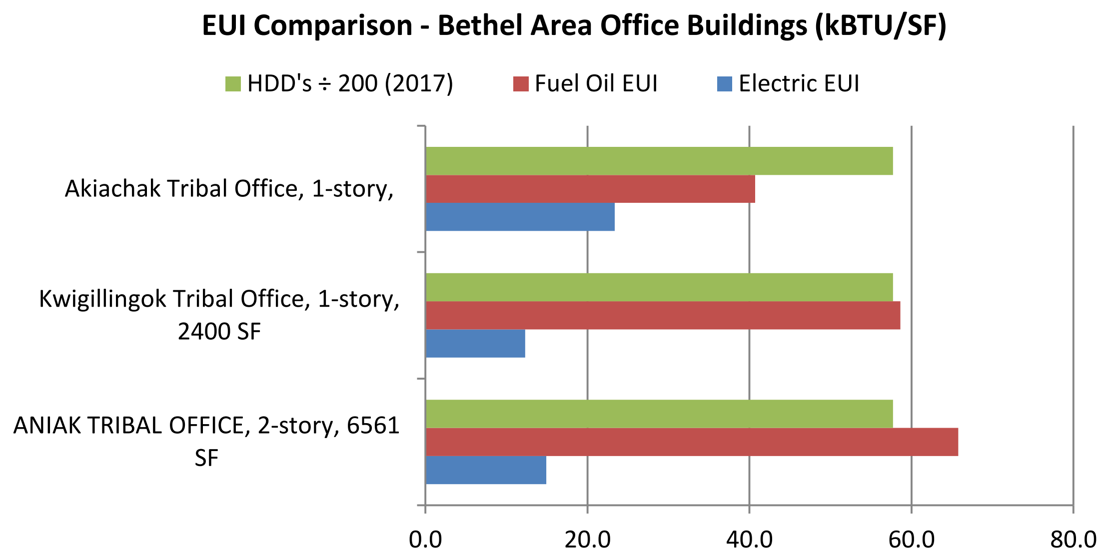
1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	82.7	6.44	$5.21
With Proposed Retrofits	59.0	4.60	$3.42
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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric EUIs are compared to similar use buildings in the region in the bar chart below. The Heating Degree Days[2] (HDDs) bars are intended to normalize the effect of weather differences; in this case, all 3 comparison buildings are in the same region, with the same number of HDDs. As seen in the chart, the subject building's heating EUI is the highest of the 3 comparison office buildings and its electric EUI is only slightly higher than the lowest of the 3 buildings. The high heating EUI indicates that there are inefficiencies in the HVAC system or heat loss through the envelope, or both.



1.6 Energy Efficiency Measures(EEMs)

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3 and Figure 1.4 shows the reduction in cost, consumption and BTUs of electricity and fuel oil if all recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

[2] HDDs are a measure of the severity of cold weather; higher HDDs indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDDs.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
HVAC related	$52,300	$8,045	6.5
Lighting	$9,427	$4,230	2.2
Totals	**$61,727**	**$12,275**	**5.0**

Figure 1.4

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	28,600	97,612	15,668	53,475	45.2%
Gallons Oil	3,220	425,040	2,416	318,912	25.0%
Energy Cost	$34,990		$22,417		35.9%

Table 1.1 below summarizes the energy efficiency measures analyzed for the Aniak Tribal Office. Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM. Table 4.1 shows an additional measure of financial return on investment as well as CO_2 savings.

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	Lighting - Power Retrofit: Entry, Hallway T8-2M 6x48 always on	Replace with 6 LED (2) 15W Module StdElectronic	$728 + $30 Maint. Savings / -0.7 MMBTU	$443	13.85	0.6	2,009.6
2	Lighting - Power Retrofit: HPS wall pack, 70w	Replace with 5 LED 17W Module StdElectronic	$779 + $35 Maint. Savings / 4.8 MMBTU	$600	11.43	0.7	2,395.8
3	Setback Thermostat: Offices (Finance, Office 3, 4, 5, and Office Storage)	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Offices (Finance, Office 3, 4, 5, and Office Storage) space.	$439 / 10.6 MMBTU	$1,200	4.96	2.7	1,702.3
4	Lighting - Power Retrofit: 2nd Floor Offices, Hallways core T8-2M 6x48 surf mt	Replace with 11 LED (2) 15W Module StdElectronic	$344 + $55 Maint. Savings / 2.1 MMBTU	$812	4.15	2.0	1,057.9

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
5	Lighting - Power Retrofit: Entry2 T8-2M 16x48 wrap	Replace with LED (2) 15W Module StdElectronic	$32 + $5 Maint. Savings / 0.0 MMBTU	$74	4.12	2.0	89.9
6	Setback Thermostat: Entry1, Entry, Gaming Office, Conf Room, Office 6, Office 1	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Entry1, Entry, Gaming Office, Conf Room, Office 6, Office 1 space.	$585 / 14.2 MMBTU	$2,100	3.78	3.6	2,270.5
7	Lighting - Power Retrofit: Office 6, Conf 2, Dead File (core) T8-4E 24x48 surf mt	Replace with 8 LED (4) 15W Module (2) StdElectronic	$330 + $40 Maint. Savings / 2.0 MMBTU	$910	3.43	2.5	1,015.0
8	Lighting - Power Retrofit: Fin.Office, Office 3, Off.Stor, Soc.Work2 T8-4M 24x48 surf mt	Replace with 14 LED (4) 15W Module (2) StdElectronic	$562 + $70 Maint. Savings / -0.1 MMBTU	$1,593	3.24	2.5	1,569.0
9	Setback Thermostat: OCS Offices	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the OCS Offices space.	$237 / 5.7 MMBTU	$1,000	3.22	4.2	919.6
10	Lighting - Power Retrofit: Off.4, Off. 5, Off.Stor, Soc.Work1 T8-4M trof	Replace with 14 LED (4) 15W Module (2) StdElectronic	$560 + $70 Maint. Savings / -0.2 MMBTU	$1,593	3.22	2.5	1,560.0
11	Setback Thermostat: 2nd floor Offices	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the 2nd floor Offices space.	$343 / 8.3 MMBTU	$1,500	3.10	4.4	1,330.8
12	Lighting - Power Retrofit: Gaming Office T8-4E 16x48 wrap	Replace with 4 LED (4) 15W Module (2) StdElectronic	$150 + $20 Maint. Savings / 0.0 MMBTU	$455	3.05	2.7	420.4
13	Lighting - Power Retrofit: Bathrooms (4) T8-2E x24" wrap	Replace with 4 LED (2) 15W Module StdElectronic	$83 + $20 Maint. Savings / 0.5 MMBTU	$295	2.93	2.9	253.8

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**
14	HVAC And DHW	1.) Replace (2) existing circ pumps with variable speed (VFD) models, estimated parts $2000 each plus 12 hrs labor @ $125/hr total $5500. 2.) At boiler end of life (anticipated 30 year life) replace with new, 87% thermally efficiency model @ no incremental cost. Estimated total cost to replace is $30,000. 3.) Retro-commission the heating system in this building.	$4,809 / 83.4 MMBTU	$35,500	2.21	7.4	17,183.9
15	Ventilation	1.) Implement CO2-based demand controlled ventilation in AHU, estimated cost $8000. 2.) Replace fan motor with variable speed (VFD) model, estimated parts cost $2000, estimated 8 hrs labor @ $125/hr, total $3000. 3.) Retro-commission the AHU controls and re-balance the system.	$1,632 / 24.3 MMBTU	$11,000	1.87	6.7	5,652.9
16	Lighting - Power Retrofit: Server T8-2E x24" wrap	Replace with LED 8W Module StdElectronic	$3 + $10 Maint. Savings / 0.0 MMBTU	$84	1.81	6.6	8.5
17	Lighting - Power Retrofit: Conf Room, Office 1, 2nd floor offices T8-2M 6x48 surf mt	Replace with 22 LED (2) 15W Module StdElectronic	$233 + $110 Maint. Savings / 0.3 MMBTU	$1,623	1.75	4.7	667.0
18	Lighting - Power Retrofit: Storage OCS T8-2M 8x48 wrap	Replace with LED (2) 15W Module StdElectronic	$6 + $5 Maint. Savings / 0.0 MMBTU	$74	1.69	7.0	17.2
19	Lighting - Power Retrofit: Janitor T8-2M 6x48 surf mt	Replace with LED (2) 15W Module StdElectronic	$4 + $5 Maint. Savings / 0.0 MMBTU	$74	1.48	7.9	12.6
	TOTAL, cost-effective measures		**$11,860 + $475 Maint. Savings / 155.5 MMBTU**	**$60,930**	**2.57**	**4.9**	**40,136.5**

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]**	**CO_2 Savings**
The following measures (if any are listed) were *not* found to be cost-effective from a financial perspective but are still recommended:							
20	Lighting - Power Retrofit: Wating Rm, Reception T8-4E 8x48 wrap	Replace with 7 LED (4) 15W Module (2) StdElectronic	-$94 + $35 Maint. Savings / -0.1 MMBTU	$797	-0.59	999.9	-268.0
	TOTAL, all measures		**$11,766 + $510 Maint. Savings / 155.4 MMBTU**	**$61,727**	**2.53**	**5.0**	**39,868.5**

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.

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 existing building. 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. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate									
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$20,753	$0	$350	$1,268	$8,884	$387	$2,542	$0	**$34,183**
With Proposed Retrofits	$14,428	$0	$262	$422	$4,377	$387	$2,542	$0	**$22,417**
Savings	$6,326	$0	$88	$846	$4,507	$0	$0	$0	**$11,766**

1.7 Energy Conservation Measures (ECM's)

No- and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called "avoided costs" rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring.** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC "performance drift" is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.

   There is a range of simple to very complex building monitoring systems commercially available, and most utilize a user-friendly internet or network-based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

   ARIS–The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owners track and manage energy use and costs. For more information contact Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us)

   BMON–AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings, and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

   Monnit – "product model" sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPTION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures, is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas and/or oil	
Reset AHU mixed air temperature and boiler temperature set points based on the heating season (twice per year)	
Assure that schedule timers (lighting and AHU) reflect the correct time – especially after a power outage	
Re-program Toyo stoves after a power outage	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.
4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Weather-stripping should be maintained if it exists or added if it does not.
5) **Turn off plug loads** including computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves their desk, add an occupancy sensing plug load management device (PLMD) like the "Isole IDP 3050" power strip produced by Wattstopper (See Appendix J).
6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans, and thermostats in this building. An unmaintained HVAC component like a boiler can reduce operating efficiency by 3% or more.
7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone and turn down the heat and lighting in that zone.
8) **Additional ECM recommendations**:
    a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes, and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.

b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.

c. At their end of useful life (EOL), replace refrigeration equipment with Energy Star versions.

d. Keep heating coils in air handlers, unit heaters, and fan coil units clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Aniak Tribal Office. 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 including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager, if possible, to understand their objectives and ownership strategy and to gather other information the auditor could use to make the audit most useful. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment including refrigeration equipment
- Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and energy management programs (if they exist) provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from Aniak Tribal Office enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building." The analysis involves distinguishing the different fuels used on site and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model

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, adding any HVAC systems, ventilation, and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat) and the hours of operation of the building.

Aniak Tribal Office is classified as being made up of the following activity areas:

1) Entry 1, Entry, Gaming Office, Conf Room, Office 6, Office 1: 1,218 square feet
2) Janitor, Mechanical, Server, Fan Room: 1,114 square feet
3) Toilets - First & Second Floor, OCS: 153 square feet
4) Hallways: 472 square feet
5) Offices (Finance, Office 3, 4, 5, and Office Storage): 885 square feet
6) OCS Offices: 1,079 square feet
7) 2nd floor Offices: 949 square feet
8) 2nd floor storage: 691 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model is typically calibrated to actual fuel consumption and is then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions. Because no fuel oil data was provided, the model was only calibrated to electrical consumption.

Limitations of AkWarm© Models
The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis
Our analysis provides a number of tools for assessing the cost effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions, and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the projected life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIRs and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR>=1 to be considered financially viable on a stand-alone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. Costs are considered to be accurate within +/-30% in this level of audit; they are derived from Means Cost Data, industry publications, the auditor's experience, and/or local contractors and equipment suppliers.

Interactive effects of EEMs:

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases, lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in others, negatively. If all EEM's are implemented, their order of implementation is irrelevant, because the total savings after full implementation will be unchanged. If an EEM is calculated outside of the AkWarm© model, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:
The underlying assumptions used in the calculations made in this audit follow:

- 3,413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline, shall accept full responsibility and liability for the design, engineering, and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects is not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. ANIAK TRIBAL OFFICE EXISTING CONDITIONS

3.1. Building Description

The 6,561 square foot Aniak Tribal Office was originally constructed in 1985 as a canning and tanning facility. In the mid 1990s it was renovated, an addition was constructed, and the entire building was converted to office space. Its current use is as an office building and it has an occupancy of 14 staff and 10 to 20 visitors per day. The building's normal operating hours are 9:00am until 5:00pm, Monday through Friday.

The details that follow are either based on observation or the 1996 plan set provided.

Description of Building Shell

This building is constructed on a concrete slab poured on grade. The canning/tanning walls have 6" of rigid foam between studs. The walls added in 1996 are constructed with 2" x 10" wood studs 16" OC, whose cavities are filled with R30 fiberglass batt. Interior wall finishes are gypsum and the exterior is finished with painted metal siding. Several sections of the exterior siding were in need of repair (see photo at right). The windows utilize double-pane glass in wood frames and are in average-to-poor condition (all require paint) and all entry doors are metal, some with security windows. As seen in the IR images in Appendix E, the doors are in poor condition. The "hot roof" (i.e. no attic) deck is also painted metal, and, per plans, covers 8" of rigid foam insulation.

Description of Heating and Cooling Plants

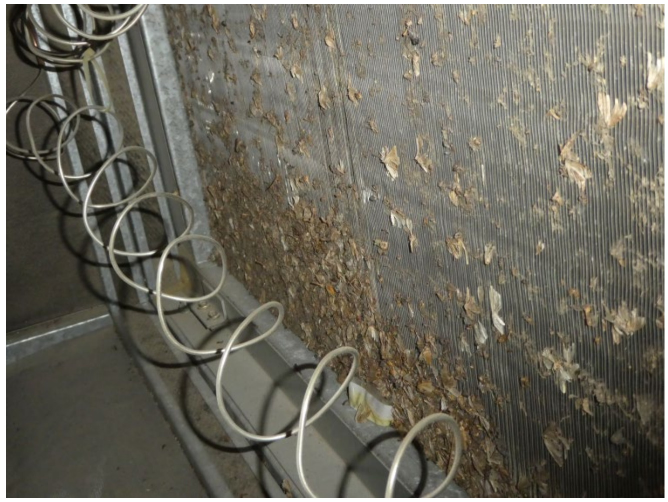
Weil-McLain Boiler A/B-WTGO-8

Nameplate Information:	Weil-McLain model A/B-WTGO-8
Fuel Type:	#2 Oil
Input Rating:	274,000 BTU/hr
Steady State Efficiency:	71 %
Idle Loss:	1.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	274 MBH input, 238 MBH output, nominal thermal efficiency 87% when new, de-rated to 71% for age (presumed 1996)

Space Heating and Cooling Distribution Systems

Heat is distributed by a hydronic system utilizing (2) ¾ HP constant speed circulation pumps and perimeter fintube baseboard radiators and cabinet unit heaters at each entry. There is no cooling in the building, other than economizer cooling if and when the AHU is operating. The AHU has a heating coil and distributes tempered air to most building spaces.

Building Ventilation System



Ventilation is provided by an air handler located in the east second-floor fan room, which also acts as the return air plenum with a barometric relief damper. As previously mentioned, the AHU had been manually turned off and was not in use. Plans indicate that it has a 2HP constant speed fan motor and provides 3900 cfm of airflow. It has a heating coil with a 3-way valve used to temper incoming air. The heating coil was in very poor condition (see photo at left) and in need of maintenance, as it was substantially blocked by insects and other contaminants. The table below shows the sample CO_2 readings taken in a number of rooms; none showed excessively high levels. See Appendix I for additional information on CO_2 levels and limits.

CO2 data logging results			
Location	**Time**	**Occupants**	**PPM CO2**
Main conference room	9:50am	3-4 people	750
Room 102, Finance	10:05am	1-2 people	567
Main conference room	1:00pm	3 people	733

A 250 cfm central exhaust fan serving the bathrooms appears to be controlled by a timer (photo at left), but the timer was not operating during the site survey.

HVAC Controls

No control drawings or sequence of operations was available so many of the details below are presumed based on observation and conversations with on-site staff.

The boiler temperature is controlled manually by a Tekmar 262 Boiler controller. It is not clear if the Tekmar controller is programmed properly or is functioning properly. There are 18 room thermostats which presumably control local zone valves and 3 manual thermostats, presumably line voltage, controlling cabinet unit heater (CUH) fans. Two of the three CUH fans were running continually during the site

survey.

A single manual thermostat is assumed to provide input to an on-board controller in the AHU, which presumably controls the RA and OSA dampers based on mixed air temperature. A timer controls the AHU fan motors based on a building schedule and the mixed air setpoint appears to be manually reset twice a year (photos above right).

A barometric relief damper in the attic fan room presumably controls building static pressure.

Domestic Hot Water System
DHW is provided by an indirect hot water generator located in the boiler room. There does not appear to be a DHW re-circulation pump in use.

Lighting
The interior lighting consists mainly of 2 and 4-lamp, 48" fixtures utilizing T8 florescent lamps and magnetic ballasts[3]. There is a lighting timer located in the boiler room, which is said to control the first floor corridor lighting, but it was 4 hours off during the site survey. There are also several ceiling mounted occupancy sensors in the first floor corridor, but they do not appear to control any lighting. Exterior lighting consists of what appear to be 70w HPS wall packs controlled by a photocell sensor which appeared to be working properly.

Major Equipment and Plug Loads
A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis to match the actual, baseline electric data and after calibration, the AkWarm© model predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

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.

[3] Note that when magnetic ballasts are not replaced with electronic ballasts, even though 40w T12 lamps are replaced with 32w T8 lamps, there is only a 3w/lamp energy savings, whereas if an electronic ballast was used, there would be a 13w/lamp savings.

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

The utility companies providing energy to the subject building, and the class of service provided by each, are listed below:

Electricity: Aniak Light & Power - 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	$ 0.5528/kWh
#2 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or from invoices, which also included customer charges, service charges, energy costs, and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically gallons delivered, not gallons consumed. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $34,183 annually for electricity and other fuel costs for the Aniak Tribal Office.

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

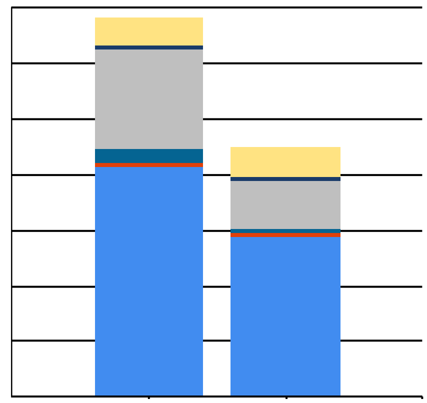


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

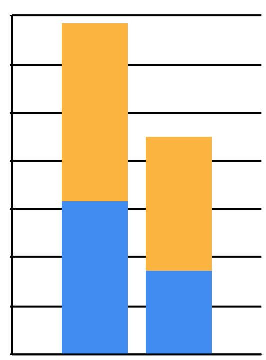
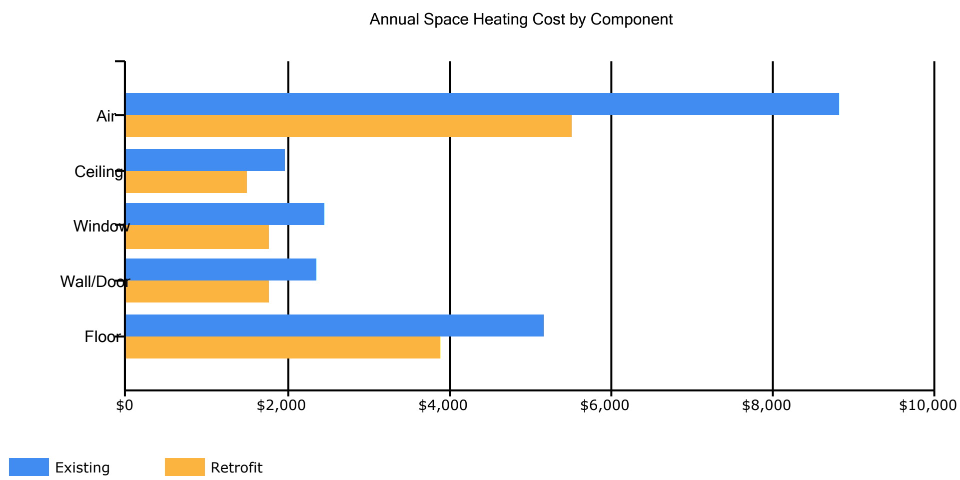


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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 the model'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	427	389	427	413	427	413	427	427	413	427	413	427
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	195	177	195	188	195	188	195	195	188	195	188	195
Lighting	1364	1243	1364	1320	1364	1320	1364	1364	1320	1364	1320	1364
Refrigeration	59	54	59	57	59	57	59	59	57	59	57	59
Other_Electrical	461	420	461	446	324	309	320	320	309	320	446	461

Fuel Oil #2 Consumption (Gallons)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Space_Heating	540	402	370	219	89	79	83	79	102	264	409	522
DHW	5	4	5	5	6	6	6	6	5	5	5	5

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building.
It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUIs are calculated by converting all the energy consumed by a building in one year to BTUs and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy." Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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, and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\textit{Building Site EUI} = \frac{\textit{(Electric Usage in kBtu + Gas Usage in kBtu + similar for other fuels)}}{\textit{Building Square Footage}}$$

$$\textit{Building Source EUI} = \frac{\textit{(Electric Usage in kBtu X SS Ratio + Gas Usage in kBtu X SS Ratio + similar for other fuels)}}{\textit{Building Square Footage}}$$

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

Table 3.4
Aniak Tribal Office 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	28,694 kWh	97,931	3.340	327,091
#2 Oil	3,220 gallons	444,343	1.010	448,787
Total		**542,274**		**775,877**
BUILDING AREA		6,561	Square Feet	
BUILDING SITE EUI		83	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		118	**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	**82.7**	**6.44**	**$5.21**
With Proposed Retrofits	**59.0**	**4.60**	**$3.42**
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.			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C.

Table 4.1
Aniak Tribal Office, Aniak, 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	Lighting - Power Retrofit: Entry, Hallway T8-2M 6x48 always on	Replace with 6 LED (2) 15W Module StdElectronic	$728 + $30 Maint. Savings / -0.7 MMBTU	$443	13.85	0.6	2,009.6
2	Lighting - Power Retrofit: HPS wall pack, 70w	Replace with 5 LED 17W Module StdElectronic	$779 + $35 Maint. Savings / 4.8 MMBTU	$600	11.43	0.7	2,395.8
3	Setback Thermostat: Offices (Finance, Office 3, 4, 5, and Office Storage)	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Offices (Finance, Office 3, 4, 5, and Office Storage) space.	$439 / 10.6 MMBTU	$1,200	4.96	2.7	1,702.3
4	Lighting - Power Retrofit: 2nd Floor Offices, Hallways core T8-2M 6x48 surf mt	Replace with 11 LED (2) 15W Module StdElectronic	$344 + $55 Maint. Savings / 2.1 MMBTU	$812	4.15	2.0	1,057.9
5	Lighting - Power Retrofit: Entry2 T8-2M 16x48 wrap	Replace with LED (2) 15W Module StdElectronic	$32 + $5 Maint. Savings / 0.0 MMBTU	$74	4.12	2.0	89.9
6	Setback Thermostat: Entry1, Entry, Gaming Office, Conf Room, Office 6, Office 1	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Entry1, Entry, Gaming Office, Conf Room, Office 6, Office 1 space.	$585 / 14.2 MMBTU	$2,100	3.78	3.6	2,270.5
7	Lighting - Power Retrofit: Office 6, Conf 2, Dead File (core) T8-4E 24x48 surf mt	Replace with 8 LED (4) 15W Module (2) StdElectronic	$330 + $40 Maint. Savings / 2.0 MMBTU	$910	3.43	2.5	1,015.0

Table 4.1
Aniak Tribal Office, Aniak, 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
8	Lighting - Power Retrofit: Fin.Office, Office 3, Off.Stor, Soc.Work2 T8-4M 24x48 surf mt	Replace with 14 LED (4) 15W Module (2) StdElectronic	$562 + $70 Maint. Savings / -0.1 MMBTU	$1,593	3.24	2.5	1,569.0
9	Setback Thermostat: OCS Offices	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the OCS Offices space.	$237 / 5.7 MMBTU	$1,000	3.22	4.2	919.6
10	Lighting - Power Retrofit: Off.4, Off. 5, Off.Stor, Soc.Work1 T8-4M trof	Replace with 14 LED (4) 15W Module (2) StdElectronic	$560 + $70 Maint. Savings / -0.2 MMBTU	$1,593	3.22	2.5	1,560.0
11	Setback Thermostat: 2nd floor Offices	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the 2nd floor Offices space.	$343 / 8.3 MMBTU	$1,500	3.10	4.4	1,330.8
12	Lighting - Power Retrofit: Gaming Office T8-4E 16x48 wrap	Replace with 4 LED (4) 15W Module (2) StdElectronic	$150 + $20 Maint. Savings / 0.0 MMBTU	$455	3.05	2.7	420.4
13	Lighting - Power Retrofit: Bathrooms (4) T8-2E x24" wrap	Replace with 4 LED (2) 15W Module StdElectronic	$83 + $20 Maint. Savings / 0.5 MMBTU	$295	2.93	2.9	253.8
14	HVAC And DHW	1.) Replace (2) existing circ pumps with variable speed (VFD) models, estimated parts $2000 each plus 12 hrs labor @ $125/hr total $5500. 2.) At boiler end of life (anticipated 30 year life) replace with new, 87% thermally efficiency model @ no incremental cost. Estimated total cost to replace is $30,000. 3.) Retro-commission the heating system in this building.	$4,809 / 83.4 MMBTU	$35,500	2.21	7.4	17,183.9

Table 4.1
Aniak Tribal Office, Aniak, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
15	Ventilation	1.) Implement CO2-based demand controlled ventilation in AHU, estimated cost $8000. 2.) Replace fan motor with variable speed (VFD) model, estimated parts cost $2000, estimated 8 hrs labor @ $125/hr, total $3000. 3.) Retro-commission the AHU controls and re-balance the system.	$1,632 / 24.3 MMBTU	$11,000	1.87	6.7	5,652.9
16	Lighting - Power Retrofit: Server T8-2E x24" wrap	Replace with LED 8W Module StdElectronic	$3 + $10 Maint. Savings / 0.0 MMBTU	$84	1.81	6.6	8.5
17	Lighting - Power Retrofit: Conf Room, Office 1, 2nd floor offices T8-2M 6x48 surf mt	Replace with 22 LED (2) 15W Module StdElectronic	$233 + $110 Maint. Savings / 0.3 MMBTU	$1,623	1.75	4.7	667.0
18	Lighting - Power Retrofit: Storage OCS T8-2M 8x48 wrap	Replace with LED (2) 15W Module StdElectronic	$6 + $5 Maint. Savings / 0.0 MMBTU	$74	1.69	7.0	17.2
19	Lighting - Power Retrofit: Janitor T8-2M 6x48 surf mt	Replace with LED (2) 15W Module StdElectronic	$4 + $5 Maint. Savings / 0.0 MMBTU	$74	1.48	7.9	12.6
	TOTAL, cost-effective measures		**$11,860 + $475 Maint. Savings / 155.5 MMBTU**	**$60,930**	**2.57**	**4.9**	**40,136.5**
The following measures (if any are listed) were *not* found to be cost-effective from a financial perspective, but are still recommended:							
20	Lighting - Power Retrofit: Waiting Rm, Reception T8-4E 8x48 wrap	Replace with 7 LED (4) 15W Module (2) StdElectronic	-$94 + $35 Maint. Savings / -0.1 MMBTU	$797	-0.59	999.9	-268.0
	TOTAL, all measures		**$11,766 + $510 Maint. Savings / 155.4 MMBTU**	**$61,727**	**2.53**	**5.0**	**39,868.5**

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 effects 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 Insulation Measures (There were no improvements in this category)

4.3.2 Window Measures (There were no improvements in this category)

4.3.3 Door Measures (There were no improvements in this category)

4.3.4 Air Sealing Measures (There were no improvements in this category)

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation				
14	1.) Replace (2) existing circ pumps with variable speed (VFD) models, estimated parts $2000 each plus 12 hrs labor @ $125/hr total $5500. 2.) At boiler end of life (anticipated 30 year life) replace with new, 87% thermally efficiency model @ no incremental cost. Estimated total cost to replace is $30,000. 3.) Retro-commission the heating system in this building.				
Installation Cost	$35,500	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$4,809
Breakeven Cost	$78,613	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	83.4 MMBTU
		Savings-to-Investment Ratio	2.2		
Auditors Notes:					

4.4.2 Ventilation System Measures

Rank	Description	Recommendation			
15		1.) Implement CO2-based demand controlled ventilation in AHU, estimated cost $8000. 2.) Replace fan motor with variable speed (VFD) model, estimated parts cost $2000, estimated 8 hrs labor @ $125/hr, total $3000. 3.) Retro-commission the AHU controls and re-balance the system.			
Installation Cost	$11,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,632
Breakeven Cost	$20,607	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	24.3 MMBTU
		Savings-to-Investment Ratio	1.9		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
3	Offices (Finance, Office 3, 4, 5, and Office Storage)			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Offices (Finance, Office 3, 4, 5, and Office Storage) space.	
Installation Cost	$1,200	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$439
Breakeven Cost	$5,952	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	10.6 MMBTU
		Savings-to-Investment Ratio	5.0		
Auditors Notes:					

Rank	Building Space			Recommendation	
6	Entry1, Entry, Gaming Office, Conf Room, Office 6, Office 1			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Entry1, Entry, Gaming Office, Conf Room, Office 6, Office 1 space.	
Installation Cost	$2,100	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$585
Breakeven Cost	$7,939	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	14.2 MMBTU
		Savings-to-Investment Ratio	3.8		
Auditors Notes:					

Rank	Building Space			Recommendation	
9	OCS Offices			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the OCS Offices space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$237
Breakeven Cost	$3,216	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	5.7 MMBTU
		Savings-to-Investment Ratio	3.2		
Auditors Notes:					

Rank	Building Space			Recommendation	
11	2nd floor Offices			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the 2nd floor Offices space.	
Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$343
Breakeven Cost	$4,653	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	8.3 MMBTU
		Savings-to-Investment Ratio	3.1		
Auditors Notes:					

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	
1	Entry, Hallway T8-2M 6x48 always on	6 FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with 6 LED (2) 15W Module StdElectronic	
Installation Cost	$443	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$728
Breakeven Cost	$6,137	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	-0.7 MMBTU
		Savings-to-Investment Ratio	13.9	**Maintenance Savings ($/yr)**	$30
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (6) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (12) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
2	HPS wall pack, 70w	5 HPS 70 Watt Magnetic with Manual Switching		Replace with 5 LED 17W Module StdElectronic	
Installation Cost	$600	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$779
Breakeven Cost	$6,859	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	4.8 MMBTU
		Savings-to-Investment Ratio	11.4	**Maintenance Savings ($/yr)**	$35
Auditors Notes: Replace (5) 70w HPS fixtures with new 17w LED fixtures with integral photocell sensor @ parts cost of $75 ea + 1 hr labor ea. @ $45/hr. Maintenance savings $5/fixture					

Rank	Location	Existing Condition		Recommendation	
4	2nd Floor Offices, Hallways core T8-2M 6x48 surf mt	11 FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with 11 LED (2) 15W Module StdElectronic	
Installation Cost	$812	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$344
Breakeven Cost	$3,366	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	2.1 MMBTU
		Savings-to-Investment Ratio	4.1	**Maintenance Savings ($/yr)**	$55
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (11) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (22) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
5	Entry2 T8-2M 16x48 wrap	FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$74	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$32
Breakeven Cost	$305	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	4.1	**Maintenance Savings ($/yr)**	$5

Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
7	Office 6, Conf 2, Dead File (core) T8-4E 24x48 surf mt	8 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 8 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$910	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$330
Breakeven Cost	$3,121	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	2.0 MMBTU
		Savings-to-Investment Ratio	3.4	**Maintenance Savings ($/yr)**	$40
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (8) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (32) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
8	Fin.Office, Office 3, Off.Stor, Soc.Work2 T8-4M 24x48 surf mt	14 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant EfficMagnetic with Manual Switching		Replace with 14 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$1,593	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$562
Breakeven Cost	$5,158	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	3.2	**Maintenance Savings ($/yr)**	$70
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (14) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (56) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
10	Off.4, Off. 5, Off.Stor, Soc.Work1 T8-4M trof	14 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant EfficMagnetic with Manual Switching		Replace with 14 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$1,593	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$560
Breakeven Cost	$5,136	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	-0.2 MMBTU
		Savings-to-Investment Ratio	3.2	**Maintenance Savings ($/yr)**	$70
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (14) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (56) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
12	Gaming Office T8-4E 16x48 wrap	4 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 4 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$455	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$150
Breakeven Cost	$1,389	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	3.1	**Maintenance Savings ($/yr)**	$20
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (4) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (16) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
13	Bathrooms (4) T8-2E x24" wrap	4 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 4 LED (2) 15W Module StdElectronic	
Installation Cost	$295	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$83
Breakeven Cost	$865	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.5 MMBTU
		Savings-to-Investment Ratio	2.9	**Maintenance Savings ($/yr)**	$20
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (4) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (8) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
16	Server T8-2E x24" wrap	FLUOR T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED 8W Module StdElectronic	
Installation Cost	$84	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$3
Breakeven Cost	$152	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.8	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 8.5w T8 LED's @ $25 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
17	Conf Room, Office 1, 2nd floor offices T8-2M 6x48 surf mt	22 FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with 22 LED (2) 15W Module StdElectronic	
Installation Cost	$1,623	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$233
Breakeven Cost	$2,847	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.3 MMBTU
		Savings-to-Investment Ratio	1.8	**Maintenance Savings ($/yr)**	$110
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (22) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (44) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
18	Storage OCS T8-2M 8x48 wrap	FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$74	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$6
Breakeven Cost	$125	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.7	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
19	Janitor T8-2M 6x48 surf mt	FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$74	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$4
Breakeven Cost	$109	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.5	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location		Existing Condition		Recommendation	
20	Wating Rm, Reception T8-4E 8x48 wrap		7 FLUOR (4) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 7 LED (4) 15W Module (2) StdElectronic	
Installation Cost	$797		**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	-$94
Breakeven Cost	-$468		**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	-0.6	**Maintenance Savings ($/yr)**	$35
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (7) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (28) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.						

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

ALL SCHEDULES COMPILED FROM PLANS OR ON-SITE NAMEPLATE OBSERVATION, WHERE ACCESSIBLE e= estimated

AIR HANDLER SCHEDULE

SYMBOL	MFGR/MODEL	FAN CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
AHU-1	Trane MCCA008	3,900	2.0/208/1	Serves entire building

EXHAUST FAN SCHEDULE

SYMBOL	MOTOR MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
EF-1	Penn Ventilator Zephyr Z-10	300	300w/115/1	Bathroom Exhaust
EF-2	Broan 360A	77	75w/115/1	Toilet Exhaust for room 126

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
CP-1	Grundfos UPC 50-160	27@30	.75/230/1	Main building circ pump
CP-2	Grundfos UPC 50-160	27@30	.75/230/1	Main building circ pump
	unknown		unknown	Well Pump

BOILER SCHEDULE

SYMBOL	MFGR/MODEL	NOMINAL EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
B-1	Weil-McLain Boiler A/B-WTGO-8	87%		274 MBH input, 238 MBH output; with Beckett oil burner 5.8A/120/1

UNIT HEATER SCHEDULE

SYMBOL	MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
CUH-1	Trane B12A003	420	e0.25/120/1	Entry 1, SW vestibule, 20 MBH
CUH-2	Trane B12A003	420	e0.25/120/1	Entry 2, SE vestibule, 20 MBH
CUH-3	Trane B12A003	420	e0.25/120/1	Mechanical Room, 20 MBH

HOT WATER GENERATOR SCHEDULE				
SYMBOL	MFGR/MODEL	GALLONS	NUMBER OF ELEMENTS	ELEMENT SIZE
HWG	Amtrol WH-7CDW	41	n/a	Hydronic indirect hot water generator, set point approx 110F

PLUMBING FIXTURES				
SYMBOL	FIXTURE	GPF/GPM	QUANTITY	REMARKS
	W.C.	e1.6	4	manually operated, tank type
	Lavatory	e2.0	4	manually operated

PLUG LOAD SUMMARY				
SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	14	200w	
	Laptop	1	85w	
	Personal printers	9	85w	
	large copy/scan/fax machines	1	1250 w	
	Medium printers	2	125w	
	Paper shredder	1	500w	
	Large Paper shredder	1	1000w	
	Personal coffee machine	1	1200w	
	Microwaves	1	1000w	
	1 cubic foot refrigerator (dorm size)	1	150 kWh/yr	
	half size refrigerators (under counter)	1	225 kWh/yr	
	Treadmill	1	400w	
	Server, UPS, Hubs, ethernet switches	1	est 1000 w	
	popcorn machine	1	1050w	

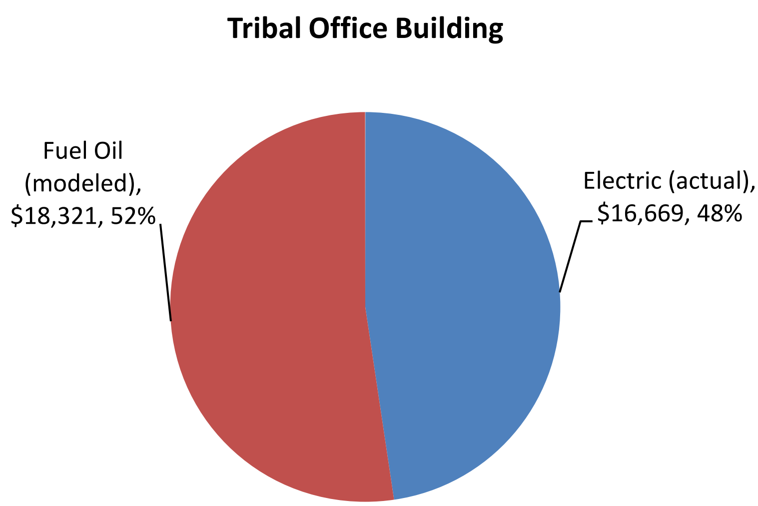
Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies, and irregularities which may provide insight regarding the building's function and efficiency. Thirty-six months of historical data is usually a sufficient period of time to gain an understanding of the building operation. Electric consumption data from 2015 through 2017 was available, but no fuel oil delivery or consumption data was provided. Figures B.1 and B.2 show the 3-year summary of electric consumption and costs for this facility and the fuel oil use and costs predicted by the AkWarm-C model. The shaded cells represent the data used in the AkWarm-C model.

Figure B.1 – Total Building Energy Consumption and Costs

TRIBAL OFFICE							
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use (predicted by AkWarm-C)	Fuel oil Cost	Total kBTU's of Energy	Total Utility Cost
2015	30,800	$17,952	3,220	$18,321	522,651	$34,990
2016	29,400	$17,136				
2017	28,600	$16,669				

Figure B.2 – Distribution of Energy Costs



Electricity: With the exception of what appear to be meter reading errors in October of 2015, June of 2016 and June of 2017, Figure B.3 shows that electric consumption in this building has been consistent on a month-to-month basis, with slightly less electrical use during the second half of each year. Figure B.4 shows a very slight decrease in annual consumption year over year.

Figure B.3 – 3 Years of monthly Electric Consumption

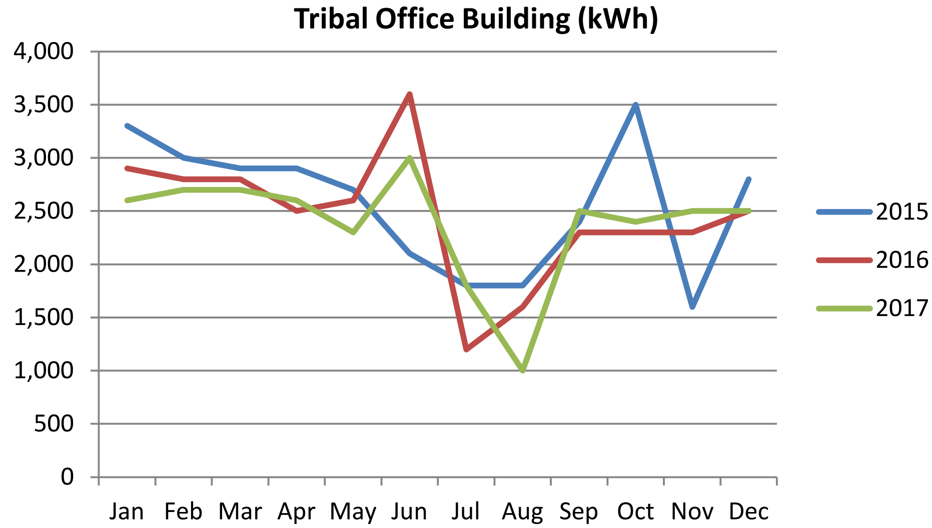
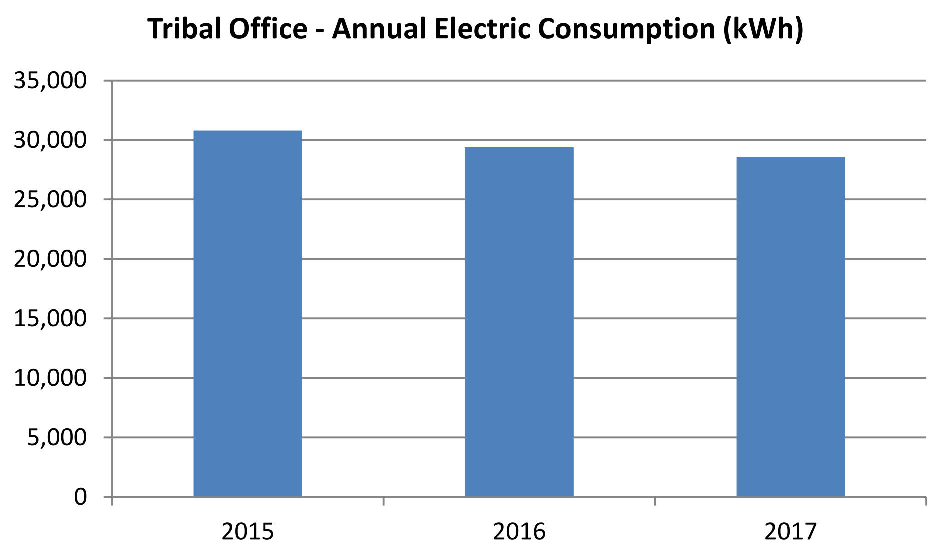


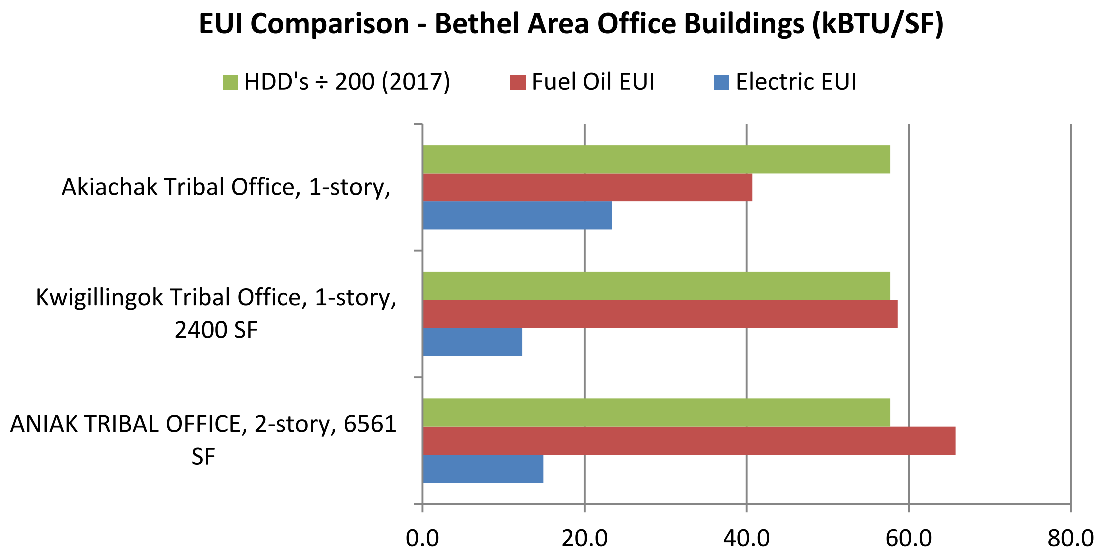
Figure B.4 – 3 years of Annual Electric Consumption



Fuel Oil: Because no oil delivery data was provided, no oil use benchmarking can be performed on this building.

Comparing EUIs: Figure B.5 and the discussion in Section 1.5 above show that this building's heating system or envelope is inefficient. Given the 10", R-30 walls and 8" of rigid foam insulation in its roof, it would appear that the envelope is not the source of the heating inefficiency. This high heating EUI supports the recommendation to recommission the heating system in this building.

Figure B.5 – EUI's



After performing the historical analysis in Section 1.5 and above, a baseline period is selected as a benchmark. This is based on factors including the consistency of the data, the periods for which data was available and the current use and occupancy of the building versus its historical use and occupancy. The benchmark baseline periods selected for this building are 2017 for electricity and the predicted AkWarm-C consumption for fuel oil. The shaded 2017 electric consumption figures below were used to calibrate the AkWarm© model.

Figure B.6 – Benchmark Utility Data

	Tribal Office (no PCE)			
	2015	**2016**	**2017**	**Costs**
Jan	3,300	2,900	2,600	$1,511.20
Feb	3,000	2,800	2,700	$1,566.48
Mar	2,900	2,800	2,700	$1,566.48
Apr	2,900	2,500	2,600	$1,511.20
May	2,700	2,600	2,300	$1,345.36
Jun	2,100	3,600	3,000	$1,732.32
Jul	1,800	1,200	1,800	$1,068.96
Aug	1,800	1,600	1,000	$599.00
Sep	2,400	2,300	2,500	$1,455.92
Oct	3,500	2,300	2,400	$1,400.64
Nov	1,600	2,300	2,500	$1,455.92
Dec	2,800	2,500	2,500	$1,455.92
	30,800	29,400	28,600	$16,669.37

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering (if required) and construction management costs are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit and are derived from and one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- Local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified Electrician $125/hr

This level of work includes changing street light heads, light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work $ 45/hr

Includes installing switch-mounted occupancy sensors which do not require re-wire or pulling additional wires, weather-stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work $125/hr

Work includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities $45/hr

Includes maintaining light fixtures, door and window weather-stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Aniak Tribal Office	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak **Client Name:** Laura Simeon	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350 **Auditor FAX:**
Client Phone: (907) 675-4349 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 6,561 square feet	**Design Space Heating Load:** Design Loss at Space: 116,164 Btu/hour with Distribution Losses: 129,071 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 196,755 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 14 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days
Utility Information	
Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.553/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate									
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$20,753	$0	$350	$1,268	$8,884	$387	$2,542	$0	**$34,183**
With Proposed Retrofits	$14,428	$0	$262	$422	$4,377	$387	$2,542	$0	**$22,417**
Savings	$6,326	$0	$88	$846	$4,507	$0	$0	$0	**$11,766**

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	82.7	6.44	$5.21
With Proposed Retrofits	59.0	4.60	$3.42

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.

BUILDING SCHEMATICS

<u>Legend</u>

<u>Windows</u>

W1 3'10" x 3' 3", 1/2" thermal break, Double pane, Wood, 1/2 Casement, 1/2 Fixed

W2 3'10" x 6', 1/2" thermal break, Double pane, Wood, 1/2 Casement, 1/2 Fixed

W3 3'10" x 3' 11", 1/2" thermal break, Double pane, Wood, 1/2 Casement, 1/2 Fixed

W4 5'10" X 4'4", 1/2" thermal break, Double pane, Wood, 1/2 Casement, 1/2 Fixed

<u>Doors</u>

D1 3' Metal Exit

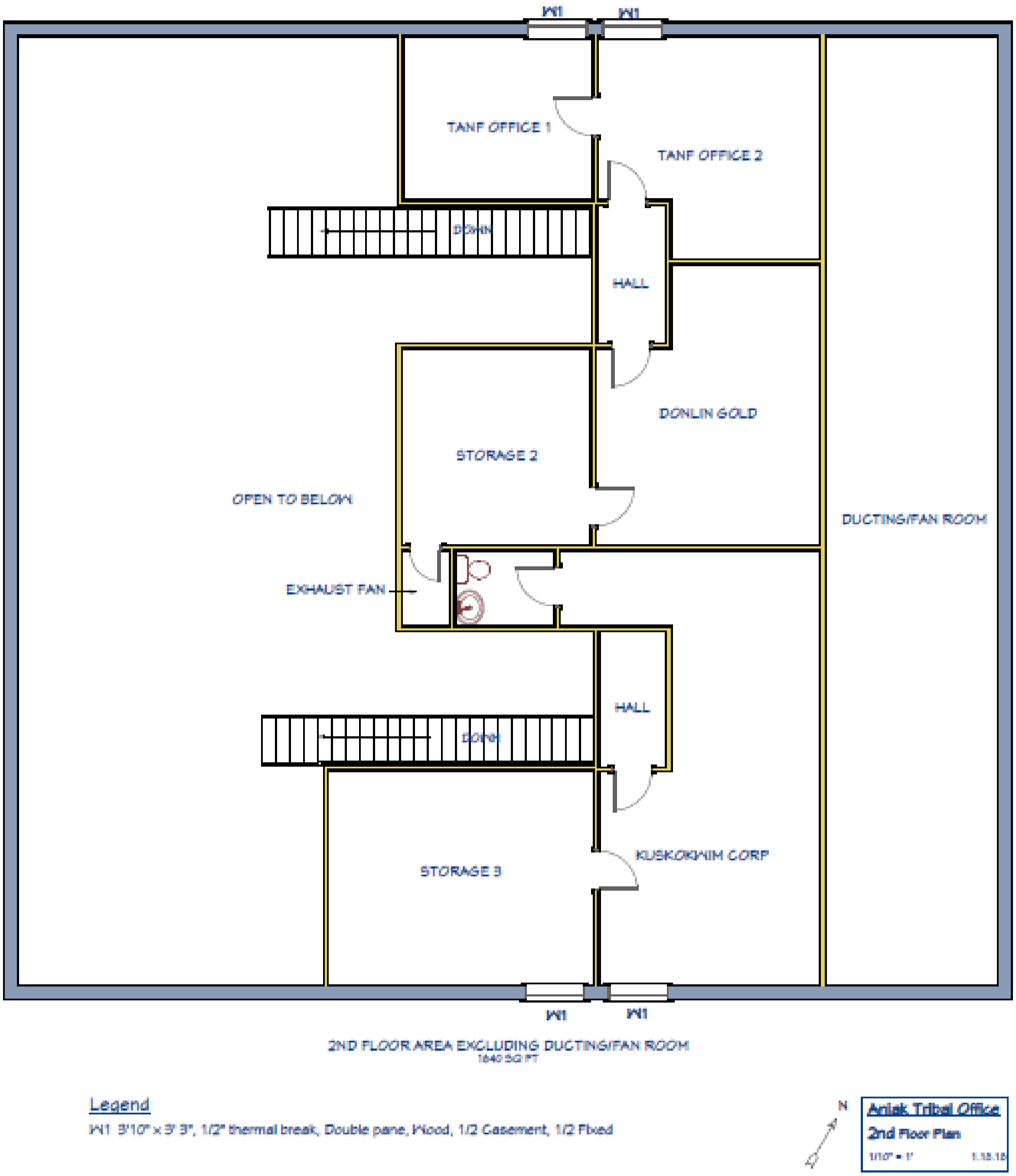
Office of Children Services Wing

N

Aniak Tribal Office

First Floor Plan

1/10" = 1' 1.18.18


W1
W1
TANF OFFICE 1
TANF OFFICE 2
DOWN
HALL
DONLIN GOLD
STORAGE 2
OPEN TO BELOW
DUCTING/FAN ROOM
EXHAUST FAN
HALL
DOWN
KUSKOKWIM CORP
STORAGE 3
W1
W1
2ND FLOOR AREA EXCLUDING DUCTING/FAN ROOM
1640 SQ FT
Legend
W1 3'10" x 3' 3", 1/2" thermal break, Double pane, Wood, 1/2 Casement, 1/2 Fixed
N
Aniak Tribal Office
2nd Floor Plan
1/10" = 1'

Legend

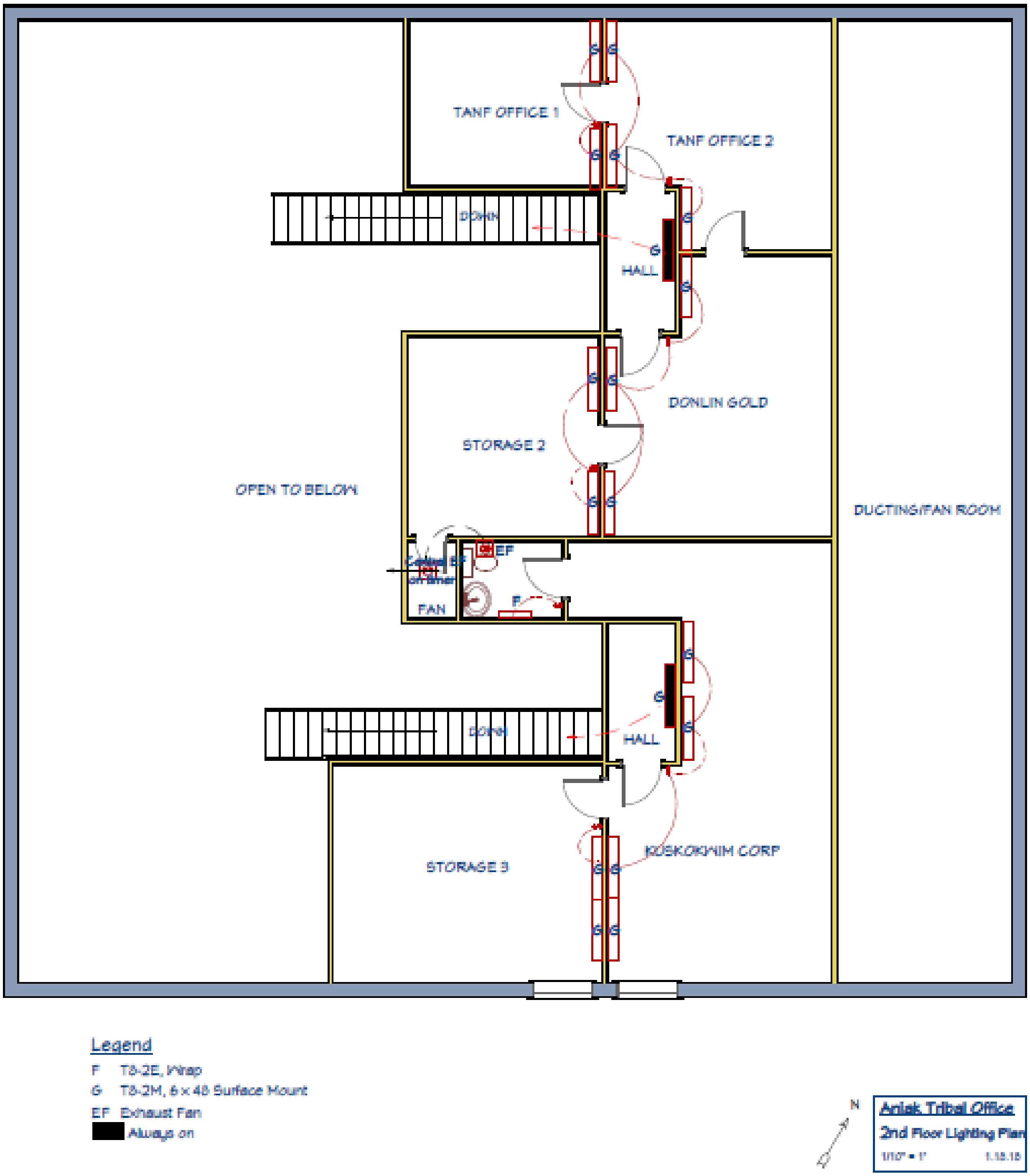
- A T8-4M, 24 x 48 Surface Mount
- B T8-4M, 24 x 48 Recessed Troffer
- C T8-2M, 16 x 48 Wrap
- D T8-4E, 16 x 48 Wrap
- E T8-2M, 8 x 48 Wrap
- F T8-2E x 24", Wrap
- G T8-2M, 6 x 48 Surface Mount
- H HPS Wall Pack, 70w
- J Duplex Head Bolt Heater Outlet
- OS Ocupancy Sensor
- bo Burned out
- * May not be functional
- Always on

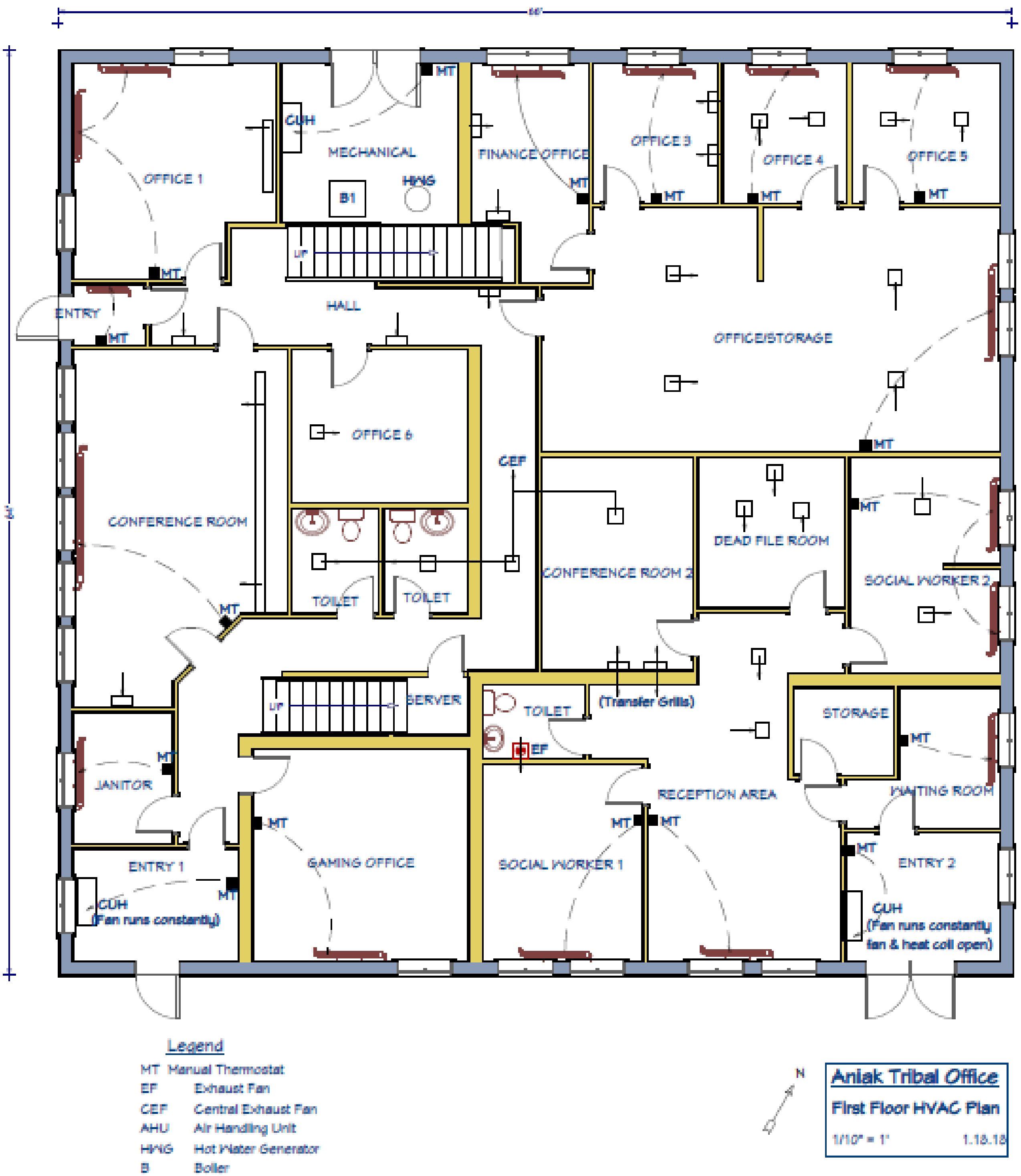
N

Aniak Tribal Office

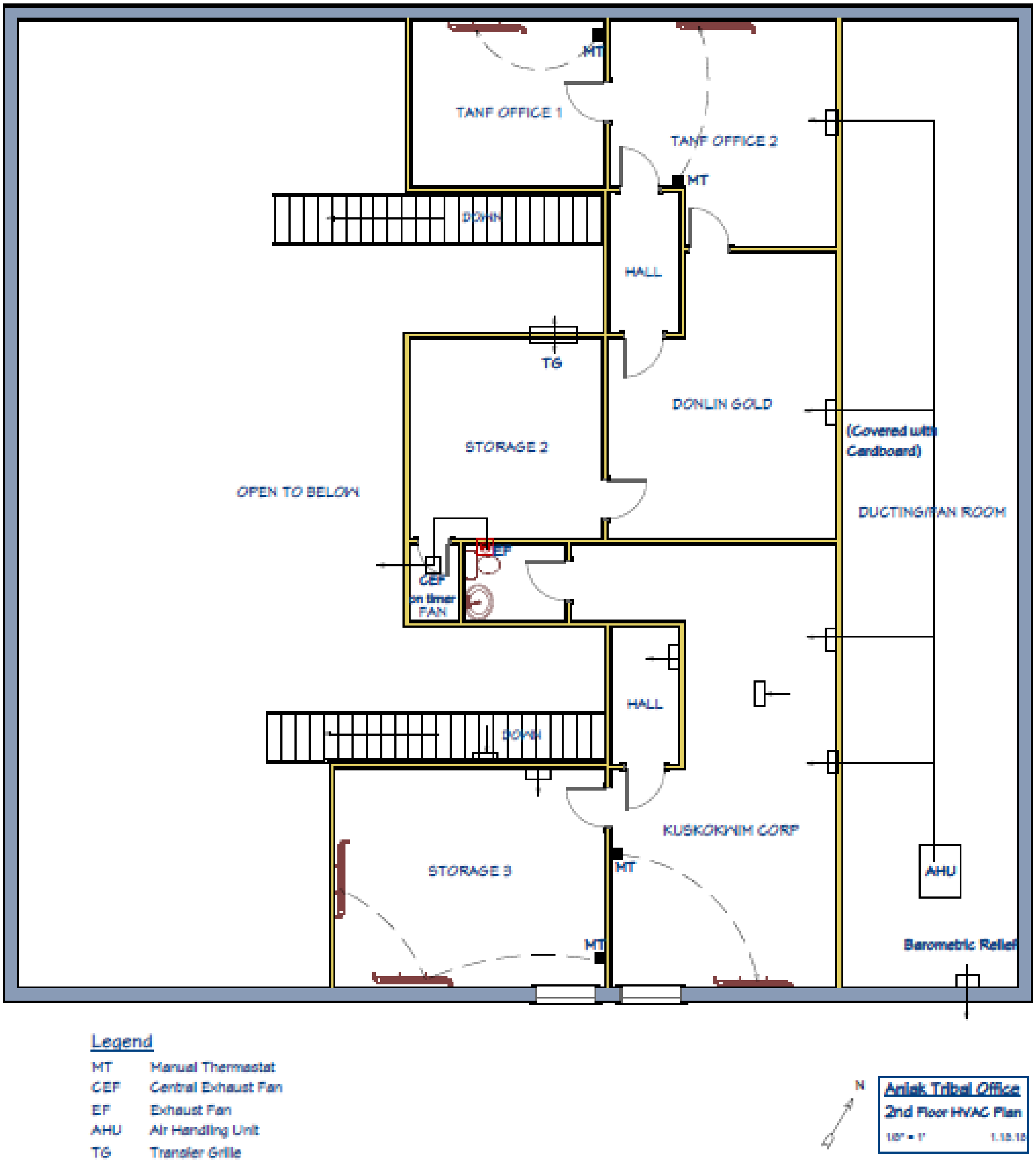
First Floor Lighting Plan

1/10" = 1' 1.18.18


TANF OFFICE 1
TANF OFFICE 2
DOWN
HALL
DONLIN GOLD
STORAGE 2
OPEN TO BELOW
DUCTING/FAN ROOM
EF
FAN
F
DOWN
HALL
STORAGE 3
KUSKOKWIM CORP
Legend
F T8-2E, Wrap
G T8-2M, 6 x 48 Surface Mount
EF Exhaust Fan
Always on
N
Aniak Tribal Office
2nd Floor Lighting Plan



OFFICE 1
CUH
MECHANICAL
HWG
B1
FINANCE OFFICE
OFFICE 3
OFFICE 4
OFFICE 5
ENTRY
HALL
OFFICE/STORAGE
OFFICE 6
CEF
CONFERENCE ROOM
TOILET
TOILET
CONFERENCE ROOM 2
DEAD FILE ROOM
SOCIAL WORKER 2
SERVER
TOILET
(Transfer Grills)
EF
STORAGE
JANITOR
RECEPTION AREA
WAITING ROOM
ENTRY 1
GAMING OFFICE
SOCIAL WORKER 1
ENTRY 2
CUH
(Fan runs constantly)
CUH
(Fan runs constantly fan & heat coil open)
MT
UP
N
Legend
MT Manual Thermostat
EF Exhaust Fan
CEF Central Exhaust Fan
AHU Air Handling Unit
HWG Hot Water Generator
B Boiler
Aniak Tribal Office
First Floor HVAC Plan
1/10" = 1'
1.18.18


TANF OFFICE 1
MT
TANF OFFICE 2
MT
DOWN
HALL
TG
DONLIN GOLD
STORAGE 2
(Covered with Cardboard)
OPEN TO BELOW
DUCTING/FAN ROOM
EF
CEF
on timer FAN
HALL
DOWN
KUSKOKWIM CORP
STORAGE 3
MT
MT
AHU
Barometric Relief
Legend
MT Manual Thermostat
CEF Central Exhaust Fan
EF Exhaust Fan
AHU Air Handling Unit
TG Transfer Grille
N
Aniak Tribal Office
2nd Floor HVAC Plan

Appendix E – Photographs & IR Images

AHU air intake is shown, and between the intake and satellite disc is the barometric relief damper

Typical condition of wood window frames, all require a coat of paint

Boiler room, well-insulated piping

Constant speed circulation pumps, assumed to be set up on lead-lag mode

Indirect hot water generator

Corridor lighting controls, time clock is 4 hours behind actual time

Boiler controller

AHU 3-way valve; relief dampers in background

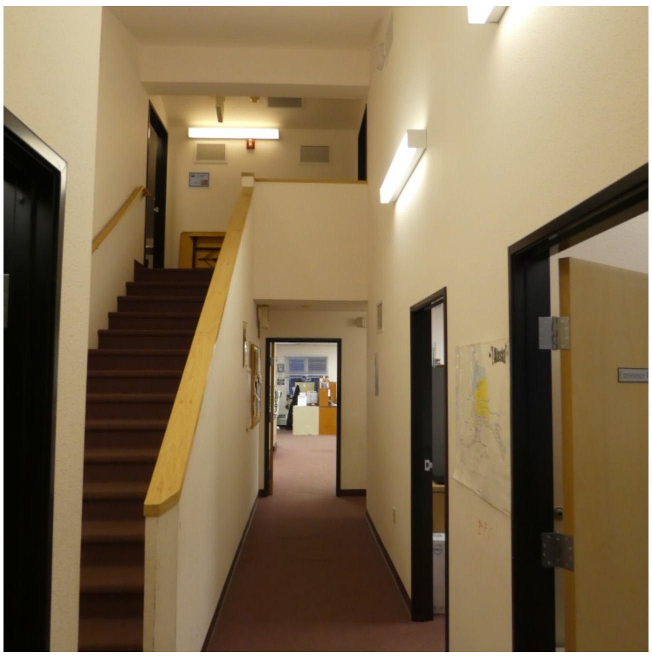
AHU Heating coil nearly clogged with insects and debris

AHU Supply fan motor pulley needs tightening

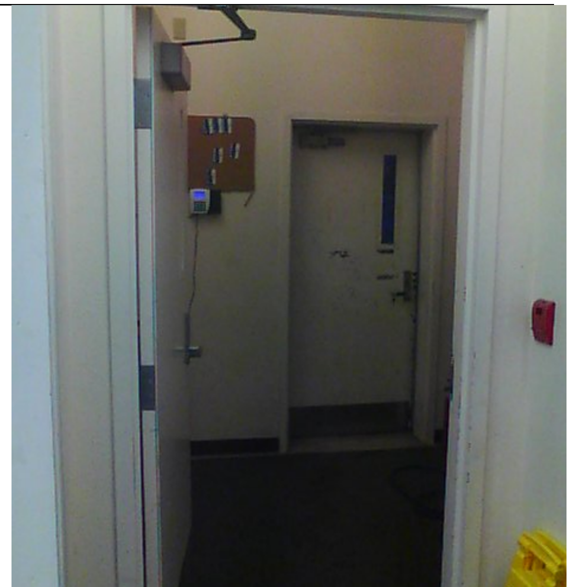
Central Exhaust fan timer is turned off

Typical manual room thermostat

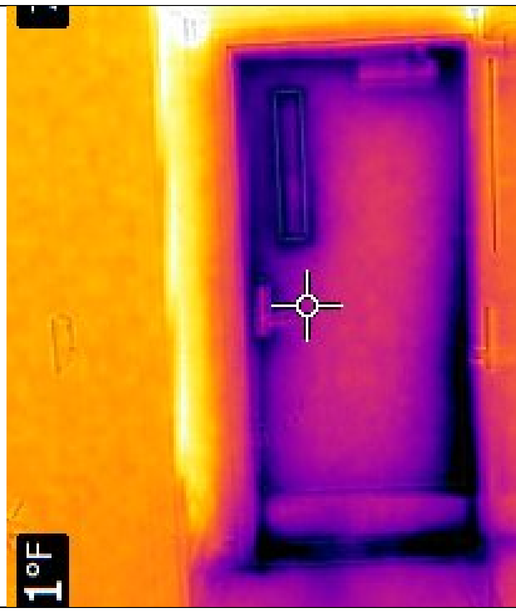
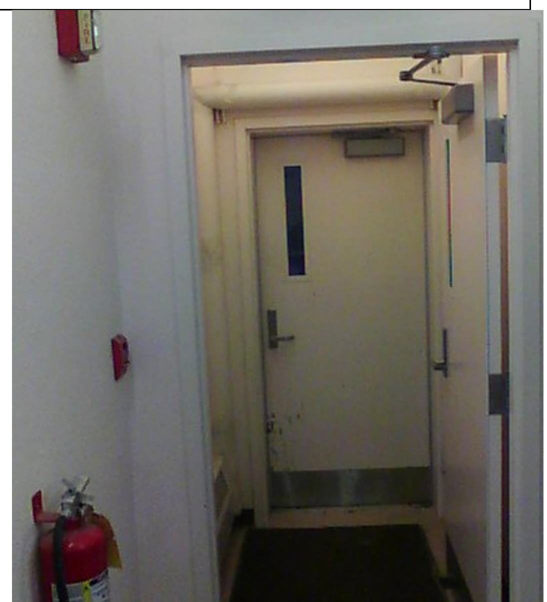
Second floor office, AHU supply diffuser covered with cardboard



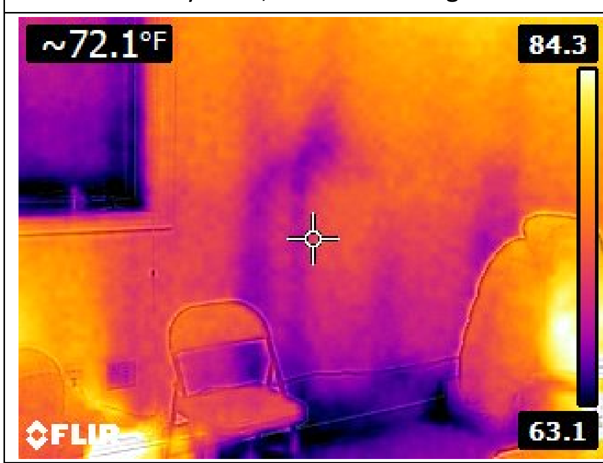
First-floor corridor; lighting controlled by timer in boiler room

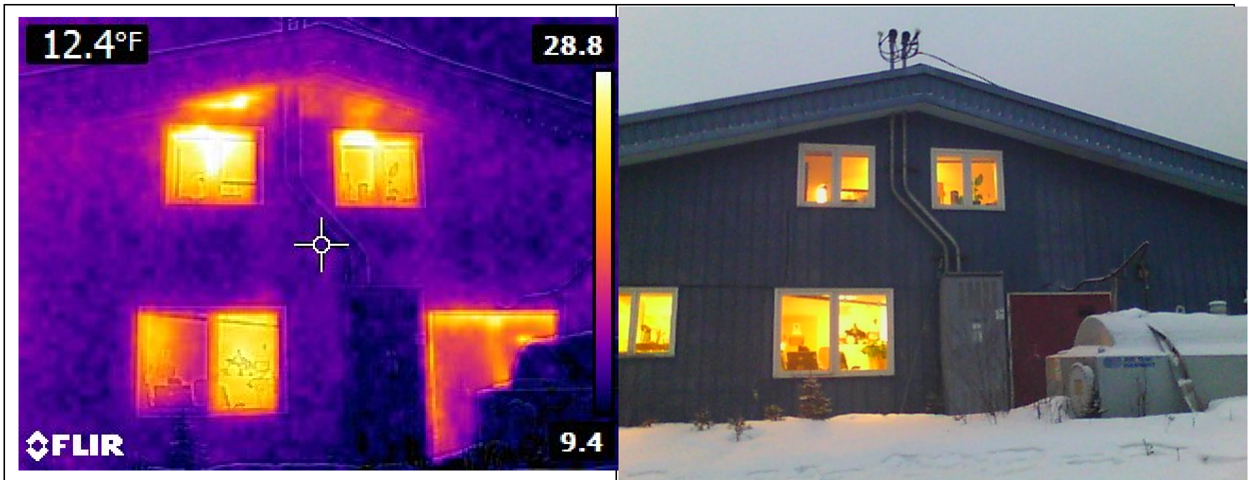
1. South entry door, shows significant heat loss around periphery

2. West entry door, shows same significant heat loss around periphery



3. Poorly installed or damaged wall insulation

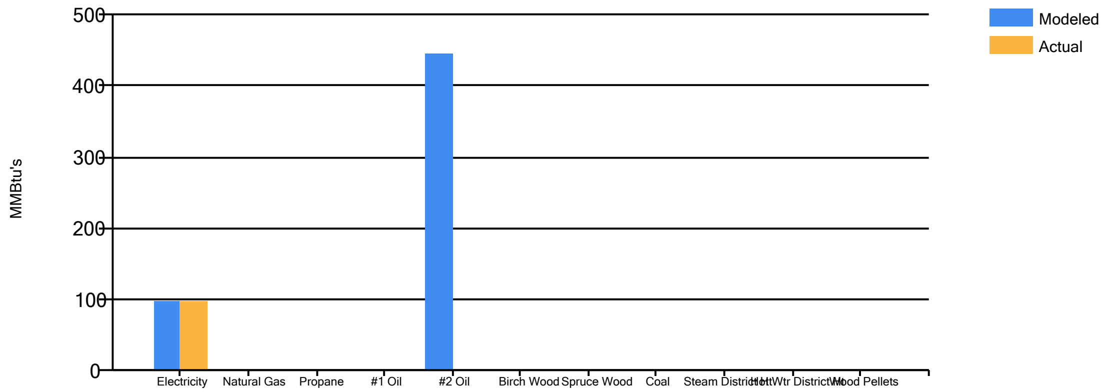


4. Damaged insulation above second floor windows; standby boiler heat losses are evident around periphery of boiler room doors, lower right

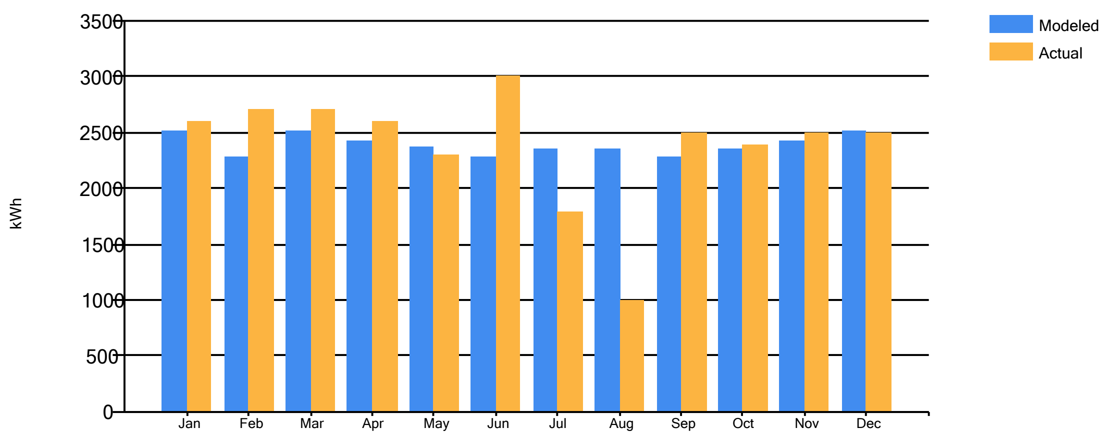
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

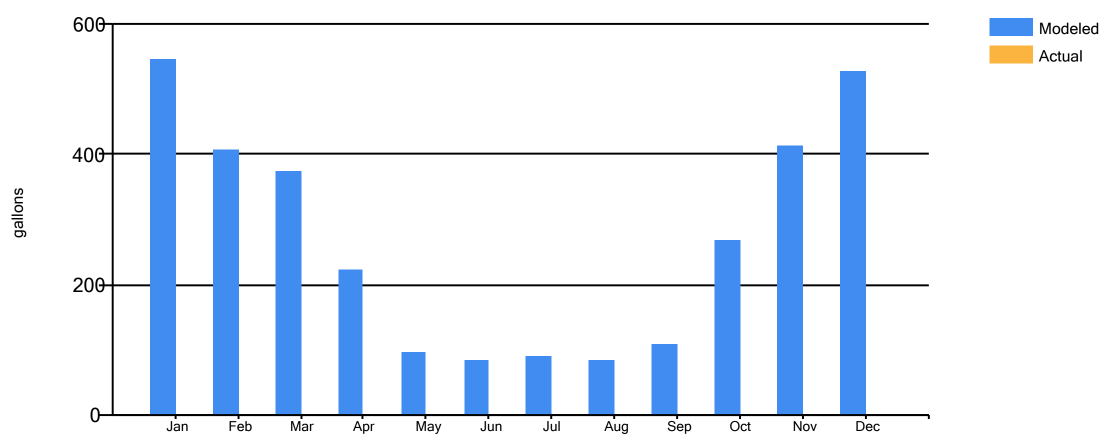
Annual Fuel Use



Electricity Fuel Use



#2 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
AHU	Air Handling Unit
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
CFM	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OSA	Outside Air
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECM's, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

Comprehensive Energy Audit
For the Aniak VPSO Tribal Police Office

Prepared For
Native Village of Aniak
Laura Simeon, Tribal Administrator
P.O. Box 349
Aniak, AK 99557
aniaktribe@gmail.com
907-675-4349

Site Survey Date:
January 16, 2018

Prepared By:
James Fowler, PE, CEM
Energy Audits of Alaska
200 W 34th Ave, Suite 1018
Anchorage, AK 99503
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Energy Audits of Alaska

Table of Contents

Appendices H, I and J are included as a separate file due to size

Revision Tracking

Copy-edited version – September 21, 2018
New Release – September 12, 2018

Disclaimers

This energy audit is intended to identify and recommend potential areas of energy savings (energy efficiency measures, or EEMs), estimate the value of the savings and approximate the costs to implement the recommendations. This audit report is not a design document and no design work is included in the scope of this audit. Any modifications or changes made to a building to realize the savings must be designed and implemented by licensed, experienced professionals in their fields. Lighting recommendations should all be first analyzed through a thorough lighting analysis to assure that the recommended lighting upgrades will comply with any State of Alaska Statutes as well as Illuminating Engineering Society (IES) recommendations. Lighting upgrades should be made by a qualified electrician in order to maintain regulatory certifications on light fixtures. Ventilation recommendations should be first analyzed by a qualified and licensed engineer experienced in the design and analysis of heating, ventilation, and air-conditioning (HVAC) systems.

Neither the auditor nor Energy Audits of Alaska bears any responsibility for work performed as a result of this report.

Payback periods may vary from those forecasted due to the uncertainty of the final installed design, configuration, equipment selected, and installation costs of recommended EEMs, or the operating schedules and maintenance provided by the owner. Furthermore, EEMs are typically interactive, so implementation of one EEM may impact the cost savings from another EEM. The auditor accepts no liability for financial loss due to EEMs that fail to meet the forecasted savings or payback periods.

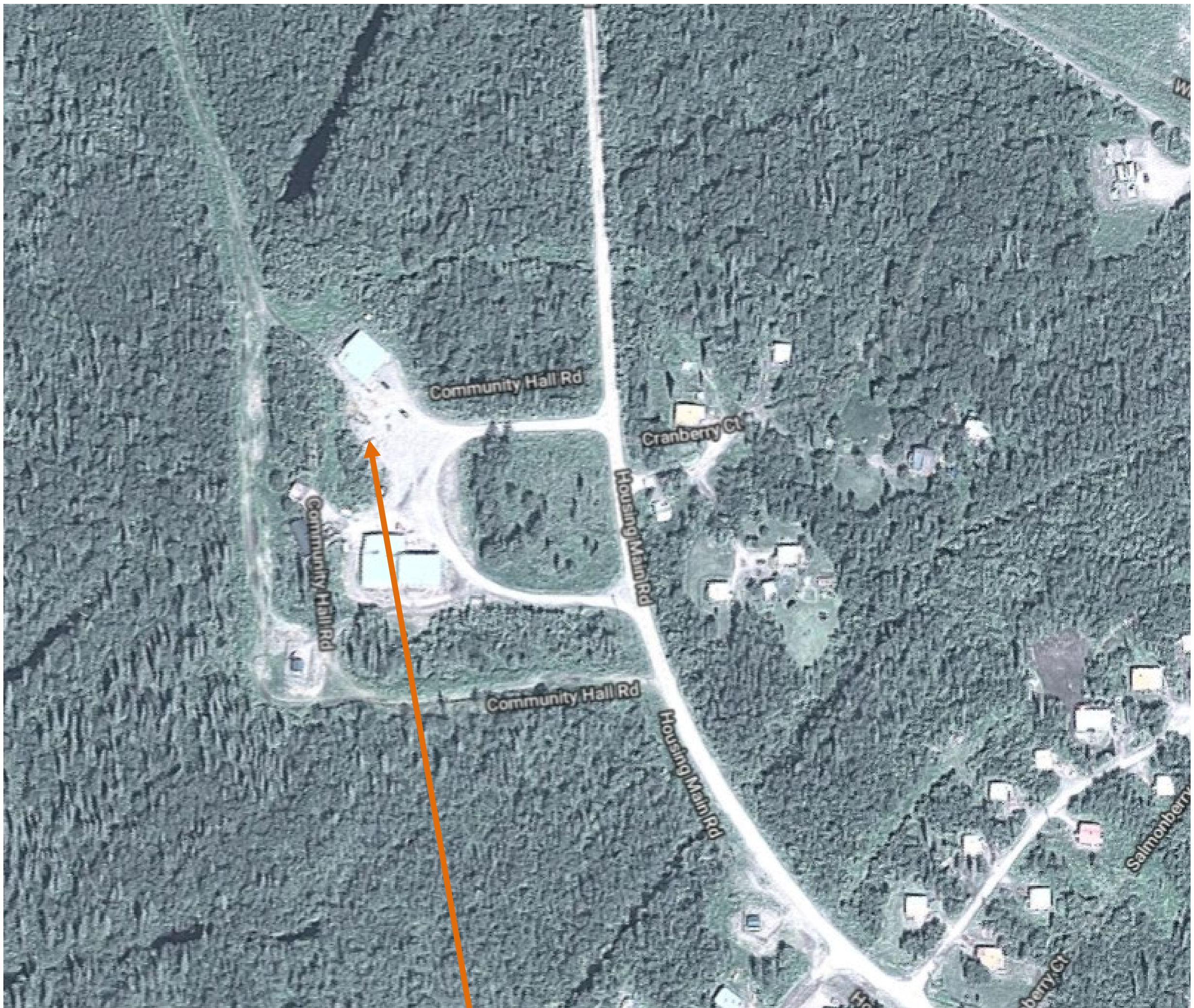
This audit meets the criteria of a Level 2 Energy Audit per the Association of Energy Engineers and per the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) definitions, and is valid for one year. The life of an audit may be extended on a case-by-case basis. This audit is the property of the client.

AkWarm-C© is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Laura Simeon, Daisy Phillips and Matt Morgan, all tribal members or officers who provided access to the buildings as well as their history, use and occupancy and electric usage, and the US Department of Energy who provided funding.

Project Location



NORTH

Subject Building

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1. SUMMARY

This report was prepared for the Native Village of Aniak, owner of the Village Public Safety officer (VPSO) Office. The scope of this report is a comprehensive energy study, which included an analysis of the building shell, interior and exterior lighting systems, HVAC systems, and any process and plug loads. There are no charges for water and wastewater and these systems were not evaluated in this analysis.

This is a Level 2+ audit as defined by ASHRAE; it is a technical and economic analysis of potential energy saving projects in a facility. The analysis must provide information on current energy consuming equipment, identify technically and economically feasible EEMs for existing equipment and provide the client with sufficient information to judge the technical and economic feasibility of the recommended EEMs. The energy conservation measures (ECMs) identified in this audit, although they have the potential to save significant consumption and cost, are not part of the technical and economic analysis. The “avoided costs” resulting from ECMs are discussed in Section 1.7, but are not included in the cost and savings calculations in this audit.

1.1 Guidance to the Reader

The 7-page summary is designed to contain all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost, their estimated annual savings and simple payback. The summary discusses the subject building and provides a summary table with the overall savings, costs, and payback for all recommended EEMs and ECMs for the facility covered in this audit.

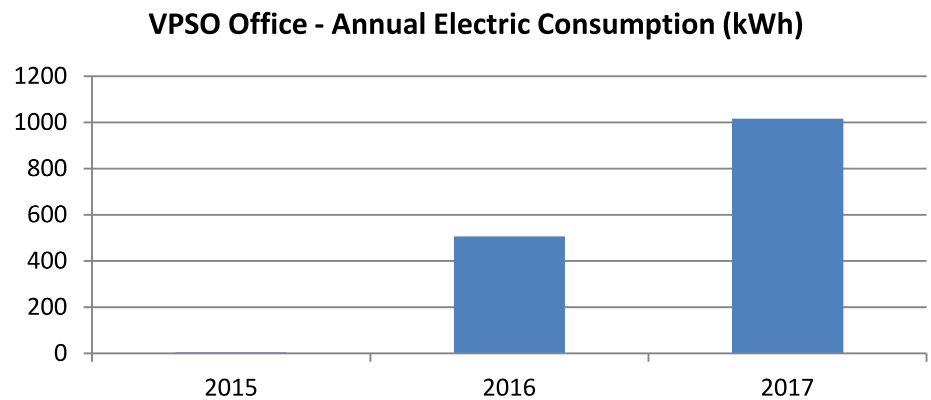
Sections 2, 3, and 4 of this report and the Appendices, are back-up and provide much more detailed information should the owner/operator, or staff, desire to investigate further. Sections 4.3 through 4.5 include additional auditor’s notes for many EEMs. Due to their length, Appendices H, I and J, which contain additional ECM detail, lighting information and manufacturer’s “cut sheets” of samples of recommended retrofit products, are included as a separate document.

<u>Issues that the auditor feels are of particular importance to the reader are underlined</u> and all abbreviations and acronyms used in this document are listed in Appendix G.

1.2 Noteworthy Points & Immediate Action

a. There was no one occupying the subject building and access was not provided during the site survey, but it is identical to the VPSO office in Kwigillingok, so the Kwigillingok interior dimensions and lighting were used for this building. An operating schedule of 9:00am-5:00pm Monday through Friday was used for the building, except the cells were considered to be occupied for 4 hours per month.

b. This is a very simple, well insulated, relatively new, low occupancy building, so there are very few possible ECMs and EEMs other than programming the setback on the Toyo stove, and upgrading the lighting, both of which are recommended.
c. If all the recommended EEMs are incorporated in this building, there will be a 26.1% reduction in annual energy costs, totaling $481, with a simple payback of 4 months on the $108 implementation cost.
d. Fuel oil delivery data for this building was not provided by the building owner, therefore the fuel oil consumption figures in this analysis had to be derived from the AkWarm-C energy simulation model. The modeled figures may not represent the actual consumption figures and therefore the energy savings may lose accuracy.
e. As seen in the bar chart below, the annual electric consumption for this building has varied considerable over the last 3 years. This indicates that its use and occupancy has changed, so the model and savings are not likely to be accurate if the use and occupancy are different from 2017 and different from the assumptions used to create the AkWarm-C energy simulation model.



f. It was assumed in this analysis, that common electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by Tribal Staff members rather than qualified electricians. A labor rate of $45/hr was used for this activity. It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician.

1.3 Current Cost and Breakdown of Energy

This building does not receive the power cost equalization (PCE) discount. Based on electricity and fuel oil prices in effect at the time of the audit, and using the uncalibrated AkWarm-C© energy model[1], the total predicted energy costs are $1,752 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$520 for Electricity
$1,232 for #1 Oil

Predicted Annual Fuel Use		
Fuel Use	Existing Building	With Proposed Retrofits
Electricity	946 kWh	668 kWh
#1 Oil	217 gallons	174 gallons

[1] If both electric and oil consumption data were available, the AkWarm-C model would normally be calibrated to these figures resulting in more accurate savings projections.

The table below shows the relative costs per MMBTU for electricity and fuel oil and Figures 1.1 and 1.2 show the breakdown of energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.55	$161.15
Fuel Oil	$5.69	$43.10

Figure 1.1

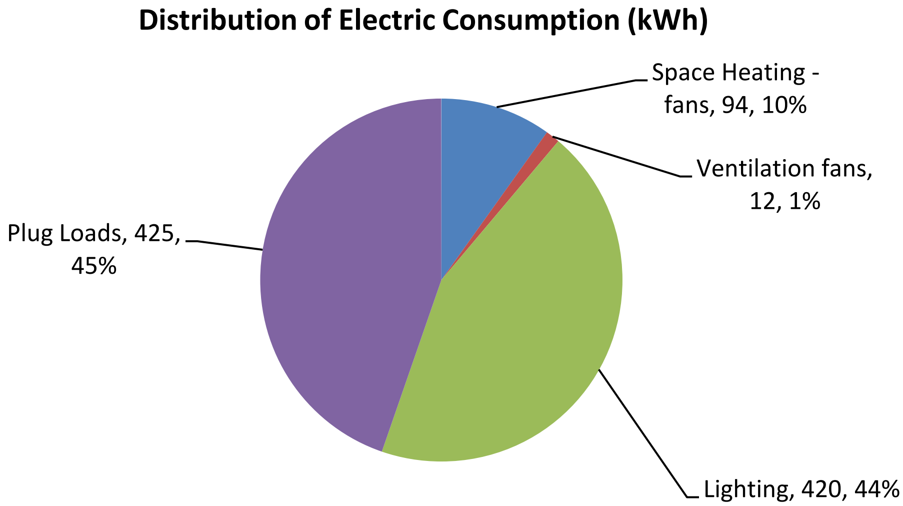
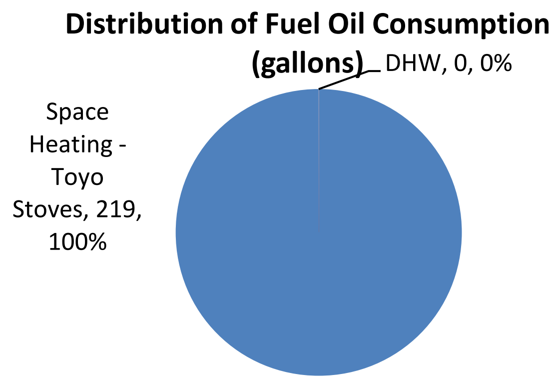


Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on lighting and space heating.

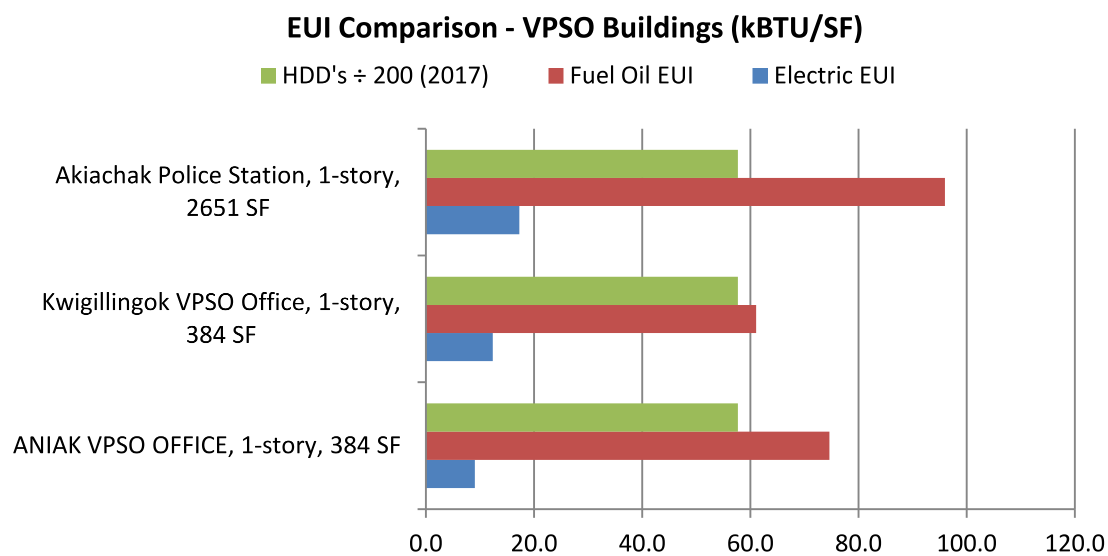
1.4 Benchmark Summary

Benchmark figures facilitate the comparison of 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 and Appendix B.

Building Benchmarks			
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	82.9	6.46	$4.56
With Proposed Retrofits	65.9	5.14	$3.54
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.			

1.5 Energy Utilization Comparison

The subject building's heating and electric energy utilization indexes (EUIs) are compared to similar use buildings in the region in the bar chart below. The Heating Degree Days[2] (HDDs) bars are intended to normalize the effect of weather differences; in this case, all 3 comparison buildings are in the same region, with the same number of HDDs. As seen in the chart, the subject building's heating EUI falls right at the average of all 3 buildings and between the other two comparison buildings. The subject building's electric EUI is lower than either of the other two, most likely attributed to its low occupancy and use. Additional discussion is provided in Appendix B.



1.6 Energy Efficiency Measures(EEMs)

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3, and Figure 1.4 shows the reduction in cost, consumption, and BTUs of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these two tables.

[2] HDD are a measure of the severity of cold weather; higher HDD indicate colder, more severe weather. A building's heating EUI should increase or decrease along with a proportional increase or decrease in HDD.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
Setback Thermostat on Toyo (owner to program)	$4	$282	0.01
Lighting	$104	$114	0.9
Totals	**$108**	**$396**	**0.3**

Figure 1.4

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	1,016	3,468	668	2,280	34.3%
Gallons Oil	217	28,644	174	22,968	19.8%
Energy Cost	$1,841		$1,360		26.1%

Table 1.1 below summarizes the energy efficiency measures analyzed for the VPSO Tribal Police Office. Estimates of annual energy and maintenance savings, installed costs, and simple paybacks are shown for each EEM. Table 4.1 shows an additional measure of financial return on investment as well as CO_2 savings. The $1.00 figure is used in AkWarm-C when no cost is anticipated[3], in the case of EEMs #1-4; the owner or staff is expected to program the Toyo Stoves.

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	Setback Thermostat: Office, Hall	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Office, Hall space.	$126 / 2.9 MMBTU	$1	1711.09	0.0	467.7
2	Setback Thermostat: Cells	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Cells space.	$91 / 2.1 MMBTU	$1	1234.08	0.0	337.3
3	Setback Thermostat: Toilet	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Toilet space.	$38 / 0.9 MMBTU	$1	507.36	0.0	138.7
4	Setback Thermostat: Storage	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Storage space.	$27 / 0.6 MMBTU	$1	371.98	0.0	101.7

3 AkWarm-C does not allow a $0 cost

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
5	Lighting - Power Retrofit: Entry & Hall Incan A-type	Replace with 2 LED 9W Module StdElectronic	$66 / 0.0 MMBTU	$10	53.90	0.2	190.9
6	Lighting - Power Retrofit: Toilet Incan A-type	Replace with LED 9W Module StdElectronic	$10 / 0.0 MMBTU	$5	16.61	0.5	29.4
7	Lighting - Power Retrofit: Exterior flood CFL-BR	Replace with LED (2) 10W Module StdElectronic	$6 / 0.0 MMBTU	$10	5.42	1.6	19.9
8	Lighting - Power Retrofit: Office T8-2lamp surf mt	Replace with LED (2) 15W Module StdElectronic	$26+ $5 Maint. Sav.	$74	3.39	2.4	73.5
9	Lighting - Power Retrofit: Storage Incan A-type	Replace with LED 9W Module StdElectronic	$1	$5	1.64	4.9	2.9
	TOTAL, all measures		**$393 + $5 Maint. Savings / 6.5 MMBTU**	**$108**	**44.07**	**0.3**	**1,362.1**

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 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.

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 existing building. 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. Maintenance savings are not included in the savings shown in this table.

Table 1.2

Annual Energy Cost Estimate

Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Service Fees	Total Cost
Existing Building	$1,284	$0	$0	$6	$231	$231	$0	**$1,752**
With Proposed Retrofits	$1,039	$0	$0	$6	$83	$231	$0	**$1,360**
Savings	$245	$0	$0	$0	$147	$0	$0	**$393**

1.7 Energy Conservation Measures (ECMs)

No- and low-cost EEMs are called ECMs and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent cost and consumption increases, which are more accurately called "avoided costs" rather than cost savings. Listed below are the ECMs applicable to the subject building.

1) **Ongoing Energy Monitoring** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. HVAC "performance drift" is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. It is recommended to implement a basic energy monitoring system for this building, ***including installing a cumulative fuel oil meter on the oil day tank***.

   There is a range of simple to very complex building monitoring systems commercially available, and most utilize a user-friendly internet or network-based dashboard. They range from a simple do-it-yourself approach utilizing a spreadsheet and graph to public domain packages to proprietary software and hardware packages. A partial listing follows:

   ARIS - The Alaska Housing Finance Corporation (AHFC) offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owners track and manage energy use and costs. For more information contact Tyler Boyes (907-330-8115, tboyes@ahfc.us) or Betty Hall at the Research Information Center (RIC) Library at AHFC (907-330-8166, bhall@ahfc.us)

   BMON - AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings, and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

   Monnit – "product model" sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPTION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures, is it too hot or cold in the building?	
Are computers left on and unattended?	
Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas and/or oil	
Re-program Toyo stoves after a power outage	

3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency and reduce the cost of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.
4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Weather-stripping should be maintained if it exists or added if it does not.
5) **Turn off plug loads** including computers, printers, faxes, etc. when leaving the room. For workstations where the occupant regularly leaves their desk, add an occupancy sensing plug load management device (PLMD) like the "Isole IDP 3050" power strip produced by Wattstopper (See Appendix J).
6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans, and thermostats in this building. An unmaintained HVAC component like a boiler can reduce its operating efficiency by 3% or more.
7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone and decrease the heat and lighting in that zone
8) **Additional ECM recommendations**:
    a. Maintain air sealing on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes, and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.
    b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix J can be purchased for as little as $15.

c. Maintain the programming on the set-back thermostat built into the Toyo Stove, especially after power outages.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the VPSO Tribal Police Office. 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 including building plans and utility consumption data (if available) was gathered in preparation for the site survey. An interview was conducted with the building owner or manager, if possible, to understand their objectives and ownership strategy and gather other information the auditor could use to make the audit most useful. The site survey provides critical information in deciphering where energy is used and what savings opportunities exist within a building. The entire building was surveyed, including every accessible room, and the areas listed below were evaluated to gain an understanding of how the building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment including refrigeration equipment
- Plug loads

Summaries of building occupancy schedules, operating and maintenance practices, and existing energy management programs provided by the building manager/owner were collected along with as much system and component nameplate information as was available.

2.3 Method of Analysis

The details collected from VPSO Tribal Police Office enable a model of the building's overall energy usage to be developed – this is referred to as "existing conditions" or the "existing building." The analysis involves distinguishing the different fuels used on site and analyzing their consumption in different activity areas of the existing building.

AkWarm-C Building Simulation Model

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, adding any HVAC systems, ventilation, and heat recovery, adding major equipment, plug loads, any heating or cooling process loads, the number of occupants (each human body generates approximately 450 BTU/hr. of heat) and the hours of operation of the building.

VPSO Tribal Police Office is classified as being made up of the following activity areas:

1) Office, Hall: 201 square feet
2) Storage: 32 square feet
3) Toilet: 50 square feet
4) Cells: 101 square feet

The methodology took a range of building-specific factors into account, including:

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

For the purposes of this study, the thermal simulation model was created using a modeling tool called AkWarm-C© Energy Use Software. The building characteristics and local climate data were used to establish a baseline space heating and cooling energy usage. The model was calibrated to actual fuel consumption and was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent existing conditions.

Limitations of AkWarm© Models

The model is based on local, typical weather data from a national weather station closest to the subject building. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the monthly fuel use bar charts in Section 3.2 will not likely compare perfectly on a monthly basis 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. For this reason the model is calibrated to the building's annual consumption of each fuel.

The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building and for buildings that can provide simultaneous heating and cooling such as a variable volume air system with terminal re-heat.

Financial Analysis

Our analysis provides a number of tools for assessing the cost effectiveness of various EEMs. 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 its life. The total cost includes both the construction cost (also called "first cost") plus 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 EEM, including annual maintenance savings. AkWarm© calculates projected energy savings based on occupancy schedules, utility rates, building construction type, building function, existing conditions, and climatic data uploaded to the program based on the zip code of the building. Changes in future fuel prices, as projected by the Department of Energy, are included over the life of the improvement. Future savings are discounted to their present value to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation is the first cost of the EEM. An SIR value of at least 1.0 indicates that the project is cost-effective, i.e. 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 energy and maintenance savings 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 of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the projected life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases, nor does it consider the need to earn interest on the investment (i.e. 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 ranked by AkWarm© in order of decreasing SIR. The program first calculates individual SIRs and ranks them from highest to lowest. The software then implements the first EEM, re-calculates each subsequent measure and again re-ranks the remaining measures in order of their SIR. An individual measure must have an individual SIR>=1 to be considered financially viable on a stand-alone basis. AkWarm© goes through this iterative process until all appropriate measures have been evaluated and implemented in the proposed building model.

SIR and simple paybacks are calculated based on estimated first costs for each measure. First costs include estimates of the labor and equipment required to implement a change. <u>Costs are considered to be accurate within +/-30% in this level of audit;</u> they are derived from Means Cost Data, industry publications, the auditors experience and/or local contractors and equipment suppliers.

Interactive effects of EEMs:
It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first (highest SIR), then the EEM with the second highest SIR, then the third, etc. Implementation of an EEM out of the order will affect the savings of the other EEMs. The savings may in some cases be higher and in other cases, lower. 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 some of the recommended EEMs are not implemented, savings for the remaining EEMs will be affected, in some cases positively, and in

others, negatively. If all EEMs are implemented, their order of implementation is irrelevant, because the total savings after full implementation will be unchanged. If an EEM is calculated outside of the AkWarm© model, the interactive effects of that EEM are not reflected in the savings figures of any other EEM.

Assumptions and conversion factors used in calculations:
The underlying assumptions used in the calculations made in this audit follow:

- 3,413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #2 fuel oil
- 91,800 BTU/gallon of propane
- 100,000 BTU/therm or CCF of natural gas

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 a design document and the auditor is not proposing designs or performing design engineering. A design professional who is following the EEM recommendations and who is licensed to practice in Alaska in the appropriate discipline, shall accept full responsibility and liability for the design, engineering, and final results.

Unless otherwise specified, budgetary estimates for engineering and design of these projects are not included in the cost estimate for each EEM recommendation; these costs can be approximated at 15% of the materials and installation costs.

3. VPSO OFFICE EXISTING CONDITIONS

3.1. Building Description

The 384 square-foot VPSO Tribal Police Office was constructed in 2013. It is used by the VPSO as an office and when needed, the cells are used to hold prisoners. Based on the wide variation in annual electric consumption (from 5 kWh in 2015 to 780 kWh in 2016 and 1415 kWh in 2017), there does not appear to be a "normal" use or occupancy for this building. Therefore, for the purposes of this analysis, it was assumed that the building is in use 9:00am until 5:00pm Monday through Friday by a single occupant.

<u>Description of Building Shell</u>

This building is constructed on wood posts supported by wood pads in ground contact. The posts support 6" x 12" glue lam beams with 2" x 12" TJI stringers which appear to be the floor joists. There is no insulation evident in the floor structure.

The walls appear to be constructed with 2" x 6" studs, whose cavities are presumably filled with R-21 fiberglass batt. Interior walls are finished with plywood and the exterior walls are finished with painted T1-11 plywood siding. The windows utilize double pane glass, presumably low-E based on their age, in vinyl frames. The single door is a 6-panel metal skinned door.

The painted metal roof is assumed to be supported by wood trusses and the vented attic is presumed to have R-38 fiberglass batt insulation.

<u>Description of Heating and Cooling Plants</u>

Toyo Laser 73

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	83 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	40 MBH input, nominal 88% thermal efficiency when new, de-rated to 83% for age.

Space Heating and Cooling Distribution Systems
There is no heating distribution system in this building.

Building Ventilation System
There is no ventilation system, ventilation is provided by operable windows.

HVAC Controls
The Toyo Stove has a remote bulb thermostat and internal controls.

Domestic Hot Water System
There appears to be potable water plumbing in the building to service a toilet and lavatory sink, but no access was provided for confirmation. There did not appear to be a hot water heater.

Lighting
The interior lighting consists of a single 2-lamp, 48" fixtures utilizing T8 florescent lamps and electronic ballasts. The surface mount and recessed can fixtures utilize a range of A-type bulbs including incandescent, CFL, and LEDs. No lighting controls appear to be in use. Exterior lighting consists of a single 2-bulb BR30 LED with a motion and photocell sensor.

Major Equipment and Plug Loads
A list of major equipment and most plug loads is found in Appendix A.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

Raw utility source data is tabulated in Appendix B. The AkWarm© model was calibrated on an annual basis to match the actual, baseline electric data before it predicts the annual usage of each fuel. As previously mentioned, the model is typically calibrated to within 95% of actual consumption of each fuel (when fuel data is provided).

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 as predicted by the AkWarm-C model. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The utility companies providing energy to the subject building, and the class of service provided by each, are listed below:

Electricity: Aniak Light & Power - 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	$ 0.5500/kWh
#1 Oil	$ 5.69/gallons

For any historical and comparative analysis in this document, the auditor used current tariff schedules obtained from the utility provider or invoices, which also included customer charges, service charges, energy costs, and taxes. These current tariffs were used for all years to eliminate the impact of cost changes over the years evaluated in the analysis.

Electric utility providers measure 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.

Fuel oil consumption is measured in gallons, but unless there is a cumulative meter on the day tank, data provided for analysis is typically <u>gallons delivered, not gallons consumed</u>. It is assumed that all of the oil delivered during the benchmark period was consumed during the benchmark period.

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, Native Village of Aniak pays approximately $1,752 annually for electricity and other fuel costs for the VPSO Tribal Police Office.

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

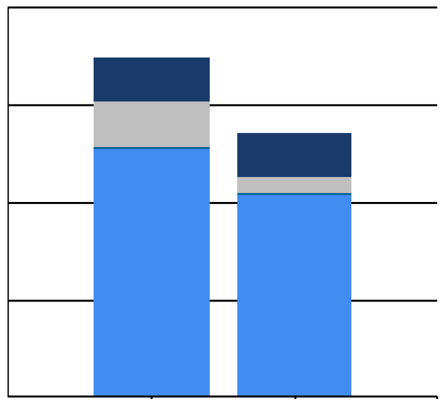


Figure 3.2 below reflects how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are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

Figure 3.2
Annual Energy Costs by Fuel Type

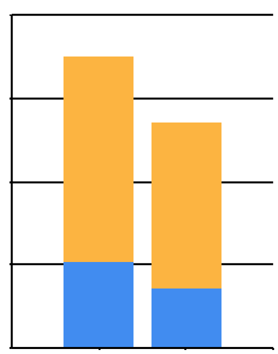
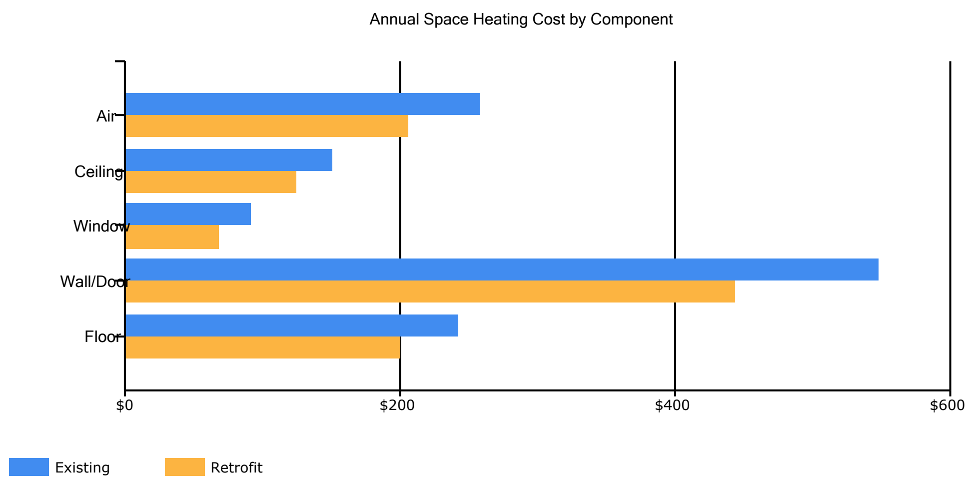


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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 the model'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	12	10	10	7	6	4	4	5	6	8	10	12
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	0	0	0	0	0	0	0	0	0	0	0	0
Ventilation_Fans	1	1	1	1	1	1	1	1	1	1	1	1
Lighting	36	32	36	34	36	34	36	36	34	36	34	36
Other_Electrical	36	33	36	35	36	35	36	36	35	36	35	36

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	37	28	26	17	8	3	2	4	9	20	29	36
DHW	0	0	0	0	0	0	0	0	0	0	0	0

3.2.2 Energy Use Index (EUI)

EUI is a measure of a building's annual energy utilization per square foot of building.
It is a good measure of a building's energy use and is utilized regularly for energy performance comparisons with similar-use buildings.

EUIs are calculated by converting all the energy consumed by a building in one year to BTUs and multiplying by 1000 to obtain kBTU. This figure is then divided by the building square footage.

"Source energy" differs from "site energy." Site energy is the energy consumed by the building at the building site only. Source energy includes the site energy as well as all of the losses incurred during the creation and distribution of 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, and allows for a more complete assessment of energy efficiency in a building. The type of energy or fuel purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the best measure to use for evaluation purposes and to identify the overall global impact of energy use. Both the site and source EUI ratings for the building are provided below.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{\text{(Electric Usage in kBtu + Gas Usage in kBtu + similar for other fuels)}}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{\text{(Electric Usage in kBtu X SS Ratio + Gas Usage in kBtu X SS Ratio + similar for other fuels)}}{\text{Building Square Footage}}$$

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

Table 3.4
VPSO Tribal Police Office 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	946 kWh	3,228	3.340	10,780
#1 Oil	217 gallons	28,588	1.010	28,874
Total		**31,816**		**39,654**
BUILDING AREA		384	Square Feet	
BUILDING SITE EUI		83	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		103	**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	**82.9**	**6.46**	**$4.56**
With Proposed Retrofits	**65.9**	**5.14**	**$3.54**
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.**			

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures considered for this building are summarized in Table 4.1. Please refer to the individual measure descriptions later in this section for more detail, including the auditor's notes. The basis for the cost estimates used in this analysis is found in Appendix C.

Table 4.1
VPSO Tribal Police Office, Aniak, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)	CO_2 Savings
1	Setback Thermostat: Office, Hall	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Office, Hall space.	$126 / 2.9 MMBTU	$1	1711.09	0.0	467.7
2	Setback Thermostat: Cells	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Cells space.	$91 / 2.1 MMBTU	$1	1234.08	0.0	337.3
3	Setback Thermostat: Toilet	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Toilet space.	$38 / 0.9 MMBTU	$1	507.36	0.0	138.7
4	Setback Thermostat: Storage	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Storage space.	$27 / 0.6 MMBTU	$1	371.98	0.0	101.7
5	Lighting - Power Retrofit: Entry & Hall Incan A-type	Replace with 2 LED 9W Module StdElectronic	$66 / 0.0 MMBTU	$10	53.90	0.2	190.9
6	Lighting - Power Retrofit: Toilet Incan A-type	Replace with LED 9W Module StdElectronic	$10 / 0.0 MMBTU	$5	16.61	0.5	29.4
7	Lighting - Power Retrofit: Exterior flood CFL-BR	Replace with LED (2) 10W Module StdElectronic	$6 / 0.0 MMBTU	$10	5.42	1.6	19.9
8	Lighting - Power Retrofit: Office T8-2lamp surf mt	Replace with LED (2) 15W Module StdElectronic	$26 + $5 Maint. Savings / 0.0 MMBTU	$74	3.39	2.4	73.5
9	Lighting - Power Retrofit: Storage Incan A-type	Replace with LED 9W Module StdElectronic	$1 / 0.0 MMBTU	$5	1.64	4.9	2.9
	TOTAL, all measures		**$393 + $5 Maint. Savings / 6.5 MMBTU**	**$108**	**44.07**	**0.3**	**1,362.1**

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 effects 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 Insulation Measures (There were no improvements in this category)

4.3.2 Window Measures (There were no improvements in this category)

4.3.3 Door Measures (There were no improvements in this category)

4.3.4 Air Sealing Measures (There were no improvements in this category)

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure (There were no improvements in this category)

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

4.4.3 Night Setback Thermostat Measures ***(a single Toyo Stove serves all building areas, the areas are listed below by function)***

Rank	Building Space			Recommendation	
1	Office, Hall			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Office, Hall space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$126
Breakeven Cost	$1,711	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	2.9 MMBTU
		Savings-to-Investment Ratio	1,711.1		
Auditors Notes: Owner to program					

Rank	Building Space			Recommendation	
2	Cells			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Cells space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$91
Breakeven Cost	$1,234	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	2.1 MMBTU
		Savings-to-Investment Ratio	1,234.1		
Auditors Notes: Owner to program					

Rank	Building Space			Recommendation	
3	Toilet			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Toilet space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$38
Breakeven Cost	$507	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.9 MMBTU
		Savings-to-Investment Ratio	507.4		
Auditors Notes: Owner to program					

Rank	Building Space			Recommendation	
4	Storage			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Storage space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$27
Breakeven Cost	$372	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.6 MMBTU
		Savings-to-Investment Ratio	372.0		
Auditors Notes: Owner to program					

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	
5	Entry & Hall Incan A-type	2 INCAN A Lamp, Std 60W with Manual Switching		Replace with 2 LED 9W Module StdElectronic	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$66
Breakeven Cost	$539	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	53.9		
Auditors Notes: Replace (2) A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
6	Toilet Incan A-type	INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 9W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$10
Breakeven Cost	$83	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	16.6		
Auditors Notes: Replace (1) A-type incandescent bulbs with 9w A-type LED bulb @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
7	Exterior flood CFL-BR	FLUOR (2) CFL, Reflector 15W R30 with Occupancy Sensor, Daylight Sensor		Replace with LED (2) 10W Module StdElectronic	
Installation Cost	$10	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$6
Breakeven Cost	$54	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	5.4		
Auditors Notes: Replace (2) BR-30 CFL bulbs with 10w BR-30 LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location	Existing Condition		Recommendation	
8	Office T8-2lamp surf mt	FLUOR (2) T8 4' F32T8 32W Standard Instant EfficMagnetic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$74	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$26
Breakeven Cost	$251	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	3.4	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast, replace end caps if required and re-wire for line voltage in (1) fixtures @ .75 hrs/fixture labor @ $45/hr. Replace (2) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
9	Storage Incan A-type	INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 9W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$1
Breakeven Cost	$8	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.6		
Auditors Notes: Replace (1) A-type incandescent bulbs with 9w A-type LED bulb @ $5 ea. No labor, owner to install.					

4.5.1b Lighting Measures – Lighting Controls (There were no improvements in this category)

4.5.2 Refrigeration Measures (There were no improvements in this category)

4.5.3 Other Electrical Measures (There were no improvements in this category)

4.5.4 Cooking Measures (There were no improvements in this category)

4.5.5 Clothes Drying Measures (There were no improvements in this category)

4.5.6 Other Measures (There were no improvements in this category)

APPENDICES

Appendix A – Major Equipment List

ALL SCHEDULES COMPILED FROM PLANS OR ON-SITE NAMEPLATE OBSERVATION, WHERE ACCESSIBLE e= estimated

EXHAUST FAN SCHEDULE

SYMBOL	MOTOR MFGR/MODEL	CFM	MOTOR DATA HP/VOLTS/PH	REMARKS
	unknown	e100	e60w/115/1	Bathroom exhaust fan

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
Well Pump	unknown		unknown	

HEAT PLANT SCHEDULE

SYMBOL	MFGR/MODEL	NOMINAL EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
	Toyo Laser 73	88%	260w/120/1	No access to bldg, assumed to be same equipment as Kwigillingok VPSO; 40 MBH input

PLUMBING FIXTURES

SYMBOL	FIXTURE	GPF	QUANTITY	REMARKS
	W.C.	e1.6	1	manually operated
	Lavatory	e2.0	1	manually operated

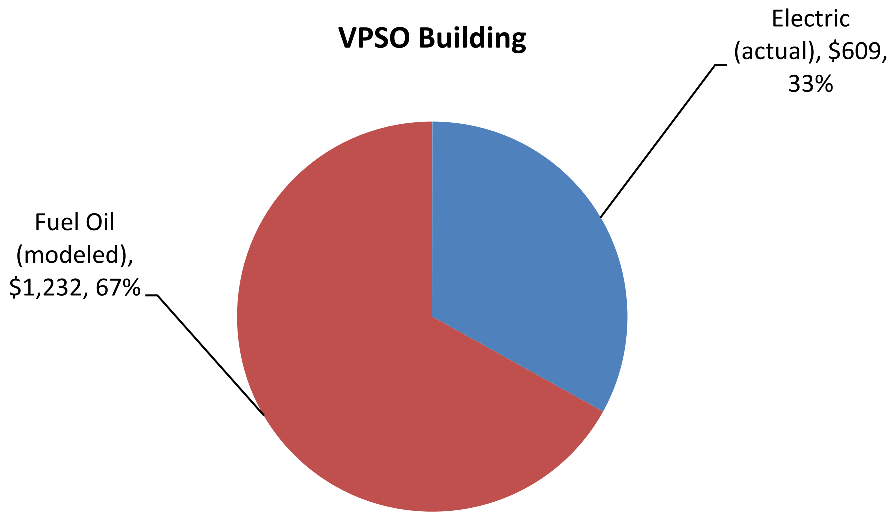
Appendix B – Benchmark Analysis and Utility Source Data

A benchmark analysis evaluates historical raw consumption and cost data for each energy type. The purpose of a benchmark analysis is to identify trends, anomalies, and irregularities that may provide insight regarding the building's function and efficiency. Thirty-six months of historical data is usually a sufficient period of time to gain an understanding of the building operation. Electric consumption data from 2015 through 2017 was available, but no fuel oil delivery or consumption data was provided. Figures B.1 and B.2 show the 3-year summary of consumption and costs for this facility. The shaded cells represent the data used in the AkWarm-C model.

Figure B.1 – Total Building Energy Consumption and Costs

VPSO BUILDING (no PCE)						
	Elec. Consumption (kWh)	**Electric Cost**	**Fuel Oil use (predicted by AkWarm-C) - gallons**	**Fuel oil Cost**	**Total kBTUs of Energy**	**Total Utility Cost**
2015	5	$3				
2016	506	$295	217	$1,232	32,112	$1,841
2017	1,016	$609				

Figure B.2 - Costs



Electricity: Figure B.3 shows very consistent electric consumption in the second half of each year, but the building appears to have been unused in the first half of 2016 and for all of 2015 (there is only one data point in 2015, December's consumption was 5 kWh). Figure B.4 does not provide any additional insight.

Figure B.3 – 2 Years of monthly Electric Consumption

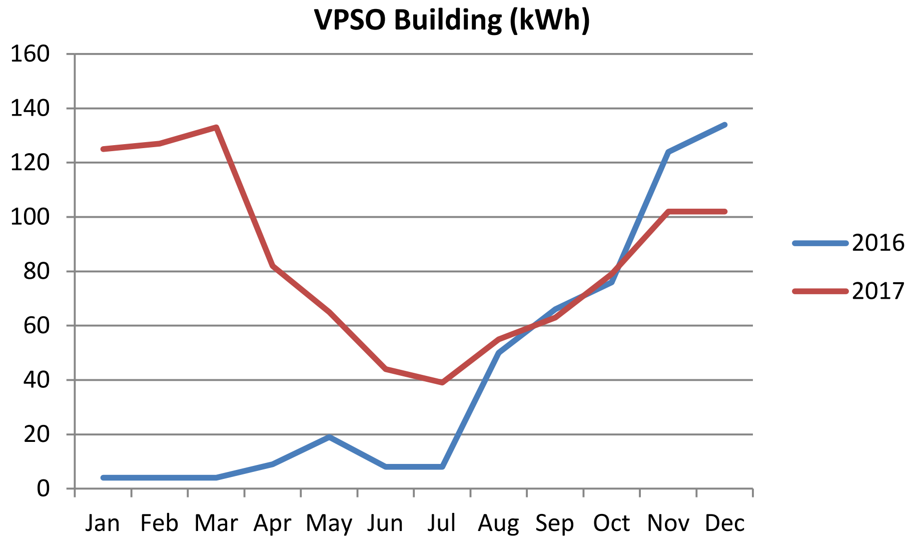
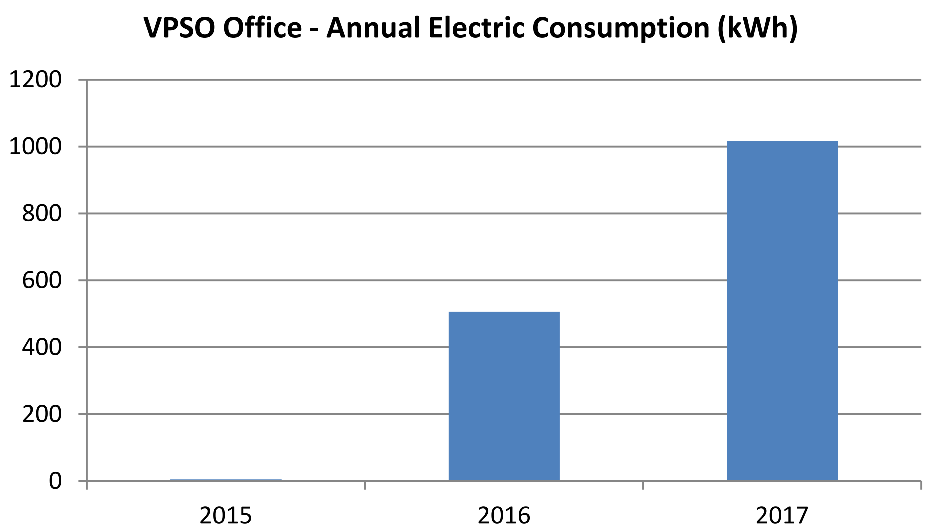


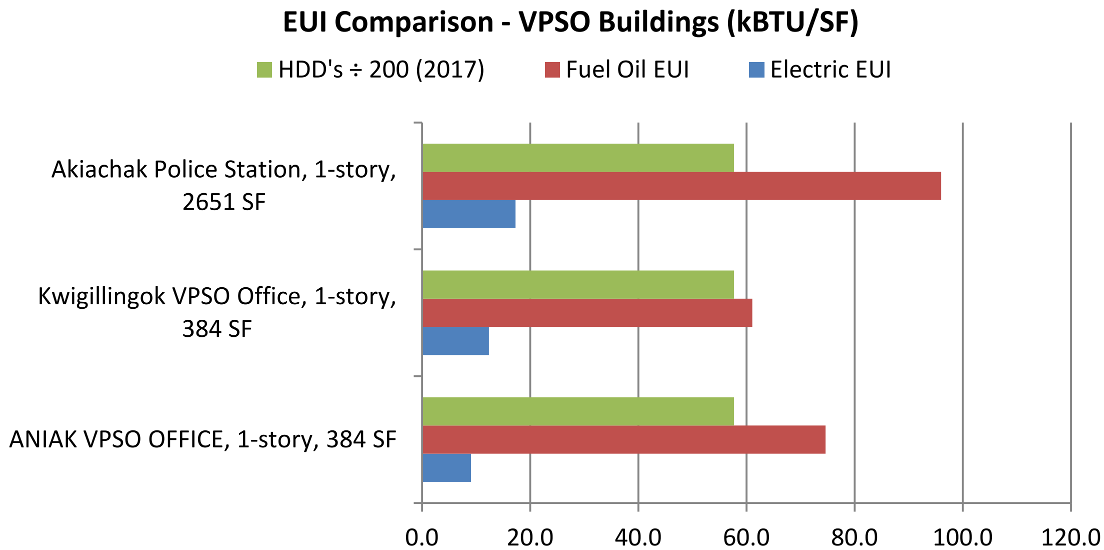
Figure B.4 – 3 years of Annual Electric Consumption



Fuel Oil: Because no oil delivery data was provided, benchmarking cannot be performed on this building.

Comparing EUIs: Figure B.5 and the discussion in Section 1.5 above show that this building's heating EUI falls between the other two comparison buildings, almost exactly on the average of all three. Its electric EUI is less than half of the Akiachak Police station and 30% less than the identical building in Kwigillingok. In both cases the comparison buildings are more heavily used by more occupants, so the electric EUI at the subject building is as expected.

Figure B.5 – EUIs



After performing the historical analysis in Section 1.5 and above, a baseline period is selected as a benchmark. This is based on factors including the consistency of the data, the periods for which data was available and the current use and occupancy of the building versus its historical use and occupancy. In the case of this building, there is only one possible baseline period, and that is 2017. The benchmark baseline period selected for fuel oil is the predicted AkWarm-C consumption. The shaded 2017 electric consumption figures below were used to calibrate the electric side of the AkWarm© model.

Figure B.6 – Benchmark Utility Data

	VPSO (no PCE)			
	2015	**2016**	**2017**	**Costs**
Jan	0	4	125	$74.87
Feb	0	4	127	$76.07
Mar	0	4	133	$79.67
Apr	0	9	82	$49.12
May	0	19	65	$38.93
Jun	0	8	44	$26.36
Jul	0	8	39	$23.36
Aug	0	50	55	$32.94
Sep	0	66	63	$37.74
Oct	0	76	79	$47.32
Nov	0	124	102	$61.10
Dec	5	134	102	$61.10
TOTALS	**5**	**506**	**1,016**	**$608.58**

Appendix C – Additional EEM Cost Estimate Details

EEM Cost Estimates

Installed costs for the recommended EEMs in this audit include the labor and equipment required to implement the EEM retrofit, but engineering (if required) and construction management costs are excluded; they can be estimated at 15% of overall costs. Cost estimates are typically +/- 30% for this level of audit and are derived from and one or more of the following:

- The labor costs identified below
- Means Cost Data
- Industry publications
- The experience of the auditor
- Local contractors and equipment suppliers
- Specialty vendors

Labor rates used:

Certified Electrician $125/hr

This level of work includes changing street light heads, light fixtures, running new wires for ceiling or fixture-mounted occupancy and/or daylight harvesting sensors, etc.

Common mechanical & electrical work $ 45/hr

Includes installing switch mounted occupancy sensors which do not require re-wire or pulling additional wires, weather stripping doors and windows, replacing ballasts, florescent lamps and fixtures, exterior HID wall packs with LED wall packs, replacing doors, repairing damaged insulation, etc.

Certified mechanical work $125/hr

Work includes boiler replacement, new or modified heat piping and/or ducting, adding or modifying heat exchangers, etc.

Maintenance activities $45/hr

Includes maintaining light fixtures, door and window weather stripping, changing lamps, replacing bulbs, etc.

EEM	Unit	Labor (hrs)	Labor rate	Labor cost	Parts cost (including shipping)	Total cost
T8 or T12 replacement: Remove or bypass ballast, replace end caps if required and re-wire for line voltage	fixture	0.75	$45	$34		$34
Replace 48" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace T8 or T12 U-tube with T8 LED	lamp	0.75	$45		$30	
Replace 24" T8 or T12 with T8 LED	lamp	0.75	$45		$25	$25
Replace 36" T8 or T12 with T8 LED	lamp	0.75	$45		$20	$20
Replace 96" T8 or T12 with T8 LED	lamp	0.75	$45		$30	$30
A-type incandescent or CFL, replace with LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 11w, 13w or 14w replace with 4.5w to 9w LED	bulb	0	$0	$0	$5	$5
CFL Plug-in, 23w, 26w or 32w replace with 12w to 15w LED	bulb	0	$0	$0	$5	$5
BR30 or BR36 incandescent or CFL, replace with LED	bulb	0	$0	$0	$8	$8
HPS or MH 50w, replace with 17w LED fixture with integral photocell	fixture	1	$45	$45	$75	$120
HPS or MH 100w, replace lamp with 45w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$100	$190
HPS or MH 250w, replace lamp with 70w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$125	$215
HPS or MH 400w, replace lamp with 120w LED (ballast may have to be removed or bypassed)	bulb	2	$45	$90	$150	$240
High Bay 250w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$450	$700
High Bay 400w HPS or MH fixture, replace fixture with LED fixture with integral occupancy sensing	fixture	2	$125	$250	$550	$800
Switch mounted occupancy sensor	sensor	1	$45	$45	$125	$170
Ceiling mounted occupancy sensor	sensor	1	$125	$125	$175	$300
Dual technology occupancy sensor	sensor	1	$125	$125	$195	$320
Toyo type stoves with programmable setback feature: assume performed by owner at no cost		0		$1	0	$1
Programmable setback thermostats	per thermo	1	125	$125	$175	$300
Air Sealing	$1.00/SF total cost					
Blown in cellulose attic insulation	AkWarm-C library costs x 150%					
Replacement windows	AkWarm-C library costs x 150%					

Appendix D – Project Summary & Building Schematics

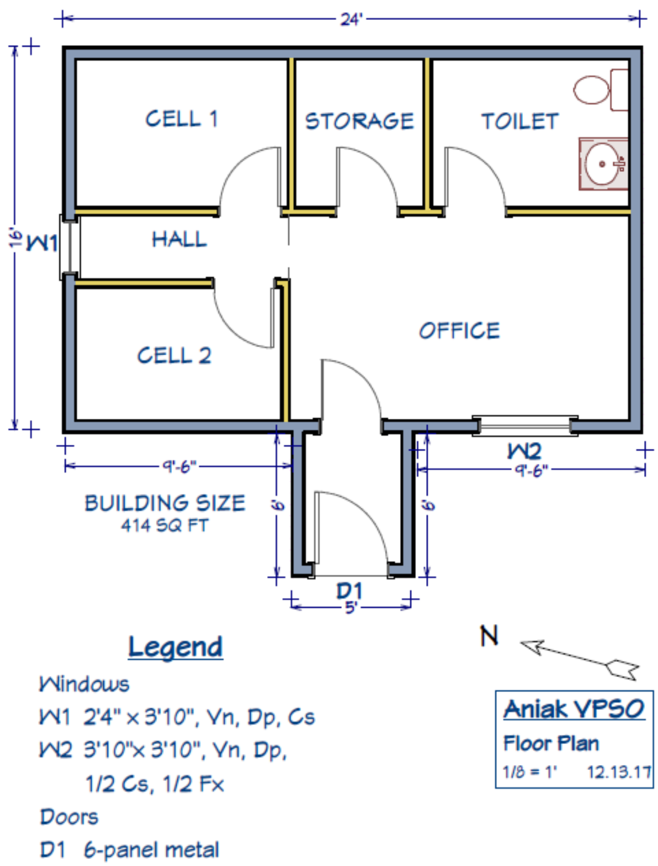
ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: VPSO Tribal Police Office	**Auditor Company:** Energy Audits of Alaska
Address: Aniak, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Aniak	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Laura Simeon	
Client Address: P.O. Box 349 Aniak, AK 99557	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 675-4349	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 384 square feet	**Design Space Heating Load:** Design Loss at Space: 14,679 Btu/hour with Distribution Losses: 14,679 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 22,377 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Aniak	**Design Outdoor Temperature:** -29.2 deg F
Weather/Fuel City: Aniak	**Heating Degree Days:** 12,829 deg F-days
Utility Information	
Electric Utility: Aniak Light & Power - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.550/kWh	**Average Annual Cost/ccf:** $0.000/ccf

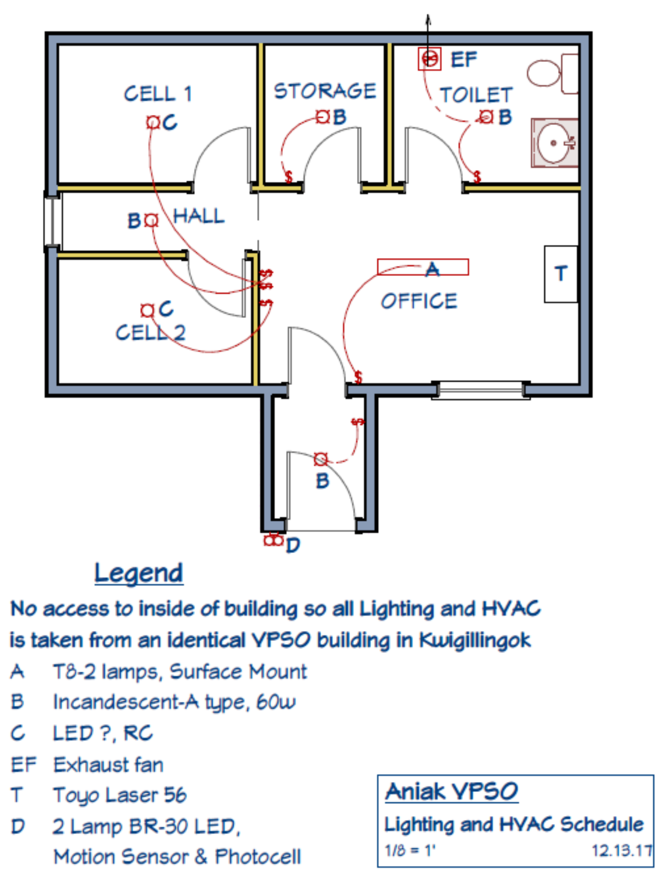
Annual Energy Cost Estimate								
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Lighting**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$1,284	$0	$0	$6	$231	$231	$0	**$1,752**
With Proposed Retrofits	$1,039	$0	$0	$6	$83	$231	$0	**$1,360**
Savings	$245	$0	$0	$0	$147	$0	$0	**$393**

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	82.9	6.46	$4.56
With Proposed Retrofits	65.9	5.14	$3.54

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.

BUILDING SCHEMATICS





Appendix E – Photographs & IR Images

It appears that the building is supplied with potable water and has waste water plumbing

Bathroom on the right, storage in center and cells to the left

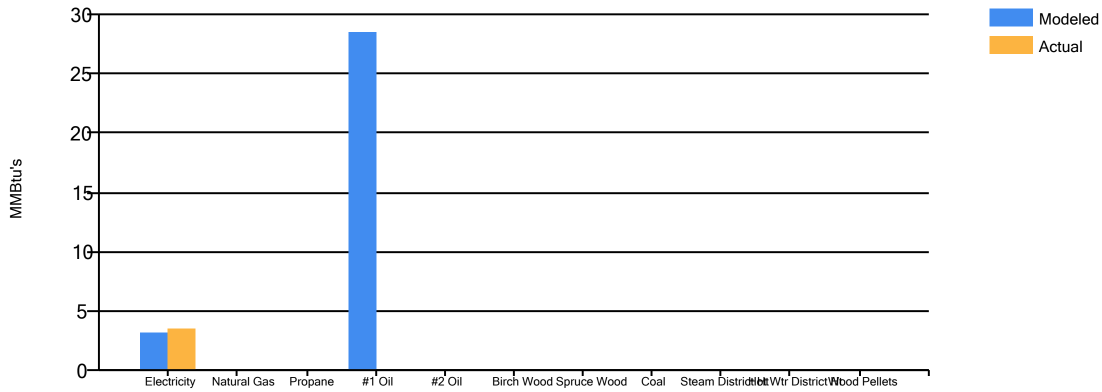
Potable water pressure tank with what appears to be a pump

THERE ARE NO IR IMAGES OF THIS BUILDING

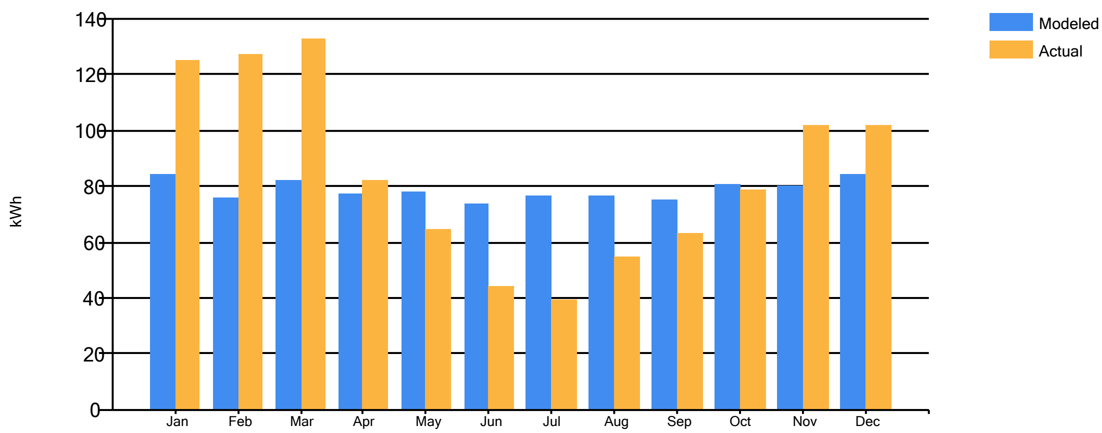
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

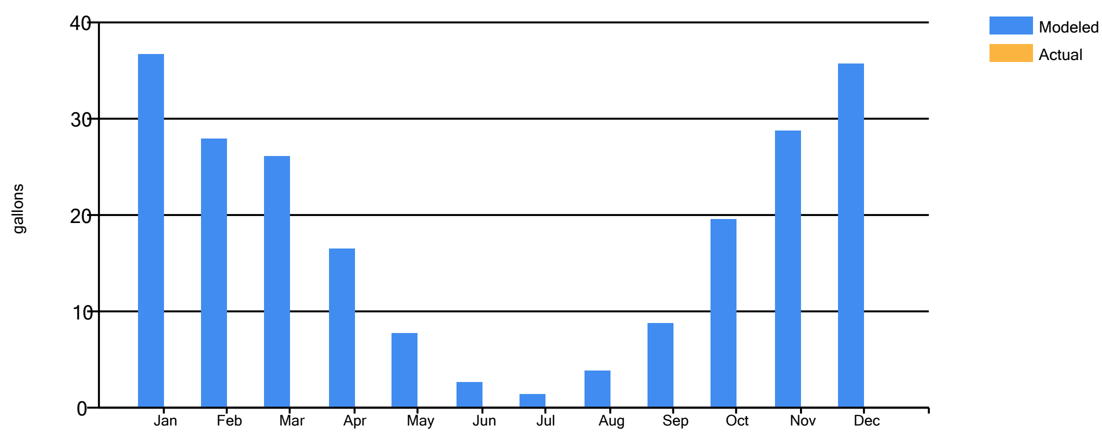
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
AHFC	Alaska Housing Finance Corporation
ARIS	Alaska Retrofit Information System
ASHRAE	American Society of Heating Refrigeration and Air Conditioning Engineers
CFL	Compact florescent lamp
cfm	Cubic Feet per Minute
CO2/CO_2	Carbon Dioxide
DHW	Domestic Hot Water
ECI	Energy Cost Index
ECM	Energy Conservation Measure (no or low cost), also called O & M recommendations
EEM	Energy Efficiency Measure
EF	Exhaust Fan
EOL	End of Life
EPA	Environmental Protection Agency
EUI	Energy Utilization (or use) Index
F	degrees Fahrenheit
Ft	Foot
gal	Gallons
gpf	Gallons per flush
gpm	Gallons per minute
HDD	Heating Degree Day
HP	Horse Power
HPS	High Pressure Sodium
Hr	Hour
HVAC	Heating Ventilation and Air Conditioning
IR	Infra-Red
K	degrees Kelvin
kBTU	1000 BTU
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light emitting diode
MBH	1,000 BTU/hour
MMBTU	1,000,000 BTU
O & M	Operations and Maintenance
OSA	Outside Air
PCE	Power Cost Equalization
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
RA	Return Air
REF	Return Air Fan
ROI	Return on Investment
SA	Supply air
SF	Square feet or Square foot
SIR	Savings to Investment Ratio
SqFt	Square Feet, or Square Foot
VPSO	Village Public Safety Officer

w	Watt
WC	Water Closet (toilet)

These Appendices are included as a separate file due to size

Appendix H – ECMs, Additional detail

Appendix I – Lighting Information

Appendix J - Sample Manufacturer Specs and Cut Sheets

INVESTIGATION INTO A POTENTIAL DISTRICT HEATING LOOP USING A CHP FOR THE NATIVE VILLAGE OF ANIAK BUILDINGS

BACKGROUND

The Native Village of Aniak (NVA) was awarded a grant from the U.S. Department Of Energy Office of Indian Energy to reduce and stabilize energy costs in tribal buildings by setting energy efficiency improvement goals through an Energy Action Plan. Outcomes include strategies and actions leading to reduced energy use, implementation of renewable energy, increased building safety and occupant comfort, and training and local capacity building. The Cold Climate Housing Research Center (CCHRC) is the prime contractor under this grant. Energy Audits of Alaska (EAA) is a subcontractor providing energy efficiency consulting and energy audits. Aniak is governed by the Aniak Traditional Council (ATC).

Part of this grant is an investigation into the feasibility of using a combined heat and power (CHP) unit to provide heat and electricity to the buildings in their compound.

This investigation is not an engineering feasibility study or an engineering analysis of a district heating loop and CHP. A proper feasibility study should be funded and conducted if NVA wishes to pursue this further. This investigation uses the energy audits and the AkWarm-C models created for each building to determine the following:

- Which buildings have existing heating systems appropriate for a district heating loop without significant modifications
- How much heat is required by each of the buildings for space heating and domestic hot water (DHW) needs
- Are the distances between buildings suitable for a district heating loop
- What would be the fuel oil savings
- What would be the electrical savings
- What are the issues related to a grid-tie if a CHP were used
- “Ballpark” cost of a CHP, a grid-tie, and district heating loop
- “Ballpark” simple payback on the investment

CONCLUSION

Although a CHP by itself serving a large single building would pay back in 6-7 years in Aniak, none of the NVA buildings are large enough or have sufficient electric or heat load to justify an individual CHP. A CHP only becomes feasible with NVA’s small buildings if 3-5 buildings are served, and then the cost of a district heat loop to move the heat to those buildings pushes the paybacks well beyond the life of the equipment. Details of the analysis follow.

NATIVE VILLAGE OF ANIAK BUILDING COMPOUND

Figure 1

The red and green lines show a possible path for a district heat loop. From the location of the duplex boiler (front of the building) to the rear corner of the AVCP building, where its boiler is located, is approximately 200’. From that point to the rear corner of the Tribal office building where its boiler is located is approximately another 300’. These distances are feasible for a district heating loop.

BUILDING HEAT REQUIREMENTS

The heat and electric requirements shown below are for the five buildings as modeled in AkWarm-C. These figures are before any of the EEMs recommended in the energy audit are implemented.

The use and occupancy of the Tribal Office and Community Center have not changed, so their baseline electric consumption was not adjusted. The use and occupancy of the Duplex, VPSO Building, and AVCP Office have changed in 2018, so their baselines were adjusted to represent their new use and occupancies as modeled in AkWarm-C. In all cases, no fuel oil data was provided, so the oil consumption predicted by the AkWarm-C models was used in each case as a baseline.

Three buildings owned by the Native Village of Aniak (NVA) and located in the compound shown above have hydronic heating systems and are therefore suitable for a district heating loop. They are listed below, along with their existing boiler capacities, heating, and DHW requirements as predicted by AkWarm-C models. The Tribal Office and AVCP Office use their boilers to produce domestic hot water (DHW) while the Duplex has a separate oil-fired water heater producing DHW.

Figure 2

EXISTING BASELINE HEAT REQUIREMENTS					
	Square Feet	**Existing boiler capacity (MBH)**	**Net boiler heat output (MBH)**	**Net DWH Capacity (MBH)**	**AkWarm-C predicted heat requirements with 50% safety margin**
Tribal Office	6561	274	194.54	uses HWG	193.5
AVCP Office	2861	156	110.76	uses HWG	45
Duplex	1904	162	136.08	118.4	48
TOTALS		**592**	**441.38**	**118.4**	**286.5**

ELECTRIC REQUIREMENTS

All five buildings in the compound can utilize the electric output from a CHP. Their monthly kW demand and kWh consumption, as predicted by AkWarm-C models, are shown in Figure 3 and Figure 4 respectively.

Figure 3

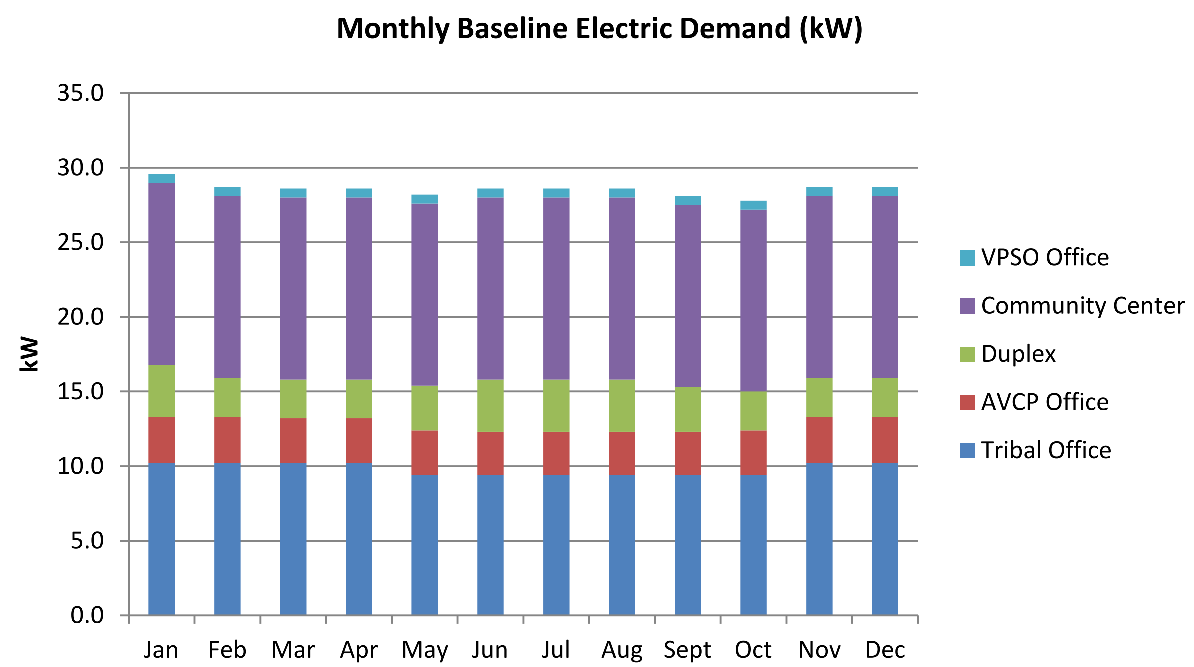
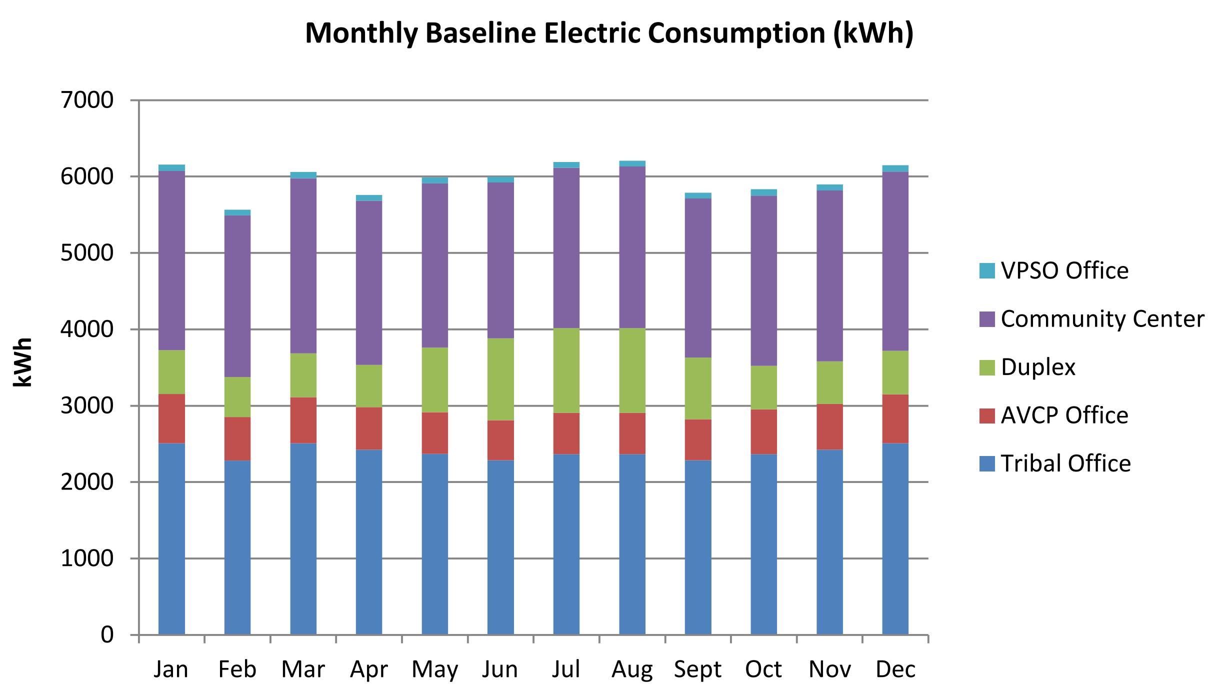


Figure 4



POTENTIAL SAVINGS, COST AND PAYBACK

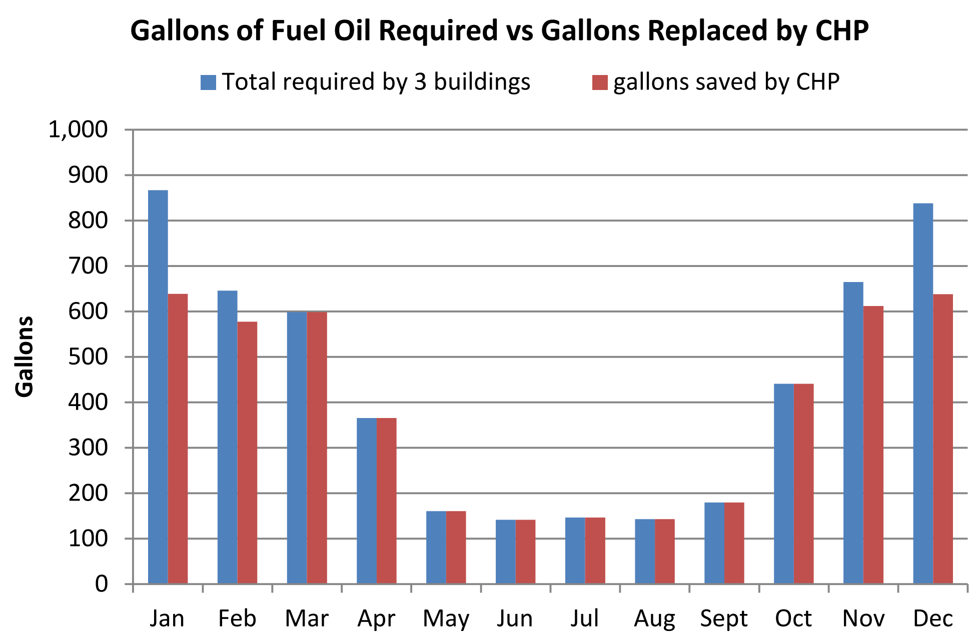
Based on the graphs above, it appears that all of the electrical needs of these five buildings could be met by a 30kW CHP. If a 30 kW CHP were to supply all electric requirements, it would cost $6,685 more than the existing electric cost, but the "free" heating would save $26,434 in oil costs.

Figure 5

	Existing	With CHP	Savings
Electric Cost	$35,447	$42,132	-$6,685
Fuel Oil Cost	$67,159	$40,725	$26,434
Total Energy Cost	**$102,606**	**$82,857**	**$19,749**

Not all of the heat produced by the CHP can be used during the warmer months of the year. The bar chart below shows the gallons of fuel oil required by the three buildings versus the gallons that can be displaced by use of the CHP. More heat is produced by the CHP during eight months of the year than what is required by the buildings in the district heat loop. The DHW requirements for the laundromat could conceivably be added to the heat loop to utilize more of the unused CHP heat during the warmer months, but that would further increase the cost of building the district heat loop.

Figure 6



Using approximate equipment and installation costs, it appears that the CHP considered by itself would pay back within six to seven years, but the cost of building a district heating loop pushes the payback well beyond the life of the equipment.

Figure 7

	Installed Cost	Maint. Contract Cost	Savings	Payback (yrs)
CHP	$150,000	$12,000	$19,749	
District Heating Loop	$750,000			
Total	**$900,000**	**$12,000**	**$19,749**	**46.2**

GRID-TIE ISSUES

A brief conversation with Aniak Light and Power about the possibility of installing a CHP unit to serve NVA buildings provided the following information:

- NVA would have to pay for a reversing meter and an interconnection charge
- If NVA wished to retain grid backup, the standby electric rate is 1.5 times the normal rate if the CHP unit did not meet all of the building's electric needs
- If the CHP is greater than 10 kW, it would require an independent Qualifying Facility agreement

Appendices H, I & J
Accompanying Level 2+ Commercial Energy Audits on
ANIAK TRIBAL BUILDINGS

Appendix H – ECMs, Additional Detail

No and low-cost EEMs are called Energy Conservation Measures (ECMs) and are usually implemented by the owner or by the existing operations and maintenance staff (they are also called O & M recommendations). ECMs can result in cost and consumption savings, but they also prevent consumption and cost increases, which are more accurately called "avoided costs" rather than cost savings. Listed below are a range of ECMs, some of which may be applicable to the subject building.

1) **Ongoing Energy Monitoring:** Extensive research by a number of organizations has validated the value of building system monitoring as an effective means to reduce and maintain lower energy consumption. A few of these organizations are the Lawrence Berkeley National Laboratories, the California Energy Commission and Texas A & M University.

HVAC "performance drift" is the deterioration of an HVAC system over time, resulting from a number of preventable issues. Performance drift typically results in a 5% to 15 % increase in energy consumption. Lawrence Berkeley National Laboratories identified these common contributors to performance drift:

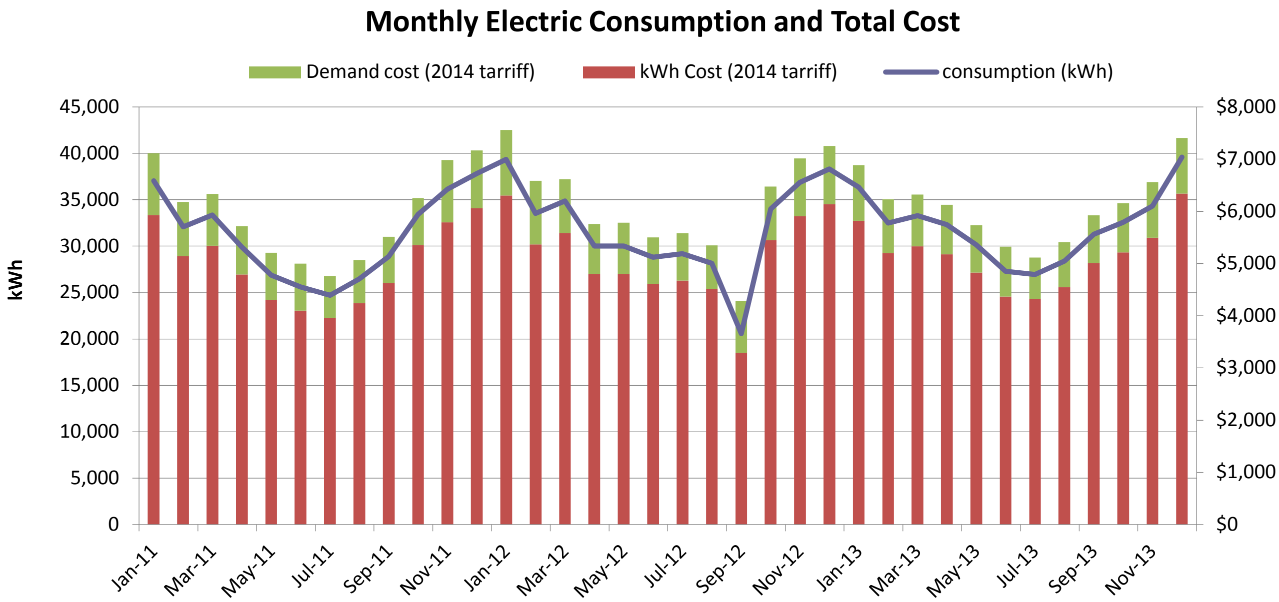
- Manually over-ridden automatic control settings including programmable thermostats, motor control switches, disabled variable frequency motor drives.
- Timer clocks not used or disabled
- Duct and/or valve leakage or dysfunction
- Pumps, fans or actuators not operating correctly
- Scheduling, resets and/or setbacks not matching building usage
- Degradation of sensors

A study of 60 commercial buildings by the same organization found that 40% had HVAC control problems, 15% had missing equipment and 25% had equipment that was not operating properly. The resulting inefficiencies created by problems like these may have been identified by this energy audit – although further investigation would be required to identify the specific causes. Any existing problems should be rectified per the EEMs recommended in this audit and a monitoring program should be implemented to prevent future performance drift.

It is recommended to implement a basic energy monitoring system for all buildings.

Monitoring Systems: There is a range of simple to very complex building monitoring systems commercially available, most utilize a user-friendly internet or network based dashboard. There are stand-alone systems as well as monitoring capability built into most DDC control systems. Some systems do not have the capability to monitor NG consumption. A small sampling of some commercially available stand-alone building monitoring systems includes:

Do it Yourself – A simple spreadsheet with an accompanying graph may be sufficient to alert a building owner that energy consumption has gone awry. All forms of energy consumed by the building (kWh, gallons of fuel, therms of gas, etc.) should be recorded on a monthly basis, and at least a rolling, 3 year historical trend should be carried. The figure below is an example.



ARIS - The Alaska Housing Finance Corporation offers free energy tracking software online. The Alaska Retrofit Information System (ARIS) can help facility owner's track and manage energy use and costs. Once data is entered, through spreadsheet or online, several reports are available to rank energy use and energy cost indices, graph year over year use for individual buildings, and compare your buildings to other facilities with the same use, i.e., how does my library, or fire station compare in energy use to other communities libraries or fire stations. For more information contact Scott Waterman at swaterman@ahfc.us.

BMON - AHFC has developed a building monitoring software to use with Monnit or other sensors. This software is free to any user, open source, can be modified to user needs, and can absorb and display data from multiple sources. It can manage multiple buildings, and can be installed by anyone with a little IT experience. This software is available at https://code.ahfc.us/energy/bmon.

Mach Energy – recurring "subscription model"; sensors are installed and proprietary software and internet based dashboards are used. Programs and software ranges from $1995/building/year for entry level packages to $5000+/building/year for comprehensive packages. http://www.machenergy.com/

Monnit – "product model"; sensors are purchased (cost from $500-$1500) and installed, basic network-based dashboard is free. A more comprehensive, higher level of functionality, internet-based dashboard for a building of this size is $60-$100/year. http://www.monnit.com/

2) **Create an organizational "energy champion" and provide training**. It can be an existing staff person who performs a monthly walk-through of the building using an Energy Checklist similar to the sample below. Savings from this activity can vary from zero to 10% of the building's annual energy cost.

ENERGY CHAMPTION CHECKLIST - MONTHLY WALK THROUGH	initial
Check thermostat set points and programming	
Note inside and outside temperatures, is it too hot or cold in the building?	
*Are computers left on and unattended?	
**Are room lights on and unoccupied?	
Are personal electric heaters in use?	
Are windows open with the heat on?	
Review monthly consumption for electric, gas and/or oil	
Reset AHU mixed air temperature and boiler temperature set points based on the heating season (twice per year)	
Assure that schedule timers (lighting and AHU) reflect the correct time – especially after a power outage	
Re-program Toyo stoves after a power outage	

* Consider adding an Isole plug load management device (Appendix J)
** Consider adding occupancy sensors (Appendix J)

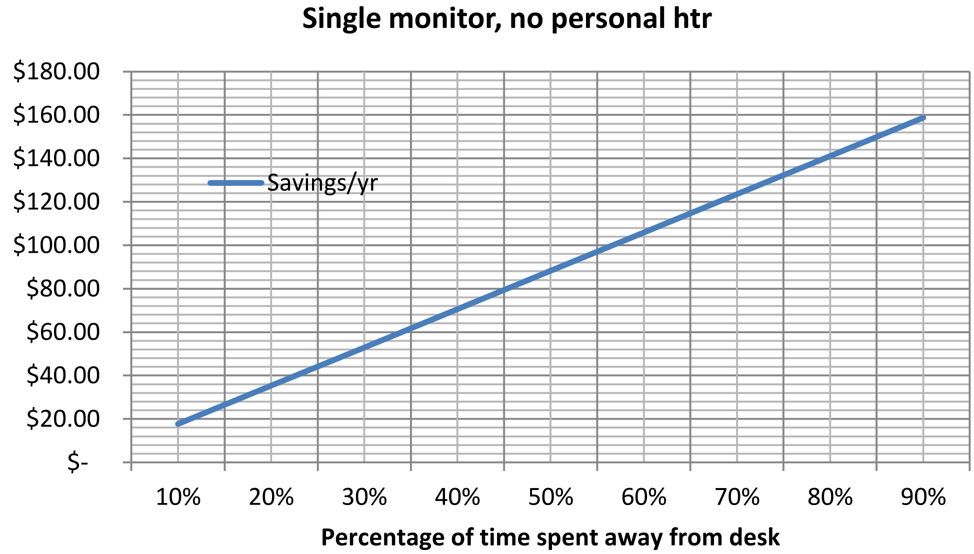
3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp inventory for the entire building should be limited to a single version of an LED or fluorescent tube (if at all possible), and all appropriate rooms should have similar occupancy controls and setback thermostats.

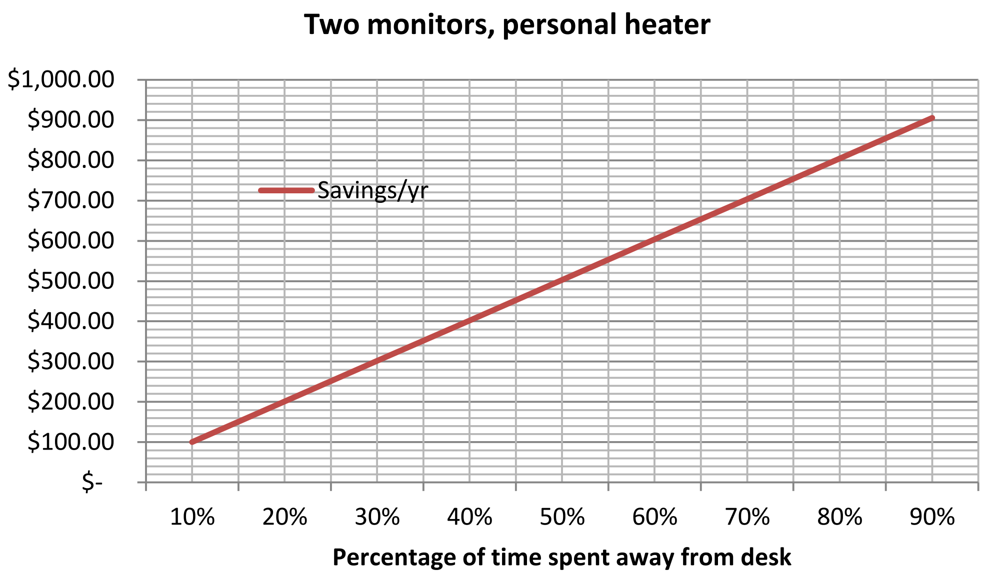
   Other examples of efficient building management include:
   - If a building is only partially occupied and has adequate zoning, group occupants together in the same heating zone and turn down the heat and turn off lighting in the unoccupied zones.
   - Conversion from an 8 hr. per day, 5-day work to a 10 hr. per day, 4-day work week, or conversion to a “work 1 day at home” and shutting down the office for 1 day per week will save energy

4) **Air Infiltration:** All entry and roll up doors and windows should be properly maintained and adjusted to close and function properly. Additionally, weather stripping should be maintained if it exists or added if it does not. Heat loss around the lower portion of several doors is apparent in the IR images in Appendix F. Poorly maintained weather stripping or leaky doors or windows can add hundreds of dollars per year to heating costs.

5) **Turn off plug loads** including computers, printers, faxes, etc. when leaving the office. For workstations where the occupant regularly leaves their desk, add an occupancy sensing plug load management device (PLMD) like The “Isole IDP 3050” power strip produced by Wattstopper. The graphs below demonstrate annual savings for various amounts of time spent away from the desk – it is not unusual to be away from the desk for 50% of the work day.

At $.51/kWh





6) **HVAC Maintenance** should be performed annually to assure optimum performance and efficiency of the boilers, circulation pumps, exhaust fans and thermostats in this building. An unmaintained HVAC component like a boiler can reduce its operating efficiency by 3% or more.

7) **Vacant Offices & Storage Areas**: If there are multiple-person offices and/or other common spaces which are currently vacant, consider moving staff such that the vacant offices are all in one zone, and turn down the heat and turn off lighting in that zone

8) **Additional ECM recommendations**:

   a. Maintain <u>air sealing</u> on the building by sealing all wall and ceiling penetrations including switch, electrical outlet and light fixture junction boxes and window and door caulking. Air sealing can reduce infiltration by 500-1000 cfm.

b. Purchase and use an electronic timer as a power strip for large copy/scan/fax machines and any other equipment that has a sleep cycle. During their sleep cycle, they can consume from 1 to 3 watts. This can cost from $8-10/year per machine. Timers similar to the sample in Appendix G can be purchased for as little as $15.

c. At their EOL, replace refrigeration equipment and commercial cooking equipment with Energy Star Versions.

d. Keep refrigeration coils clean.

e. Keep heating coils in air handlers, unit heaters and fan coil units clean.

f. Install programmable set-back thermostats and program for unoccupied setback temperatures of 60F to 63F.

g. When gas consuming commercial devices (e.g. stoves, grills, fryers, etc.) are un-used for extended periods of time, turn gas valves off.

9.) Indoor Air Quality and CO2 levels:
CO2 is not considered a toxic or hazardous gas, but high concentrations have been linked to reductions in concentration and decision making performance[1] and generally, CO2 levels are used as a measure of indoor air quality. Ambient outdoor CO2 concentrations are typically 450 PPM.

There are no regulatory requirements and various recommendations exist. ASHRAE recommends CO2 concentrations be maintained at a maximum of 800 PPM in offices and 1000 PPM in schools. OSHA recommends less than a cumulative 5000 PPM over an 8 hour period (e.g. 1000 PPM for 4 hours = cumulative 4000 PPM).

[1] *Is CO2 an Indoor Pollutant? Direct Effects of Low-to-Moderate CO2 Concentrations on Human Decision-Making Performance*; Satish, Mendell, Shekhar, et al; Environmental Health Perspectives, Volume 120, Number 12, December 2012.

Appendix I – General Lighting Information

Lighting technology in general, and LED technology in particular, is changing very rapidly in the commercial and residential sectors. This section is intended to provide general lighting and lighting controls information to the building owner.

Lighting controls include occupancy sensors, lighting management systems and daylight harvesting. Each is described below and sample products can be found in Appendix C.

LIGHTING UPGRADE PHILOSOPHY

The following general lighting upgrade philosophy is recommended for commercial buildings:

- In general, all of the lighting in a building should be upgraded at the same time, rather than operating with numerous different types of lamps and fixtures.
- All A-type, screw-in incandescent bulbs should be replaced with 4.5w-9.5w LED bulbs.
- All fixtures with linear florescent, 48”, T12 lamps and magnetic ballasts and all fixtures with 48”, 32w T8 lamps should be re-wired to bypass the ballast and provide line voltage to the end caps, and brand name, line voltage, 12w to 15w, T8 LED lamps should be installed – <u>this is the recommended approach</u>. Alternatively[2], if a T8 florescent fixture has a compatible instant start ballast, no re-wiring is required if a 14w, Philips Instant-Fit T8 LED lamp (may not be available locally) is installed. This replacement requires no fixture modification or re-wiring. If this approach is taken, an electrician should be consulted to confirm that the ballasts in this building are compatible with these lamps.
- 96” fixtures can either be re-wired to bypass the ballast (as above), or replaced with 48” LED fixtures.
- Any incandescent PAR30 and PAR36 lamps remaining in the building should be replaced with 9.5w-13w PAR30 or PAR36 LEDs.
- All exterior lighting which is on during all hours of darkness should be replaced with LED lighting with integral motion sensors and photocell sensors.
- Any emergency lighting that is on continuously should be replaced with LEDs
- As few different lamps as possible should be used in the building to simplify maintenance, inventory and stocking variations.
- In general, occupancy sensors should be installed in intermittently occupied spaces such as toilet rooms, storage and mechanical rooms, office kitchens and copy rooms, especially when used by the general public (who will usually have a reduced consciousness with regards to conservation).

CURRENT TECHNOLOGIES – LIGHTING AND LIGHTING CONTROLS

Occupancy sensors

Occupancy sensors sense the presence of occupants, turn the lights on at a pre-determined level, and then turn the lights off after a programmed time period (typically from 2.5 to 30 minutes) of no occupancy. Line of sight, motion sensing **occupancy sensors** can be installed in existing single or duplex switch boxes, as well as on ceilings. **Dual technology sensors** are typically ceiling mounted in rooms, lavatories, mechanical rooms, corridors, vehicle bays and storage areas where obstacles may interfere with line-of-sight sensors. The second technology in these sensors activates lighting based on sound or changes in position, and work even when a person is fully obscured by an obstacle. **Zoned occupancy controls** are typically

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[2] Although these lamps are very convenient, <u>they are not recommended by the auditor</u> because at some point, the ballast will fail and will have to be replaced. The same labor time and costs the owner will incur in the future should be spent now to bypass the ballast and use a line voltage lamp. The recommended approach costs the same and avoids future labor or material costs.

recommended for long corridors, large vehicle bays and large storage areas with multiple switches and lighting zones. Zoned controls are designed to activate and de-activate lighting by zone, by row, or even by fixture, based on the location of the occupant. **Step-Dim occupancy sensors** turn on a portion of room lights (usually 1/3 or 2/3) upon occupancy, and allow the occupant to manually turn on the rest of the lights. Step-dim occupancy sensors require that the lighting is wired to accommodate the step function.

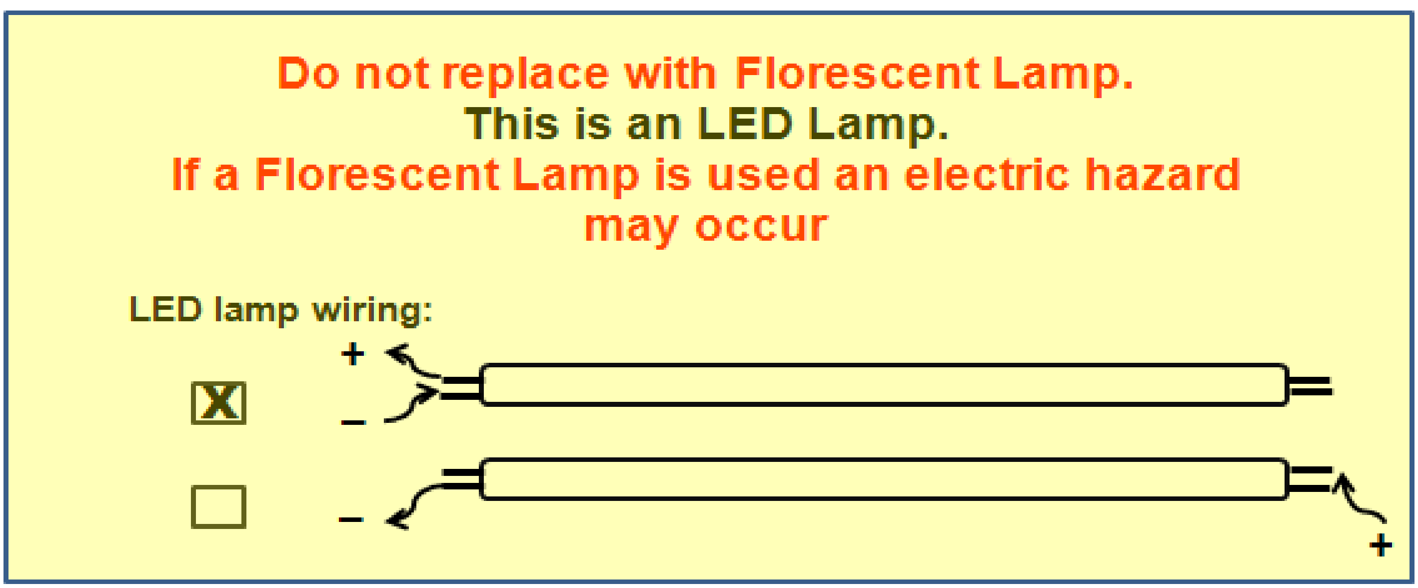
In general, occupancy sensors can reduce power consumption by 25-60%. Paybacks on occupancy sensors range from 1 to 5 years, depending on the light fixture consumption and occupancy of the room. Sample switch mounted, ceiling mounted, single technology and dual technology occupancy sensors follow. High bay, parking garage and/or **parking lot LED lighting** is now available with photocell sensors plus **dimming, motion sensing** capability built into each fixture. When motion is sensed, the fixture activates at full brightness. After a programmed period of time of no motion the fixture dims to 25% or 50% of its full brightness.

48” LED Tubes

As little as a few years ago, a 21 watt, line voltage LED tube was the standard replacement for a 32 watt T8 or a 40 watt T12 lamp. Today high “Lumens per watt” LED tubes allow a 12 to 15 watt tube to replace a 32 watt T8 or a 40 watt T12 lamp and produce approximately the same amount of light. End caps (“tombstones”) should typically be replaced during a lighting upgrade, as corrosion and wear can increase the electric consumption of the fixture. <u>In order to maintain a fixture’s regulatory certifications (UL, for example), the re-wiring must be performed by a qualified electrician.</u>

If a fluorescent lamp is installed in a fixture that has been re-wired for an LED lamp, it will short and may be a hazard. Therefore, after re-wiring a fixture, a warning label similar to the one that follows, should be put in an obvious location inside the fixture to prevent installation of the wrong kind of lamp.

Sample Safety Sticker to install after re-wiring florescent fixtures for LED lamps



LED Screw-in bulbs (Type A)

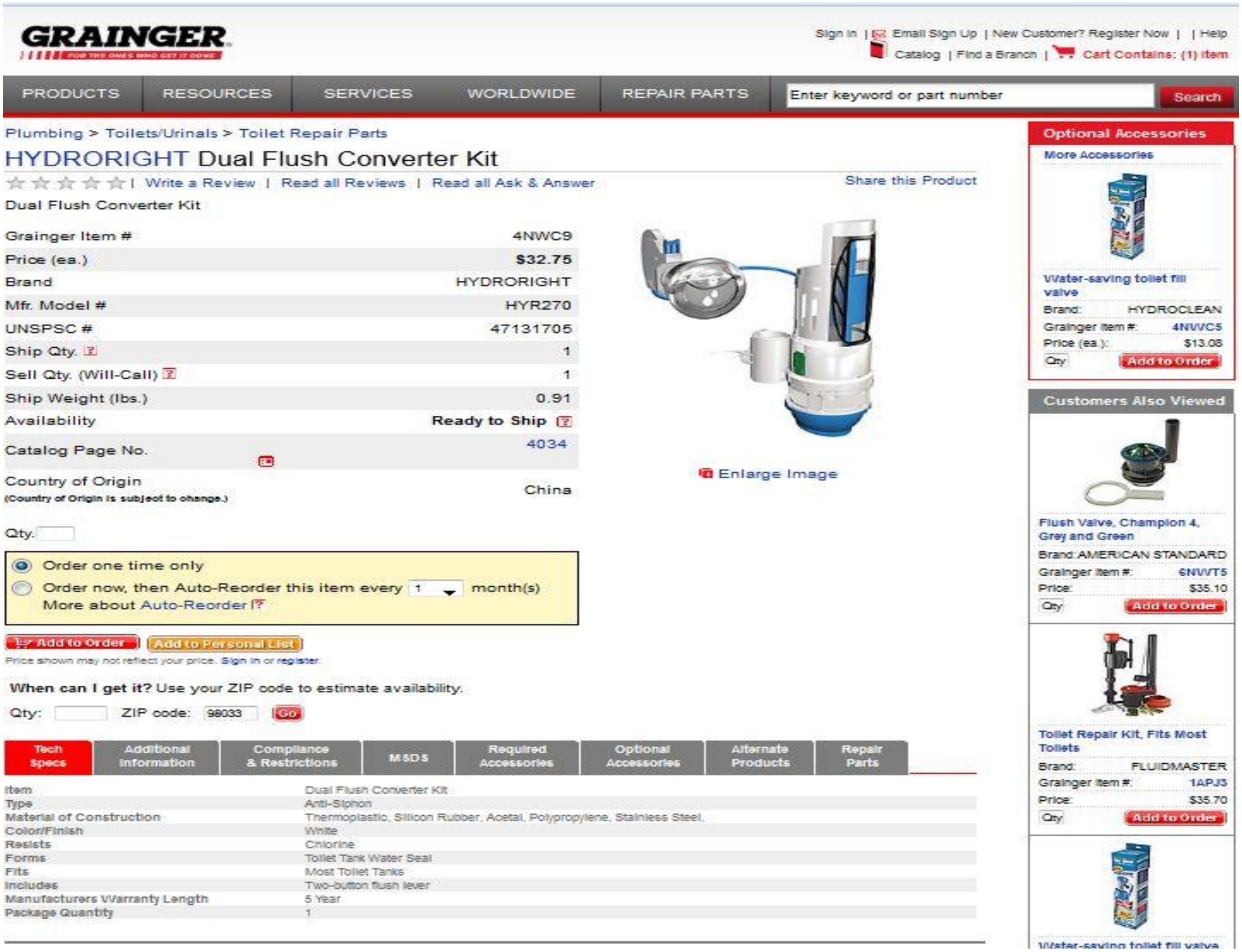
A-type, screw-in bulbs, typically using 4.5 to 9.5 watts (40w to 75w equivalent), are now available at a cost of less than $5.00 each, and often for as little as $2.00 when subsidized. LED reflector bulbs, including PAR30 (3.75" diameter) and PAR36 (4.5" diameter) sizes, typically using 9.5 to 13 watts, are now available for less than $7.00 each. All of these bulbs come in dimmable (more expensive) and non-dimming versions, and in a color spectrum which closely simulates incandescent light. See the Energy Star website at https://www.energystar.gov/index.cfm?c=lighting.pr_lighting_landing for additional information on lighting.

A-TYPE BULB COMPARISON						
	Incand		CFL's		LED's	
Lumens	Watts	Lumens/ watt	Watts	Lumens/ watt	Watts	Lumens/ watt
420-450	40	11	11	41	4.5	100
720-800	60	13	13	62	7	114
930-1100	75	15	23	48	9.5	116
1300-1600	100	16	28-32	57	15	107
Source: http://www.designrecycleinc.com/led%20comp%20chart.html						

Appendix J – Manufacturer's Specifications & Cut Sheets

This is a general sampling of products for most EEMs; not all will apply to the EEMs recommended for the subject building. Furthermore, they are provided as a sampling, and are not necessarily recommended by the auditor.

Retrofit dual flush valve for tank-type toilet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HYDRORIGHT Dual Flush Converter Kit

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Dual Flush Converter Kit

Grainger Item #	4NWC9
Price (ea.)	$32.75
Brand	HYDRORIGHT
Mfr. Model #	HYR270
UNSPSC #	47131705
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	0.91
Availability	Ready to Ship
Catalog Page No.	4034
Country of Origin (Country of Origin is subject to change.)	China

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When can I get it? Use your ZIP code to estimate availability.

Qty: ZIP code: 98033 Go

Tech Specs | Additional Information | Compliance & Restrictions | MSDS | Required Accessories | Optional Accessories | Alternate Products | Repair Parts

Item	Dual Flush Converter Kit
Type	Anti-Siphon
Material of Construction	Thermoplastic, Silicon Rubber, Acetal, Polypropylene, Stainless Steel,
Color/Finish	White
Resists	Chlorine
Forms	Toilet Tank Water Seal
Fits	Most Toilet Tanks
Includes	Two-button flush lever
Manufacturers Warranty Length	5 Year
Package Quantity	1

Optional Accessories

More Accessories

Water-saving toilet fill valve

Brand: HYDROCLEAN

Grainger Item #: 4NWC5

Price (ea.): $13.08

Qty Add to Order

Customers Also Viewed

Flush Valve, Champion 4, Grey and Green

Brand: AMERICAN STANDARD

Grainger Item #: 6NWT5

Price: $35.10

Qty Add to Order

Toilet Repair Kit, Fits Most Toilets

Brand: FLUIDMASTER

Grainger Item #: 1APJ3

Price: $35.70

Qty Add to Order

Water-saving toilet fill valve

Retrofit dual flush valve for flushometer type toilet

Low Flow Aerator – 1.5 gpm

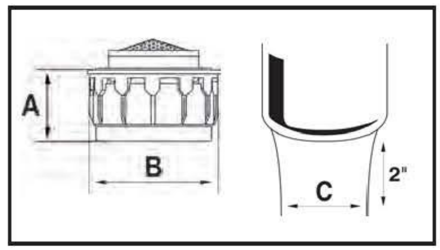
NEOPERL®

PCA® Care
Laminar Stream

1.5 gpm
Pressure compensating
Regular Size

FEATURES

- Provides a splash free crystal clear (non aerated) stream.
- Unique screenless 100% plastic Cascade® construction prevents lime build up.
- Color-coded to identify flow rate.
- Recommended for use in medical facilities to prevent airborne bacteria from entering the water stream.
- Pressure compensating for constant flow from 20 to 80 psi.
- Virtually unbreakable single piece insert ensures a longer useable life.
- Available housing finishes: unplated, chrome and PVD.
- Laser marked housings: statutory mark and custom logo.
- Rubber washer.



CERTIFICATION
ANSI/NSF 61
ASME A112.18.1M
CSA B125
Complies with VHA Directive 2002-073

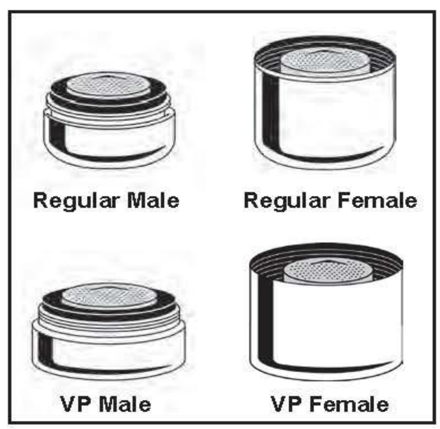
PART NUMBERS* & PACKING

Designation	Part #	Packing
Insert only	A5.4162.0	3000
Regular male 15/16"-27	B1.7723.1	500
Regular female 55/64"-27	B1.7713.1	500
Reg. dual thread 15/16"-27 55/64"-27	B1.7773.1	500
Vandal proof male 15/16"-27	B9.7723.1	400
Vandal proof female 55/64"-27	B9.7713.1	400
Vandal proof dual thread	B9.77F3.1	400
Vandal key	BX.399C.1	

*Other combinations also available

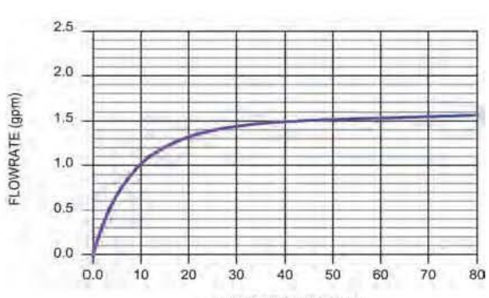
DIMENSIONS

No	mm	In
A	12.00	.472
B	20.05	.789
C	≈ 13	≈ 1/2



COLOR CODE
Dome: Orange Diffuser: Gray

FLOW RATE CURVE



TECHNICAL DATA

Materials:	Body	Acetal
	O-ring	EPDM
	Washer	EPDM
Working temperature:		150°F
Working pressure:		125 psi

NEOPERL Inc., Waterbury, CT • Tel: (203) 756-8891 • Fax: (203) 755-5717 • www.neoperl.com

04/03 - Information subject to change without notice

Digital timer

For plug-in heaters, large copy/printers, TVs and anything with a “sleep” cycle – schedule to turn devices completely off during unoccupied hours

United States [change]

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You are here: Home > Products > Surge Protection and Power Conditioning > Surge Protection Devices > SurgeArrest Essential

Product Category

- Surge Protection Devices
  - > SurgeArrest Performance
  - > SurgeArrest Home/Office
  - > **SurgeArrest Essential**
  - > ProtectNet
- Voltage Regulators (1)
- Hardwire Surge Suppression (3)

Return to Surge Protection and Power Conditioning

SurgeArrest Essential

APC Power-Saving Timer Essential SurgeArrest, 4 Outlet Wall Tap, 120V

Basic Protection Against Power Surges for Computers and Electronics

Includes: User Manual

Standard Lead Time: Usually in Stock

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More Images

P4GC

Price * : $18.99

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Email Technical Specifications

Printer Friendly

Technical Specifications | Product Overview | Documentation | Ratings and Reviews

Output	
Number of Outlets	4
Receptacle Style	NEMA 5-15R
Input	
Nominal Input Voltage	120V
Input Frequency	50/60 Hz
Input Connections	NEMA 5-15P
Maximum Input Current	15A
Surge Protection and Filtering	
Surge energy rating	1080 Joules
EMI/RFI Noise rejection (100 kHz to 10 MHz)	40 dB
Peak Current Common Mode	72 kAmps
NM Surge Response Time (ns)	1 ns
Let Through Voltage Rating	< 400

Occupancy Sensing Plug Load Management Device

Realize energy savings by turning plug loads off

Why keep plug loads operating when no one is there to use them? Isolé ends the energy waste by turning plug loads on and off based on occupancy.

The **Isolé IDP-3050** consists of an eight-outlet power strip with surge protection and a personal occupancy sensor that utilizes the latest passive infrared (PIR) technology. When the sensor detects occupancy, it turns on controlled outlets. When the space becomes vacant, the sensor turns off these outlets automatically after the preset time delay expires.

Plug loads account for an increasing percentage of the total energy consumed by buildings—up to 15 to 20% in homes and commercial buildings. According to the EPA, "energy consumption by office equipment represents the fastest growing use of electricity in the country."

How much energy can users save?

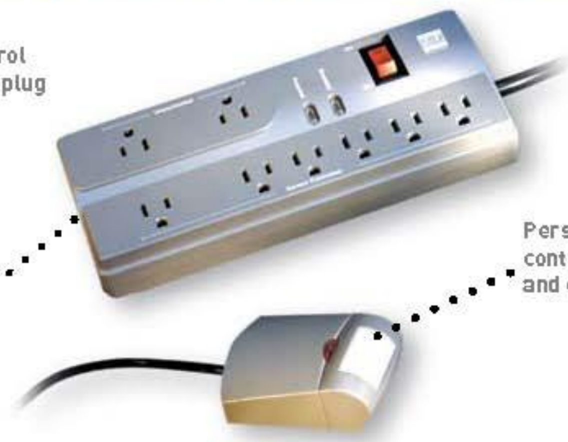
A single workspace can consume 1,500 kWh each year with an average cost of $175 (and growing)! Add up the cost of every workspace and the amount is staggering. Isolé can dramatically cut this cost with energy savings of up to 50%.

Essential machines (hard drives, faxes) use uncontrolled outlets to remain operating continuously.

Equipment that isn't needed when the workspace is unoccupied (e.g., monitors, task lighting, printers) plug into controlled outlets that respond to the occupancy signals.

OCCUPANCY SENSORS | Plug Load Controls

Isolé IDP-3050 Power Strip with Personal Sensor



PROJECT
LOCATION/TYPE

Product Overview

Description

The Isolé IDP-3050 is an energy-saving control system that provides maximum surge and noise suppression while keeping plug load equipment off when there is no occupancy. It consists of an eight-outlet power strip and a personal occupancy sensor.

Operation

The IDP-3050 turns plug load devices on and off based on occupancy. The personal sensor connects to the eight-outlet power strip with the attached cable. The power strip contains six outlets controlled by occupancy and two outlets that are uncontrolled. The IDP-3050 automatically turns all controlled devices on when the workspace is occupied, and off when the workspace has been unoccupied for the user-defined time delay. Uncontrolled devices remain on regardless of occupancy.

Surge Suppression

The power strip provides a high degree of surge suppression that protects connected equipment against threats like power surges, lightning strikes and voltage spikes. It features a resettable circuit breaker and two LEDs that indicate that the outlet is wired and grounded properly and the surge protection is functioning.

Application

The IDP-3050 is ideal for controlling task lighting and computer monitors. Additional devices for the controlled outlets include space heaters, fans and other equipment that can be turned off during unoccupied periods. Devices such as CPUs and fax machines should be plugged into the uncontrolled outlets. Applications include workstations, open office cubicles, offices and engineering stations.

Features

Power Strip

- Eight outlets; six controlled, two uncontrolled
- Surge and noise suppression protects desktop equipment
- Ground protected for safety; will not operate without a grounded outlet
- Two LEDs to indicate: 1) correct wiring and grounding; 2) surge protection is functioning
- Installation requires no hardwiring
- Flat offset plug for wire management
- One uncontrolled outlet and one controlled outlet are wall-transformer-enabled
- Plugs into a standard three-prong outlet

Personal Sensor

- Uses latest passive infrared (PIR) technology to detect occupancy
- User-adjustable time delay of 30 seconds to 30 minutes
- Multi-level Fresnel lens for superior occupancy detection
- 120° coverage, up to 300 square feet
- ASIC technology reduces components and enhances reliability
- Instantaneous response time

WattStopper
www.wattstopper.com
800.879.8585

OCCUPANCY SENSORS | Plug Load Controls

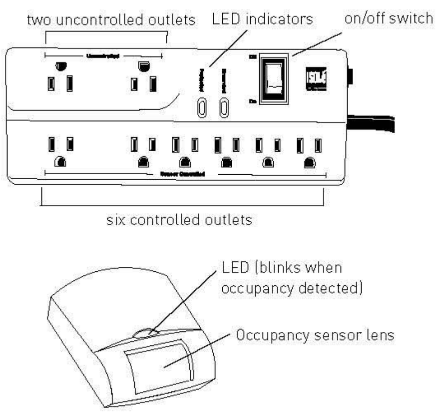
Specifications

Power Strip:
- Electrical rating: 120VAC, 12A, 50/60 Hz
- 12A dry contact relay
- Six-foot black cord
- Transformer provides power to sensor
- Mounts with screws or double-sided tape
- UL 1449 rating: 600V
- Circuit: High-energy, multistage hybrid
- Noise filtration: 0-25db (94.38%)
- Joule rating: 740 joules
- Maximum surge amperage: 48,000 Amps
- Protection modes: 500V L-N, 600V L-G, 600V N-G
- Response time: instantaneous
- Let-through voltage: 140V
- Initial clamping voltage: 200V
- UL and CUL listed; five-year warranty

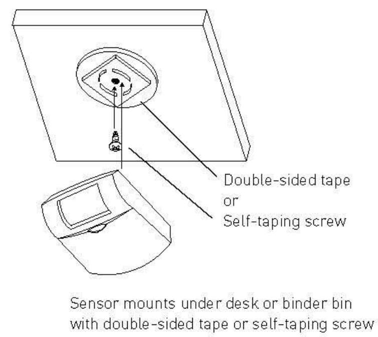
Personal Sensor:
- Nine-foot connector cable
- Supply voltage: 12 VDC
- UL and CUL listed; five-year warranty

Controls & Mounting

Product Controls

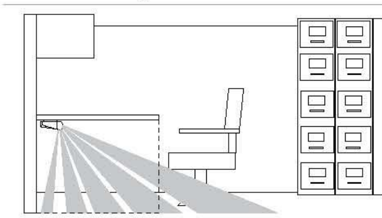


Personal Sensor Mounting

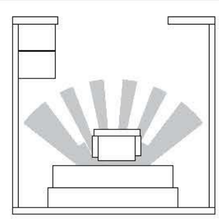


Coverage

Side Coverage



Overhead Coverage



Ordering Information

Catalog No.	Description
☐ IDP-3050-A	Eight-outlet power strip with personal sensor
☐ DI-110	Auto-on personal sensor
☐ CK1-1	20' extension cable w/single 1-1 connector (for single sensor and power strip)
☐ CK1-2	Two 10' extension cables w/duplex 1-2 connector (for multiple sensors and/or power strips)

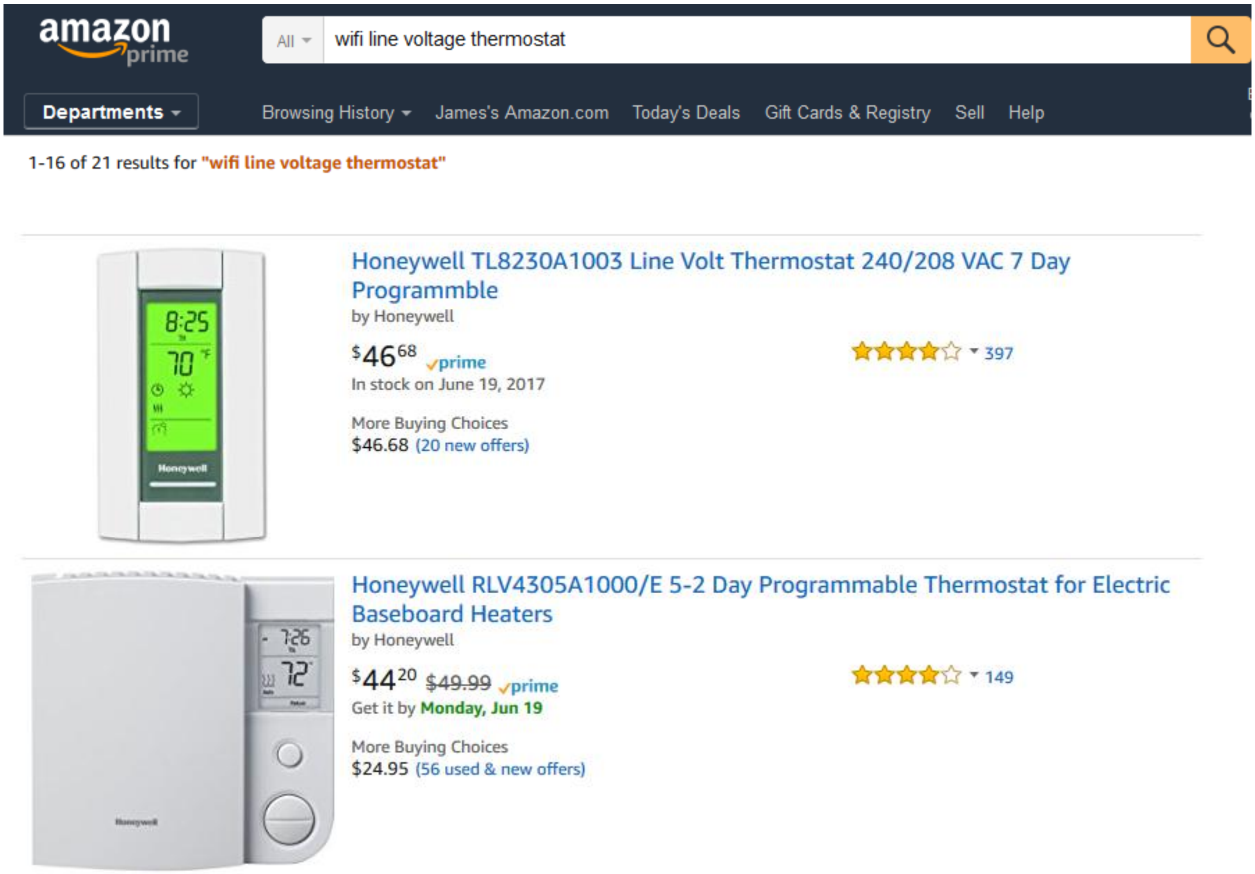
Products are dark grey

Pub. No. 11907 rev. 9/2009

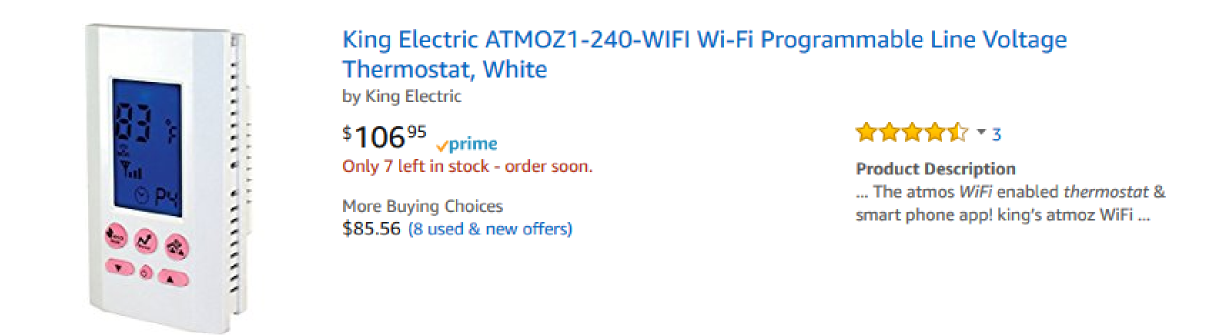
www.wattstopper.com
800.879.8585

Programmable, line voltage thermostat

(for baseboard electric heat)



With Wi-Fi capability



Programmable, 7-day set-back, low voltage thermostat (with Wi-Fi capability)

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Honeywell 7-Day Programmable Thermostat Built-In Wifi

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Additional Images Demo

Honeywell 7-Day Programmable Thermostat Built-In Wifi

Item #: 171234 | Model #: RTH6580WF1001

116 reviews | Write a review

$130.90

In-use images; accessories not included

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FREE
Store Pickup
Your order can be available for pickup in Lowe's Of Wasilla, AK today.
Change Store

Lowe's Truck Delivery
Your order will be ready for delivery to you from your selected store.

Parcel Shipping
Sent by carriers like UPS, FedEx, USPS, etc.

Honeywell 7-Day Programmable Thermostat Built-In Wifi $130.90

Subtotal: $130.90

Qty.: 1

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Description | **Specifications** | Reviews | Community Q&A

Heating Only	Yes
Cooling Only	Yes
Compatible with Warm Air Furnace	Yes
Compatible with Central Air Conditioning	Yes
Compatible with Hot Water	Yes
Compatible with Steam or Gravity	Yes
Use with Floor/Wall Furnace 24V or 750mV	No
Use with Volt Gas Fireplace 24V or 750mV	No
Use with Pellet Stove for mV Thermostats	No
Use with Electric Baseboard 120V-240V	No
Program Type	7-day
Program Periods per Day	4.0
Auto System Change from Heat to Cool	Yes
Touch Screen Programming	No
Backlit Display	Yes
Temperature Displayed	Current and setpoint/desired temperature
High/Low Desired Temperature Limits	No
Temporary Vacation Override	No
Hold Temperature Button	Yes
Early-Start Comfort Function	Yes
Filter Monitor	Yes

Daylight Savings Time Ready	Yes
Optional Battery-Free Operation	No
Shape	Rectangle
Height (Inches)	3.75
Width (Inches)	5.75
Depth (Inches)	1.25
UL Safety Listing	No
CSA Safety Listing	No
Single-Stage Heating	Yes
Single-Stage Cooling	Yes
Multi-Stage Heating	Yes
Multi-Stage Cooling	Yes
Compatible with Heat Pump (No Aux.)	Yes
Compatible with Heat Pump (No EM)	Yes
Compatible with Heat Pump (With Aux.)	Yes
Compatible with Heat Pump (With EM)	Yes
Iris Technology	No
Remote Control Included	No
Built-In WiFi	Yes
Voice Activated	No

Related Items

Honeywell 7-Day Touch Screen Programmable...
$163.90

Honeywell 7-Day Touch Screen Programmable...
$252.00

Refrigerated Display Cooler Lighting Controls
(estimated parts cost $100 ea.)

Wide Angle PIR Occupancy Sensor

Models

FS-705
Operating voltage: 24 VDC from WattStopper power pack

FS-755
Operating Voltage: 120/277 VAC; 60 Hz
Load @ 120 VAC 0-800W ballast or incandescent
Load @ 277 VAC 0-1200W ballast

Specifications and Features

- Line or low voltage
- FS-705 requires BZ-50, BZ-50RC, or BZ-150 power pack for operation
- Current consumption:
  7 mA @24 VDC
  0.5 mA @ 120/277A
- Operating temperature 32°F to 131°F (0°C to 55°C)
- Storage temperature: -22°F to 176°F (-30°C to 80°C)
- Weight: 2.11 oz (60 grams)
- Dimensions:
  FS-705: 1.77"H x 2.68"W x 3.15"D (45mm x 68mm x 80mm)
  FS-755: 1.77"H x 2.68"W x 2.16"D (45mm x 68mm x 55mm)
- Fresnel lens
- Dual pyroelectric cell
- Zero crossing
- LED detection indication: green LED
- UL and cUL listed
- Indoor use only
- 5 year warranty

Materials

ABS, Flame retardant
RoHS compliant

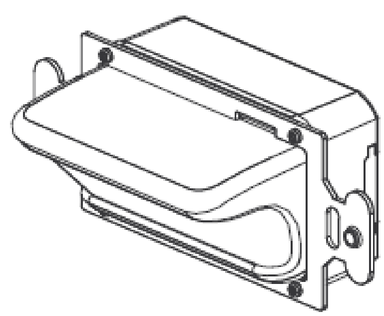
Product Overview

The FS-705 and FS-755 Wide Angle PIR Occupancy Sensors control lighting based on occupancy utilizing passive infrared (PIR) technology.

The sensors provide 180 degree coverage and are designed for locations that require wide angle occupancy detection, such as refrigerator and freezer cases, vending machines and aisleway displays.

FS-705 Wide Angle PIR Occupancy Sensor

FS-755 Wide Angle PIR Occupancy Sensor



CONTROLLED WITH WattStopper

www.wattstopper.com
800.879.8585

40 watt, 96”, T8 LED tube – used with line voltage, remove or bypass ballast

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Home > 8ft LED Linear Tube Lights > 8ft 40W LED Linear Tube - (CE)

8FT 40W LED LINEAR TUBE - (CE)

GreenTek Energy Systems

$ 29.99 SAVE $ 49

Quantity	Price
1 - 24	$ 29.99
25 - 99	$ 28.99
100 - +	$ 27.99

Trim

Frosted

Color

6000K

Quantity

1

Add to Cart

Our 8 foot LED tubes is compatible with virtually every standard fluorescent light fixture, making it the perfect replacement for fluorescent lights. The power consumption of this LED tube light is 40W and we stock both "clear" and "frosted" in 5000K and 6000K. They are really power saving and eco-friendly bulbs with a lifespan up to 50,000 hours or more and will save you at least 60% in power consumption than the fluorescent light will. They are also CE Listed, which means they come with a 1 year warranty!

To purchase non shunted sockets for these tubes, **click here**.

15watt LED T8 Tubes – used with line voltage (after bypassing or removal of ballast)

CUSTOMER SUPPORT (888) 307-3700

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Home > GE 31919 LED T8 LED Bulb - LED15BT8/G4/835

Zoom

Move your mouse over image or click to enlarge

GE 31919 LED T8 LED Bulb - LED15BT8/G4/835

Email to a Friend

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Compare Products

Availability: In stock

Retail Price: $15.00

Special Price: **$10.75**

Qty 0

ADD TO CART

Quick Overview

48" T8 LED Tube - 15 Watts - 3500K - 2050 Lumens - Medium Bi-Pin (G13) Base - Direct Wire

Product Description | Accessories | Product Video | Reviews

Details

GE Lighting

GE 31919 LED15BT8/G4/835 T8 LED Lamp

- High Efficacy > 140 Lumens/Watt
- Direct Wire Ballast Bypass - Type B
- 50,000 hrs life (L70)
- 5 Year Warranty
- Refer to Ballast Compatibility Chart for a list of all tested ballasts Ballast Compatibility

Additional Information

Brand	GE
Mfg #	31919
Order Code	LED15BT8/G4/835
Base	Medium Bi-Pin (G13)
Beam Spread	N/A
Input Volts	N/A
Watts	15
Lumens/Watt	136.7
Retrofit Type	Direct Wire
Dimmable	No
Color	Warm White
Equivalents	No
DLC Listed	No
Warranty	5 Years Limited
Life (hrs)	50,000
Length (in.)	N/A
Product Data Sheet	31919
Case Size	20

14 watt LED T8 Tubes – direct replacement for T8 Flour with instant start ballast; no ballast or wiring change required

Easily upgrade to LED from fluorescent.

PHILIPS INSTANTFIT LED T8 LAMPS

Philips InstantFit LED T8 Lamps are an ideal energy saving choice for existing linear fluorescent fixtures.

Perfect for a wide range of applications

- Full light output in spaces with temperatures down to -22˚F (-30˚C)
- Perfect for applications with frequent "on/off" switching cycles
- Buildings that desire to be mercury free

Easy to experience

- Instant on, no flicker or buzz
- Fits into existing linear fixtures
- Compatible with Instant Start ballasts[1] eliminating the need for rewiring and allows fixture to maintain original UL and CSA compliance

Energy savings

- Over 41% energy savings vs F32T8 electronic instant start systems[2]

Sustainable lighting solution

- No mercury allowing for non-hazardous waste disposal
- Emits virtually no UV rays or IR
- Glass-free for use in food areas and refrigerated food displays
- 4 year limited warranty[3]

(1, 2, 3, See back page for footnotes)

12 watt LED T8 tubes, require re-wiring and ballast removal (for T12 or T8 without instant start ballasts)

enviro-glo®
Energy Efficient Lighting

LED COB T8 4ft Tube, 12watt and 18watt

Features

- Super Lumen Output
- LED Chip COB LED
- Beam Angle 140°
- 50,000 Hrs Life
- 5 Year Warranty
- Frosted. No Visible LED's
- CRI >80
- 130 Lumens per Watt
- UL Rated
- DLC Listed* 18 watt only

130 lm/W
IES LM-79-08

LED lighting facts LED Product Partner

c UL us DESIGNLIGHTS CONSORTIUM

Part #	Input Voltage	Lumens	Operating Temp.	CRI	Average Life
T8LDCOB12W	110V or 277V	1560	-20°C to 45°C	83	>50,000 Hrs
T8LDCOB18W	110V or 277V	2260	-20°C to 45°C	83	>50,000 Hrs

bravolighting

1751 Panorama Point Suite D, Lafayette, CO 80026 Ph: 303.225.7595 Fax: 303.225.5410 sales@bravo-lighting.com bravo-lighting.com

18w T8 LED U-shaped lamp

Questions? 858.581.0597

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U-shape 2ft LED Tube

Reviews: Be the first to review this product

1880 Lumens 2 Foot U Shaped LED Tube Lights 18W Replaces 40W Fluorescent

Model #: U-BR-T8-18W-UL

At just 18W, these 2-foot U-shaped LED tube lights have the luminosity of a comparable 40W fluorescent. Learn More

FROM: $31.41	1+ @ $36.95 ea
	24+ @ $35.10 ea (save 5%)
	120+ @ $33.26 ea (save 10%)
	240+ @ $31.41 ea (save 15%)
	Larger Qty's Contact us 858.581.0597 or lights@eledlights.com

Can assort covers and colors. Quantity pricing will be reflected in the shopping cart.

Purchase

QTY 1

Make Selections to enable Add to Cart

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Select

Color *
- Cold White: 5000K
- Neutral White: 4000K

Cover *
- Transparent
- Frosted

* Required Fields

41

24” T8 LED

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Weekdays 8am-7pm EST

Light Bulbs | Ballasts | Fixtures | Light Control | Projector Lamps | Learning

This product can be found in LED Bulbs › LED Linear

Philips 8.5 Watt, 24" T8 Neutral White LED Bulb

SKU: 452029 | Ordering Code: 8.5T8/24-3500 IF | UPC: 046677452025

0.0 (No reviews) Be the first to Write a Review

In Stock

Price per Bulb
Each $15.89

Bulbs per Case
10

1 x Bulb

ADD TO CART

Save to BulbTrack

Printer friendly

Description | Full Specs | Reviews | Q & A

Lighting Facts Per Bulb

Brightness	1170 lumens
Estimated Yearly Energy Cost Based on 3 hrs/day, 11¢/kWh Cost depends on rates and use	$1.02
Life Based on 3 hrs/day	45.7 years
Light Appearance Warm — Cool 3500 K	
Energy Used	8.5 watts

Philips LED T8 24" InstantFit Neutral White 8.5 Watt Non-Dimmable T8 LED lamps are compatible with most instant-start ballasts and some programmed-start and emergency ballasts. They eliminate the need to have an electrician rewire the fixture. Simply take out the existing fluorescent T8 lamp and replace with the Philips LED T8 InstantFit lamp. They are an ideal energy saving choice for existing linear fluorescent fixtures. Suitable for use in fixtures where ambient temperature is between -4°F and 113°F. Can be used in lensed recessed troffers.

- *Compatible with most instant-start ballasts and some programmed-start and emergency ballasts. Does not work with magnetic or rapid-start ballasts. Call one of our Lighting Specialists at 888.455.2800 FREE for details.*
- Non-Dimmable. Do not use with dimming ballasts
- Direct replacement for:
  - F15T8 15W
  - F17T8 17W
- Eliminate the need for rewiring and allows the fixture to maintain original UL and CSA compliance
- Perfect for applications with frequent "on/off" switching cycles, and buildings that desire to be mercury free
- Instant on, no flicker or buzz
- Fits into existing linear fixtures
- Emits virtually no UV rays or IR
- Glass-free for use in food areas and refrigerated food displays
- To be used with shunted lamp holders
- Brightness (Lumens) of 1170 is based on a high ballast factor
- Suitable for damp locations
- DLC listed

2G11 Base 40w Biax LED (17w) Replacement

"BIAX to LED"

LEDBIAX®

Replaces the following:

17in or 21in 2G11 BIAX fluorescent lamps

High LPW OSRAM LED:

The next generation of energy efficient LED **BIAX replacement lamps**

RemPhos "BIAX to LED" LEDBIAX® Lamps

The "BIAX to LED" LEDBIAX® lamps *by RemPhos Technologies* offers an economical alternative to upgrade to long lasting LED lighting, while retaining the original fixture. The LEDBIAX® series replaces fluorescent 16in and 22in lamps. Light is emitted 180 degrees so that the original fixture will be illuminated perfectly and uniformly. Extremely efficient at >100LPW, the LEDBIAX® runs off of a built in driver operating at 120-277VAC through its 2G11 pin base. UL Listed. Multiple lumen output and CCTs are available.

All the benefits of a quality LED retrofit:

- Energy savings
- Long life (L70=50,000hrs)
- Reduced maintenance costs
- Superior quality LED light
- Supports digital control systems
- No hum, no flicker, no mercury

Plus the unique benefits of the LEDSS lamps:

- UL Listed
- Easily mounts inside existing fixtures
- Damp environment approved
- Low glare, high uniformity clean white light

RemPhos Technologies LLC | Phone: (877)99-REMPHOS | www.remphos.com October 7, 2014

LEDBIAX® Lamps

c UL us LISTED (LED LAMP)

DATE	
JOB NAME	
TYPE	

Features	Applications
• UL Listed	• Pendants
• >100LPW	• Troffers
	• Soffits
	• Custom fixtures

Manufacturer	Series	Light Output	Color Temp.	Base Type	Options
RPT	LEDBIAX				
		1500LM=15W (16IN) 2000LM=20W (22IN)	3000K 4000K	2G11	

Ordering Example: RPT-LEDBIAX-1500LM-3000K-2G11

Details

Application Features: The LEDBIAX® "BIAX to LED" lamps easily replace older bulb technologies. The lamps are perfect for new construction or retrofits. The LED lamps is designed to safely and **quickly** replace most existing bulb types. Product includes all of the mounting hardware and electrical connections required.

Construction: UV protected and flame retardant plastic, anodized aluminum

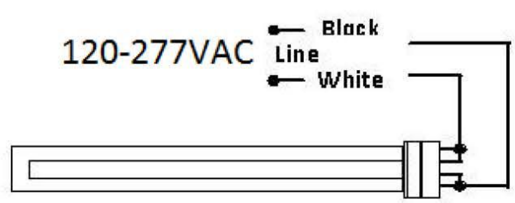
Finish: White bottom, Diffused lens

Electrical: 89% efficient UL Recognized internal driver, LM80 LEDs

Optics: Patent-pending optical system delivers perfectly uniform light from the integral LED lamp. You will be unable to tell the difference between this LED lamp and traditional fluorescent.

Approvals: cUL, FCC, RoHs

Manufactured: USA – 5 Year Warranty



Dimensions:
1500LM: 16.6in x 1.7in x 1.2in
2000LM: 21.0in x 1.7in x 1.2in

Designed by US. Made by US.

RemPhos Technologies LLC | Phone: (877)99-REMPHOS | www.remphos.com October 7, 2014

30w LED fixture – equivalent to 2-lamp, 32w T8 or 40w T12 florescent fixtures

(used when existing fixtures cannot be upgraded)

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DLC Listed LED Fixtures

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- G16 G25 G40 Globe LEDs
- GU24 LED Bulbs
- LED Flameless Candles
- LED PL Lamps
- LED Retrofit Bulbs
- LED Security Lights
- LED Under Cabinet
- LED Vintage Filament Bulbs
- PAR16/20/30/38 LED Bulbs
- Patio/Party Lights
- R20/R30/R40 LED Bulbs

LED Commercial Fixtures

- 277 Volt LED Lighting
- 347 Volt LED Lighting
- 480 Volt LED Lighting

Home > LED Commercial Fixtures > LED Wraparound Fixtures > 48" 30W Dim LED Wraparound 40K

48" 30W Dim LED Wraparound 40K

Our price (Before qty discounts*): $137.76

Please Contact Our Office For Current Availability.

Item Number: 73249

Manufacturer: MaxLite
Manufacturer Part No: LSU4806SU30DV40

Operating Voltage: 120-277 Universal Voltage
UPC: 767627925566
Technology: LED
Application: Surface Mount
Watts: 30
Lumens: 3583
Color Temp: 4000K
CRI (Color Rendering Index): 83
Benefit: Assembled in the USA, DLC QPL Listed
Color: Cool White
Dimmable: Yes 0-10V
Fixture Type: Wrap Around
Finish Color: White

Quantity: 1 ADD TO CART

Add to a new shopping list

Buy more and save!

Quantity	Amount
1 to 3	$137.76
4 to 6	$132.25
7 or more	$128.12

Product Specifications - Quick Reference			
Power Consumption: Delivered Lumens:	30 Watts 3,583 Lumens	Dimensions: Operating Temperature:	48.75"L x 6.75"W x 2.5"H -4F to 104F
LED Color: Dimmable:	4000 Kelvin Yes 0-10V	Lumen Maintenance: Lumens Per Watt:	76,000 Hours (L70) 103 L/W
Operating Voltage: Power Factor:	120-277 Volt Over 0.90	Environment: Certifications:	Indoor/Outdoor Covered Only DLC, UL, Lighting Facts

Assembled in the USA, The Maxlite LSU Series of LED Wraparound fixtures are a cost effective,

Share

Current shipping department status.
In-stock items will ship Tuesday if ordered within the next 20 hours and 33 minutes

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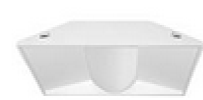
New Arrivals

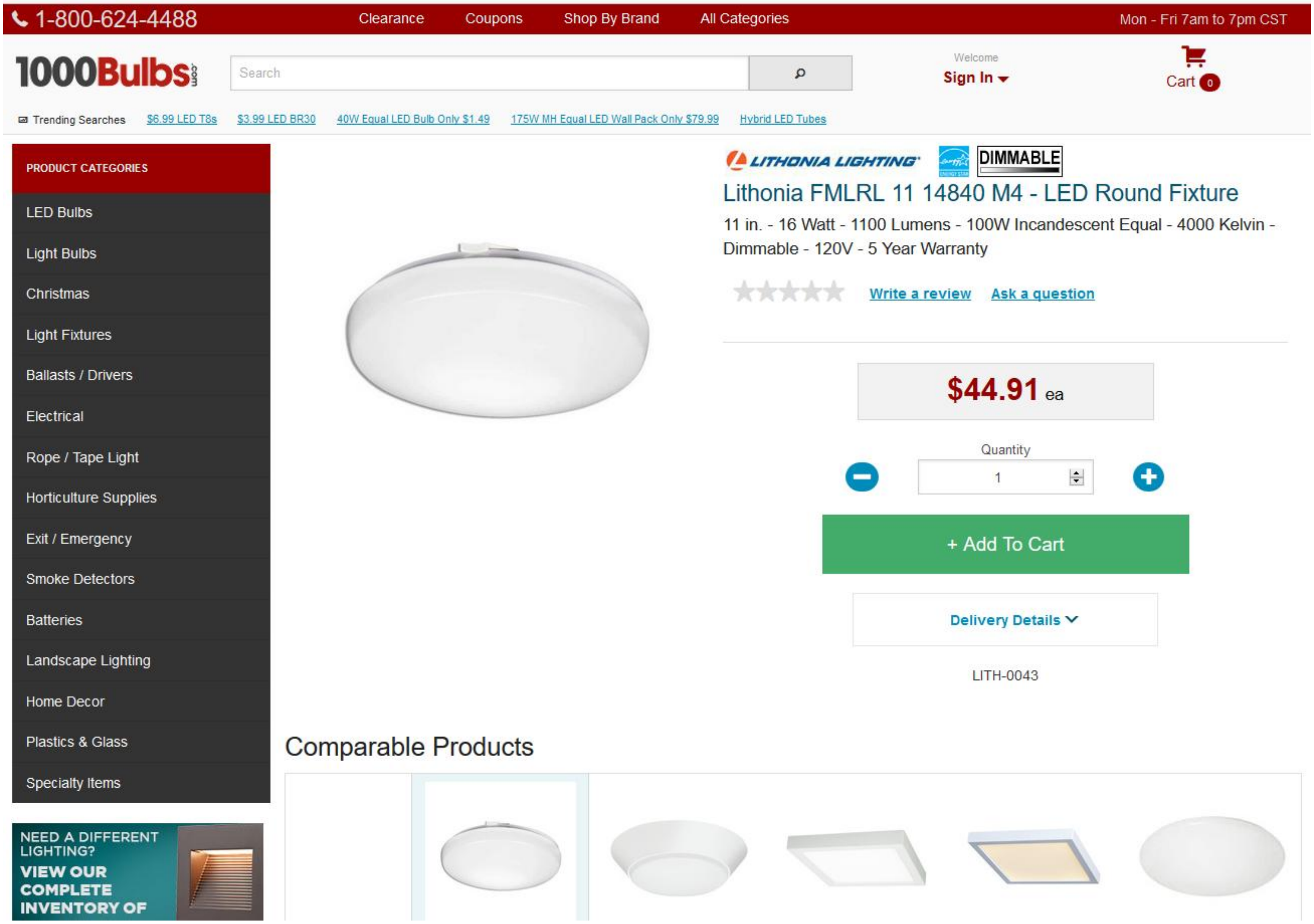
2x2 LED Light Fixture 4000K



$141.42

120W Type V LED Retrofit 5000K

12" LED fixture – replaces Circline Florescent fixture



LED high bay

Lusio
COMMERCIAL & INDUSTRIAL

ESSENTIALS™ BAY SERIES

2 SHORT LED MODULES (2MS) v 1.1 FIXTURE OVERVIEW

TYPE

ESSENTIALS 2MS

ABOUT THE LUSIO ESSENTIALS BAY SERIES

The Lusio Commerical and Industrial Essentials Bay Series features high lumen, high efficacy LED fixtures with economically designed housings and fast paybacks for cost conscious applications or in one-for-one replacement of traditional fluorescent and HID light sources. As with all Lusio fixtures, the Lusio Essentials Bay Series is backed by an industry-leading 7-year warranty.

ESSENTIALS 2MS FIXTURE DESCRIPTION

The 2MS fixture is equivalent in light output to a 2-lamp T5HO fluorescent fixture but draws 40% less watts so you can meet strict energy codes and IES recommended illuminance levels.

115° distribution. 1.44 maximum spacing criterion (diagonal) allows for wide fixture spacing and high uniformity. Typically used for mounting heights of 10-25 feet (3-7.5 M).

ESSENTIALS 2MS • LIGHT OUTPUT

	WATTAGE[1]	LUMENS[1]	EFFICACY[1]	CRI[2]
NO BAFFLE WITH CLEAR LENS				
COOL WHITE (5200K +/- 475K)[3]	60	5,500	92	70
NEUTRAL WHITE (3985K +/- 275K)[3]	60	5,400	90	70
BAFFLE (BAFY) WITH CLEAR LENS				
COOL WHITE (5200K +/- 475K)[3]	60	5,500	92	70
NEUTRAL WHITE (3985K +/- 275K)[3]	60	5,300	88	70
FROSTED LENS (FROST)				
COOL WHITE (5200K +/- 475K)[3]	60	4,500	75	70
NEUTRAL WHITE (3985K +/- 275K)[3]	60	4,300	72	70

[1]Typical [2]Typical CRI. Contact factory if your application has specific requirements of 70 CRI minimum or higher.
[3]Consult factory for other CCT offerings. Lead times may be longer.

ESSENTIALS 2MS • DIMENSIONS: INS (CMS)

LENGTH	WIDTH	DEPTH	WEIGHT
23-1/8 (58.7)	12-1/8 (30.8)	2 (5.1)	12 LBS (5.4 KGS)

[4]Dimensions listed are for the fixture only. See dimensional drawings for measurements with mounting hardware

NOTES

ESSENTIALS 2MS • FEATURES

POWER
- POWER INPUT: 100-277, 347-480 VAC (50/60 hz)
- POWER FACTOR: Minimum 0.9 (typical 0.99)
- DRIVE CURRENT: 700mA
- TOTAL HARMONIC DISTORTION: Less than 20%
- DIMMING: Optional factory installed dimmable power supply (10-100% dimming) that interfaces to standard third party 0-10v dimmers.
- SENSORS: Optional on-board, factory installed occupancy sensors available. See Lusio Accessories sheet for more information.

RELIABILITY/LUMEN MAINTENANCE
- L70 LIFE: 92.3% lumen maintenance at 70,000 hours (77°F/25°C ambient); L70 predicted life of more than 200,000 hours.

LISTINGS AND CERTIFICATIONS
- UL | CUL listed for safety (1598)
- UL | CUL dry/damp location listed
- CE (120-277v only)
- RoHS compliant
- FCC Class B
- Lighting Facts (U.S. Department of Energy) certified
- DesignLights™ Consortium approved
- Made in the USA (contact factory)

CE
RoHS

FIXTURE
- ENVIRONMENT: Dry/damp locations. For interior applications.
- END CAPS: End caps are white powder coat (standard) with multi-stage corrosion resistant pre-treatment.
- HEAT SINKS: Extruded aluminum heat sinks allows for superior thermal management, decreasing LED junction temperature and ensuring long life.
- POWER SUPPLY ACCESS: Center channel cover is removable for access to power supplies and quick wiring.
- LENSES: Lenses are high efficiency, UV stabilized acrylic.
- WARRANTY: Limited product only 7-year warranty. See complete warranty coverage and exclusions details at www.LusioLighting.com.
- REPLACEABLE LED LIGHT MODULES: Allows field replacement of individual light modules. See Installation Instructions.
- AMBIENT OPERATING TEMPERATURES
  Cable, Loop, Hook, and Stem Mounted Fixtures
  -31° to 122°F (-35° to 50°C)
  Surface Mounted Fixtures
  -31° to 104°F (-35° to 40°C)
  Cold Storage Applications
  For applications -4°F (-20°C) and below, fixture should not be frequently switched on and off. LED driver has a 400 maximum switching cycle between cycling temperatures of -40° to -4°F (-40° to -20°C). Use a dimming system or an occupancy sensor (Lusio's OCCDIM sensor only) to set a low level dim (10% or 1V) instead of switching off. See Lusio Essentials Accessories for more information.

PHOTOMETRIC AND DISTRIBUTION DATA IS TYPICAL FOR THIS FIXTURE. PERFORMANCE WILL VARY DEPENDING ON LED AND POWER SUPPLY. LUSIO COMMERCIAL AND INDUSTRIAL LIGHTING MANUFACTURES THIS FIXTURE TO AN OVERALL PERFORMANCE TOLERANCE OF +/- 5%. VISIT WWW.LUSIOLIGHTING.COM FOR PHOTOMETRIC INFORMATION AND UPDATED PRODUCT INFORMATION. ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

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Fixture I

Lusio
COMMERCIAL & INDUSTRIAL

ESSENTIALS™ BAY SERIES

2 LED MODULES (2M) v 1.1 FIXTURE OVERVIEW

TYPE

ESSENTIALS 2M

ABOUT THE LUSIO ESSENTIALS BAY SERIES

The Lusio Commerical and Industrial Essentials Bay Series features high lumen, high efficacy LED fixtures with economically designed housings and fast paybacks for cost conscious applications or in one-for-one replacement of traditional fluorescent and HID light sources. As with all Lusio fixtures, the Lusio Essentials Bay Series is backed by an industry-leading 7-year warranty.

ESSENTIALS 2M FIXTURE DESCRIPTION

The 2M fixture features a linear 1x4-ft housing and is a great energy-saving alternative to 4 lamp T5HO fluorescent and 250 Watt metal halide fixtures.

115° distribution. 1.46 maximum spacing criterion (diagonal) allows for wide fixture spacing and high uniformity. Typically used for mounting heights of 15-30 feet (4.5-9 M). Optional factory installed baffles or frosted lens can provide additional glare control.

ESSENTIALS 2M • LIGHT OUTPUT

	WATTAGE[1]	LUMENS[1]	EFFICACY[1]	CRI[2]
NO BAFFLE WITH CLEAR LENS				
COOL WHITE (5200K +/- 475K)[3]	119	11,800	99	70
NEUTRAL WHITE (3985K +/- 275K)[3]	119	11,300	95	70
BAFFLE (BAFY) WITH CLEAR LENS				
COOL WHITE (5200K +/- 475K)[3]	119	11,700	98	70
NEUTRAL WHITE (3985K +/- 275K)[3]	119	10,800	91	70
FROSTED LENS (FROST)				
COOL WHITE (5200K +/- 475K)[3]	119	9,700	82	70
NEUTRAL WHITE (3985K +/- 275K)[3]	119	9,400	79	70

[1]Typical [2]Typical CRI. Contact factory if your application has specific requirements of 70 CRI minimum or higher.
[3]Consult factory for other CCT offerings. Lead times may be longer.

ESSENTIALS 2M • DIMENSIONS: INS (CMS)

LENGTH	WIDTH	DEPTH	WEIGHT
44-1/4 (112.4)	12-1/8 (30.8)	2 (5.1)	18 LBS (8.1 KGS)

*Dimensions listed are for the fixture only. See dimensional drawings for measurements with mounting hardware.

NOTES

ESSENTIALS 2M • FEATURES

POWER

- POWER INPUT: 100-277, 347-480 VAC (50/60 hz)
- POWER FACTOR: Minimum 0.9 (typical 0.99)
- DRIVE CURRENT: 700mA
- TOTAL HARMONIC DISTORTION: Less than 20%
- DIMMING: Optional factory installed dimmable power supply (10-100% dimming) that interfaces to standard third party 0-10v dimmers.
- SENSORS: Optional on-board, factory installed occupancy sensors available. See Lusio Accessories sheet for more information.

RELIABILITY/LUMEN MAINTENANCE

- L70 LIFE: 92.3% lumen maintenance at 70,000 hours (77°F/25°C ambient); L70 predicted life of more than 200,000 hours.

LISTINGS AND CERTIFICATIONS

- UL | CUL listed for safety (1598)
- UL | CUL dry/damp location listed
- CE (120-277v only)
- RoHS compliant
- FCC Class B
- Lighting Facts (U.S. Department of Energy) certified
- DesignLights™ Consortium approved
- Made in the USA (contact factory)

CE RoHS

FIXTURE

- ENVIRONMENT: Dry/damp locations. For interior applications.
- END CAPS: End caps are white powder coat (standard) with multi-stage corrosion resistant pre-treatment.
- HEAT SINKS: Extruded aluminum heat sinks allows for superior thermal management, decreasing LED junction temperature and ensuring long life.
- POWER SUPPLY ACCESS: Center channel cover is removable for access to power supplies and quick wiring.
- LENSES: Lenses are high efficiency, UV stabilized acrylic.
- WARRANTY: Limited product only 7-year warranty. See complete warranty coverage and exclusions details at www.LusioLighting.com.
- REPLACEABLE LED LIGHT MODULES: Allows field replacement of individual light modules. See Installation Instructions.
- AMBIENT OPERATING TEMPERATURES

  Cable, Loop, Hook, and Stem Mounted Fixtures

  -31° to 122°F (-35° to 50°C)

  Surface Mounted Fixtures

  -31° to 104°F (-35° to 40°C)

  Cold Storage Applications

  For applications -4°F (-20°C) and below, fixture should not be frequently switched on and off. LED driver has a 400 maximum switching cycle between cycling temperatures of -40° to -4°F (-40° to -20°C). Use a dimming system or an occupancy sensor (Lusio's OCCDIM sensor only) to set a low level dim (10% or 1V) instead of switching off. See Lusio Essentials Accessories for more information.

PHOTOMETRIC AND DISTRIBUTION DATA IS TYPICAL FOR THIS FIXTURE. PERFORMANCE WILL VARY DEPENDING ON LED AND POWER SUPPLY. LUSIO COMMERCIAL AND INDUSTRIAL LIGHTING MANUFACTURES THIS FIXTURE TO AN OVERALL PERFORMANCE TOLERANCE OF +/-5%. VISIT WWW.LUSIOLIGHTING.COM FOR PHOTOMETRIC INFORMATION AND UPDATED PRODUCT INFORMATION. ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

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Jim Fowler

From:	Don Williams <dwilliam@ncelec.com>
Sent:	Tuesday, June 17, 2014 8:43 AM
To:	jim@jim-fowler.com
Cc:	Matt Helm
Subject:	LUCIO Quote

Jim please see below for pricing, we quoted both ways with and without OCSS. Shipping 3-4 weeks. pricing is Prepaid into Anchorage

Short, with and without occ sensors
20ea LW-LUSIO-ES2-2MS-40K-CA-BAFN-208-HOOK-OCC40-C6W $ 427.50ea Total $ 8550.00
20ea LW-LUSIO-ES2-2MS-40K-CA-BAFN-208-HOOK-C6W $ 341.25ea Total $ 6825.00

4' with and without occ sensors
20ea LW-LUSIO-ES2-2M-40K-CA-BAFN-208-HOOK-OCC40-C6W $ 537.50ea $ 10,750.00
20ea LW-LUSIO-ES2-2M-40K-CA-BAFN-208-HOOK-C6W $ 451.25ea $ 9025.00

Any questions please let us know

Thanks
Don

1

LED Wall Pack replacement for entry lighting – replacement for 50w HPS

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20W Wall Mount LED Wall Pack - SWP20

$59.90

Quantity

1

Add to cart

In Stock - Ships same/next day after order

WPD Lighting Solutions
Model Number - SWP20
20W Wall Mount LED Wall Pack

Important Links:

Spec Sheet
3 Year Warranty

Applications:

This compact LED fixture is ideal for doorways, stairways, residential exteriors and security lighting. Great for apartment complexes, businesses, and any type of commercial or residential building.

Key Features:

- 120V input voltage with Dusk to Dawn photocell included
- 20W of power
- 1,500 Lumens
- Neutral White CCT - 5,000K
- Comparable to a 70W incandescent Fixture
- Easy Installation
- 50,000+ Hours Lifetime
- 3 year manufacturers warranty

WPD Lighting Solutions

LED Wall Pack – replacement for 100w HPS or MH

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Home > LED Wall Pack Lighting > 30W Forward Throw LED Wall Pack - Bronze

30W Forward Throw LED Wall Pack - Bronze

$165.90

WP3FT-30-BRZ

Quantity
1

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Jarvis Corp
Model Number: WP3FT-30
30W Forward Throw LED Wall Pack.
Important Links:
- Specification Sheet
- 5-Year Manufacturer's Warranty

Compatible Photocells/Dusk to Dawn Sensors Available for Purchase:
- 120V Button Photocell
- 120V Stem Photocell
- 208-277V Stem Photocell

Applications:
- Security, doorway, pathway and perimeter lighting
- Typical mounting height is 8-12 feet
- Typical spacing is 2 times mounting height

Key Features:
- Universal input voltage (120-277V)
- Comparable to a 125W metal-halide light
- Dark bronze aluminum housing with prismatic lens
- Conduit entrances on back, side and bottom
- 30 Watts of power
- 5000K Daylight White Color Output
- Easily accepts photo cells (May require field drilling)
- ETL Listed

LED Wall Pack – replacement for 250w HPS or MH

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LED Lighting Supplier
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Home > Forward Throw Wall Packs > 60W Forward Throw LED Wall Pack

60W Forward Throw LED Wall Pack

$219.90

60W Forward Throw LED Wall Pack

Quantity

1

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Dark bronze aluminum housing with prismatic lens. Universal voltage (120-277V) Comparable to a 175-250W metal-halide light.

Applications: Security, doorway, pathway and perimeter lighting. Typical mounting height is 8-15 feet. Typical spacing is 2 times mounting height.

Specifications Sheet WP3FT-60

Key Features:

5 year manfacturer's warranty
60 Watts of power
5000K Daylight White Color Output
Aluminum Housing with conduit entrances on back, sides, bottom.
Easily accepts photo cells
ETL Listed
Optional photocell may require field drilling

MADE IN CHICAGO

Manufactured by Jarvis Corp LED Products in Chicago, Illinois

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LED Wall Pack – replacement for 400w HPS or MH wall pack

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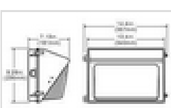
Home > LED Wall Pack Lighting > 90W Forward Throw LED Wall Pack - Bronze

90W Forward Throw LED Wall Pack - Bronze



90W Forward Throw LED Wall Pack - Bronze

$298.90

WP3FT-90-BRZ

Quantity
1

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Jarvis Corp
Model Number: WP3FT-90
90W Forward Throw LED Wall Pack

Due to high sales volume, current lead time is approximately 5-7 business days to ship

Important Links:
- Specification Sheet
- 5-Year Manufacturer's Warranty

Compatible Photocells/Dusk to Dawn Sensors Available for Purchase:
- 120V Button Photocell
- 120V Stem Photocell
- 208-277V Stem Photocell

Applications:
- Security, doorway, pathway and perimeter lighting
- Typical mounting height is 10-20 feet
- Typical spacing is 2 times mounting height

Key Features:
- Universal input voltage (120-277V)
- Comparable to a 320-400W metal-halide light
- Dark bronze aluminum housing with prismatic lens
- Conduit entrances on back, side and bottom
- 90 Watts of power
- 5000K Daylight White Color Output
- Easily accepts photo cells (May require field drilling)
- ETL Listed

LED Wall Pack bulb – 25w replacement for 70w-100w HPS or 70w MH
(requires bypassing or removing ballast)

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HID LED Directional Replacement 70 Watt Retrofit 5500K 110-277V

Olympia

CL-20W8-55K-E26R

$84.11

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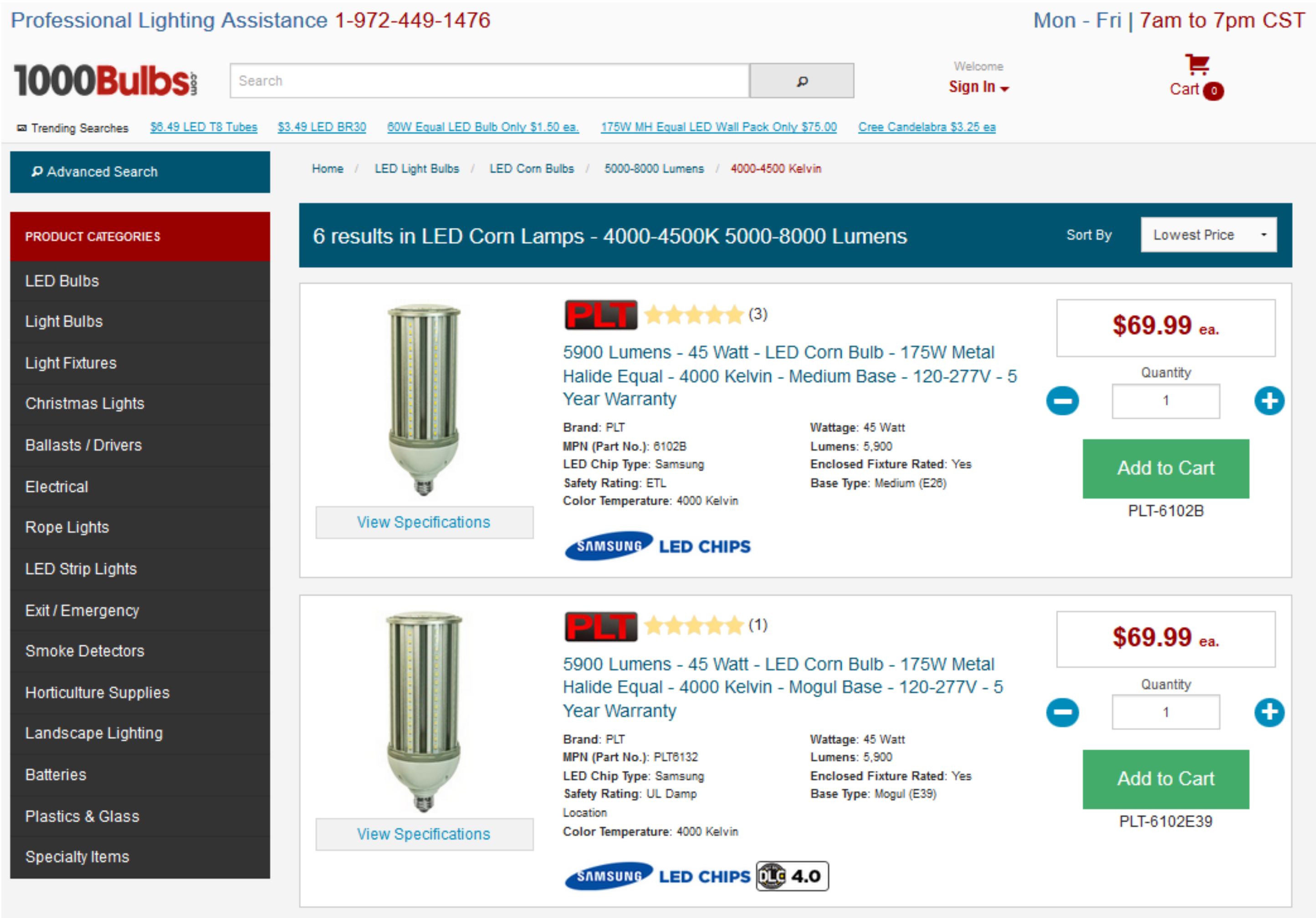
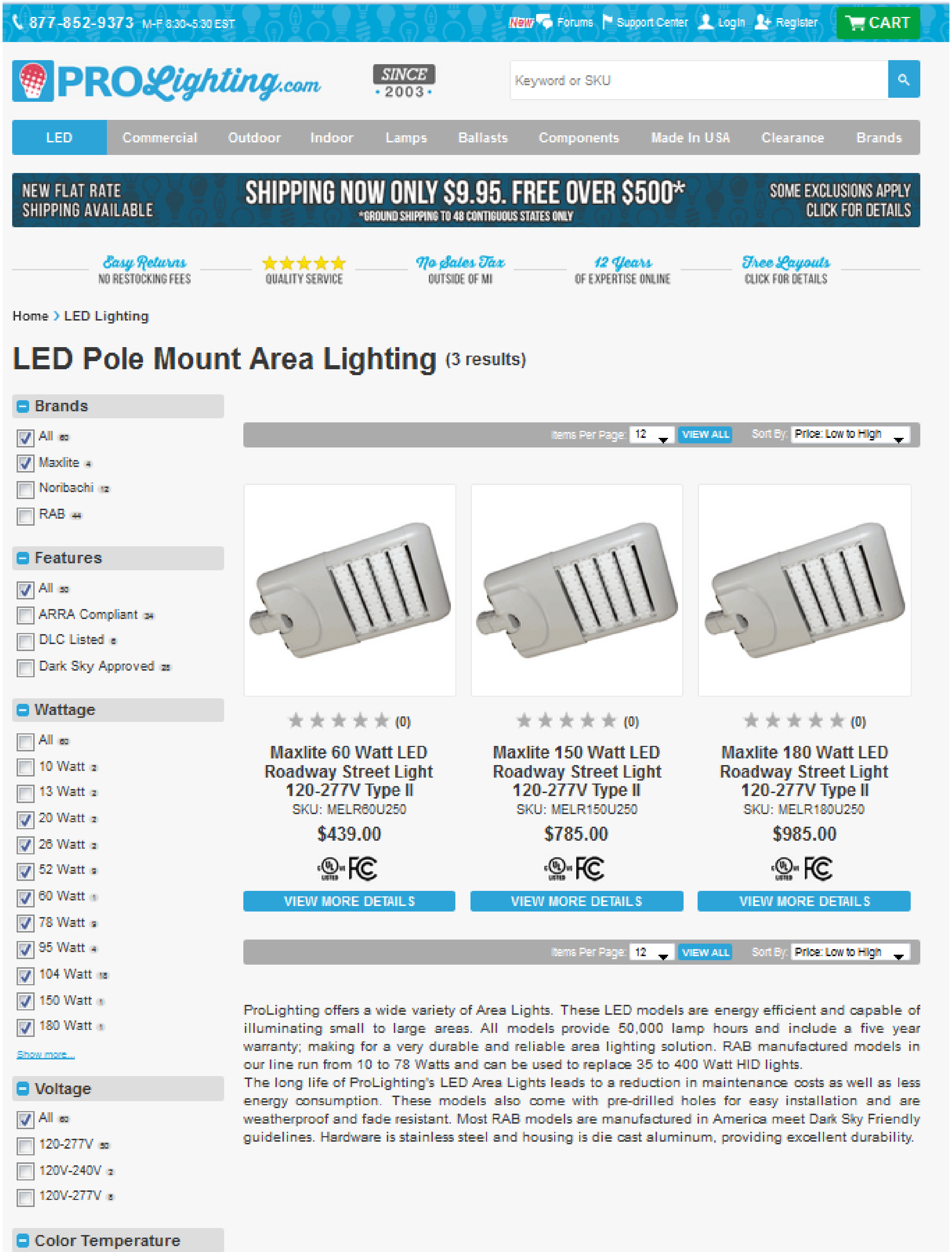
Quick Overview of HID LED Directional Replacement 70 Watt Retrofit 5500K 110-277V

This is a Olympic Lighting 20 watt LED lamp that replaces a 70 watt metal halide or 100 high pressure sodium lamp. This lamps color is 5500k which is a nice bright white light. It has a mogul E26 base but you can buy a medium to mogul adapter to fit in the mogul E39 base. The CL-20W8-55K-E26R has a rated life of 50,000 hours and come with a 5 year warranty. The rotating base with directional lighting offers a brighter light & greater energy savings. Use in horizontal fixtures, street lights, shoebox & wall packs.

LED Wall Pack or Pole Light bulb – 45w replacement for 175w-200w HPS or MH (requires bypassing or removing ballast)



LED Cobra Head – 60w replacement for 250w HPS or MH Pole Light;



LED Cobra Head – replacement for 400w HPS or MH Pole Light

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LED Lighting Supplier (800) 701-1371

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Home > LED Parking Lot and Area Lights > **120W LED Area Light - Bronze**



120W LED Area Light - Bronze

$440.90

Color
AR3-120 Bronze

Quantity
1

Add to cart

Jarvis Corp
Model Number: AR3-120-ADJ-4LED26-700C-50K-TFT
120W LED Area Light
Important Links:

- Specifications Sheet
- Photocell/Dusk to Dawn Sensor
- 5-Year manufacturer's warranty

Applications:

- LED parking lot lighting, perimeter lighting, roadway lighting and LED flood lighting

Key Features:

- Universal input volage (120-277V)
- 120 watts of power (approx)
- Comparable to a 320-400W metal halide fixture
- 5000K daylight white color output
- Die-cast aluminum housing with powder-coat finish
- Mounts to a standard round slip-fitter (2-5/8" diameter pipe)
- Type FT optics are standard
- Light spreads forward and to the sides
- ETL listed

MADE IN CHICAGO
Manufactured by
Jarvis Corp LED Products
in Chicago, Illinois

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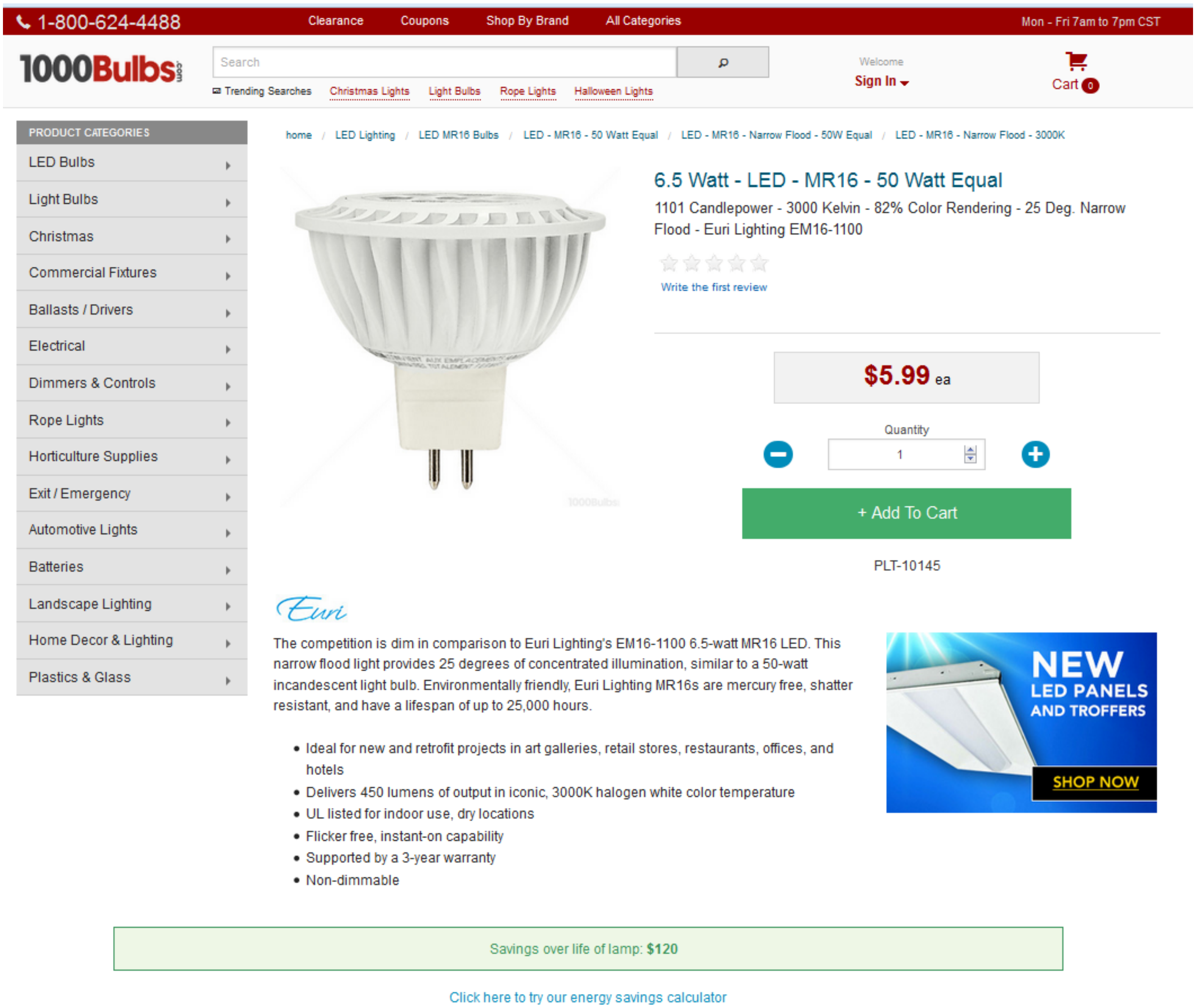
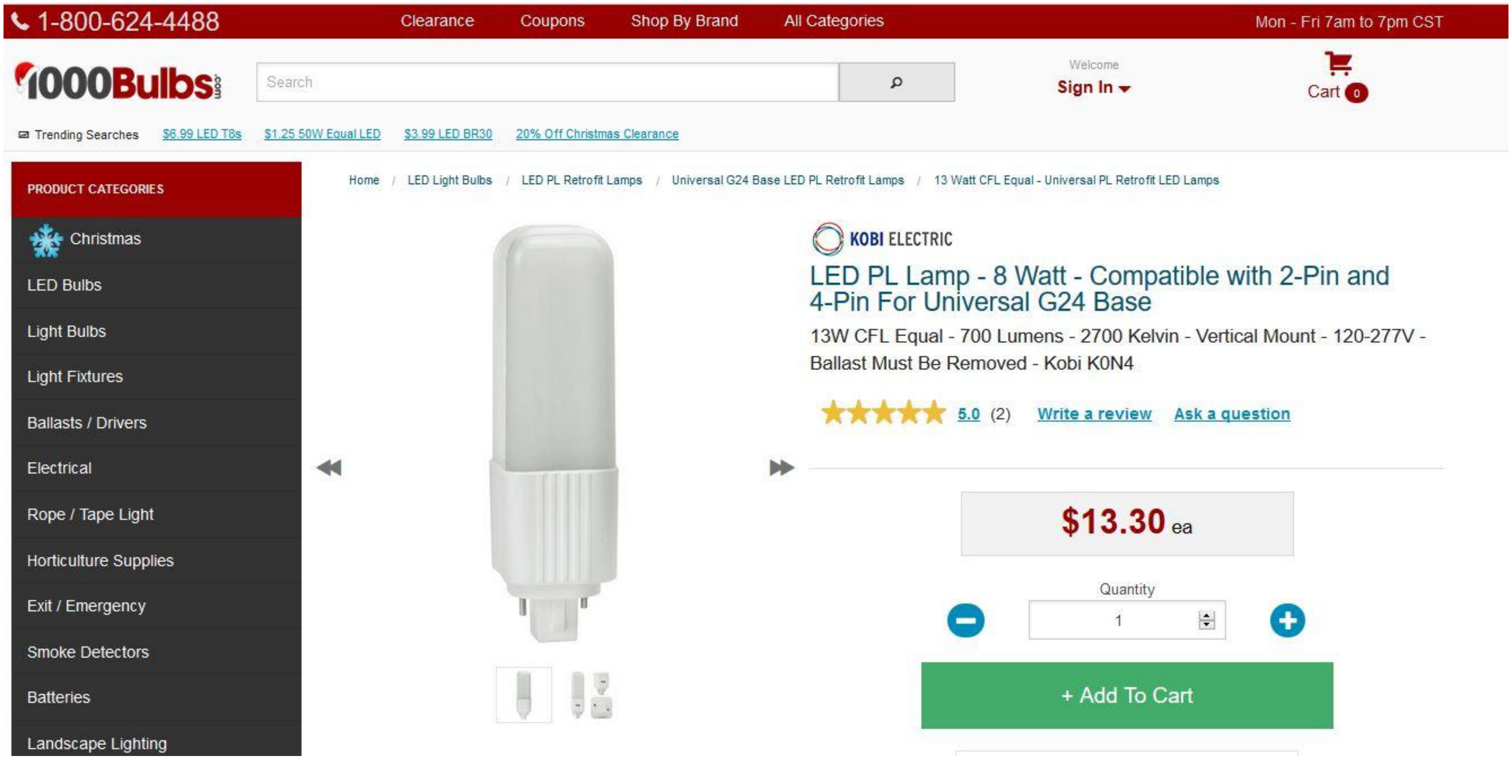
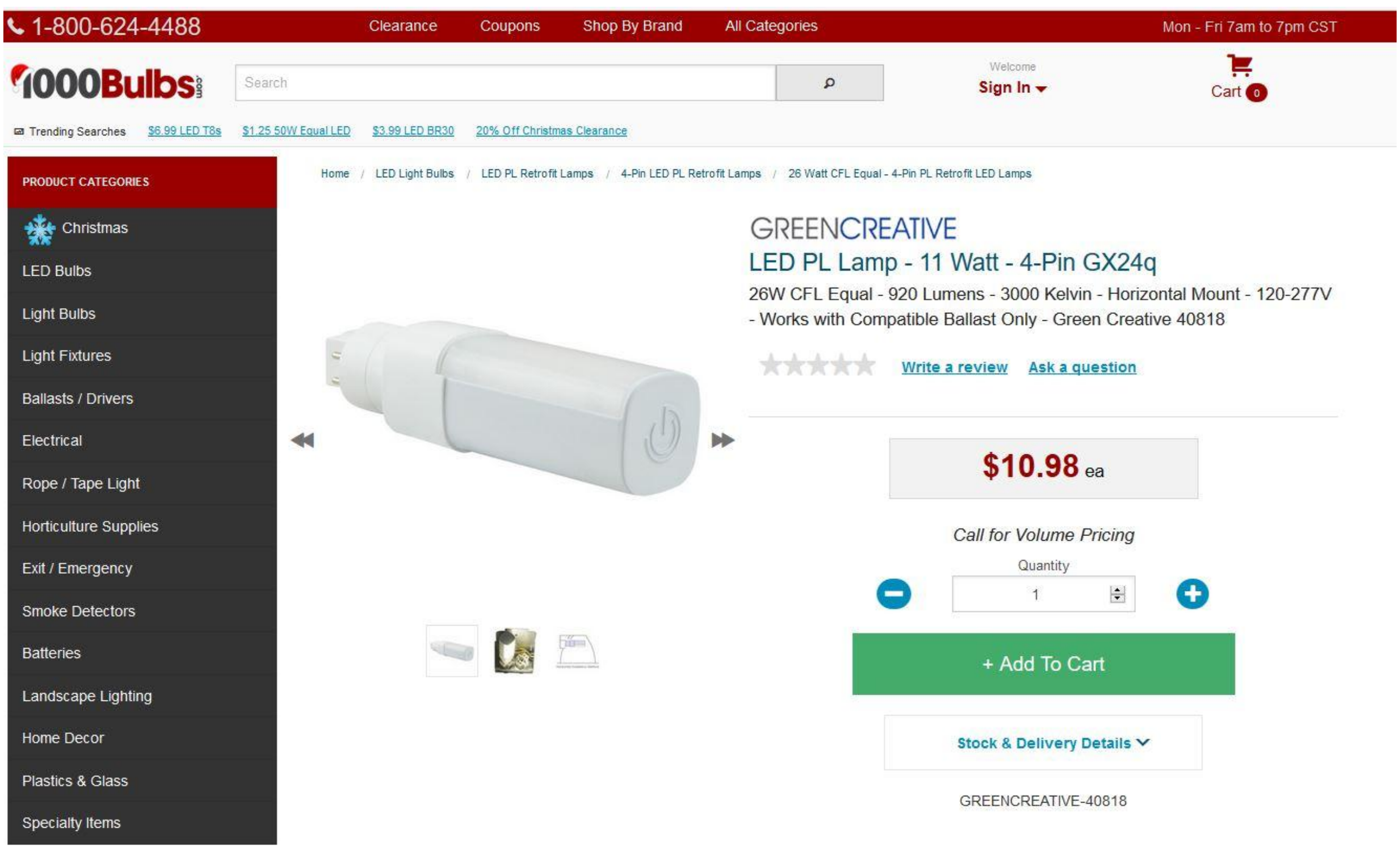
LED replacement for 50w MR-16 lamp



LED replacement for 13w & 26 w CFL Plug-in lamps

(ballast may need to be removed or bypassed, depending on fixture)





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6 Inch - 9.5 Watt - 50 Watt Replacement - Dimmable LED Downlight Retrofit Module - GU24 Base - Wet Location - Cree

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Product Overview:

- GU24 Base
- ENERGY STAR®
- Excellent Color Rendering
- Dimmable to 5%
- Wet location approved
- 5-Year warranty
- Learn More

Item #	CR6-575L-GU24
Rating	(0 Review)
Price	Reg. Price: $46.90 Sale Price: $29.90 You Save: 36%: ($17.00)
Availability	Usually ships the next business day
Quantity	1

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GU24 Socket Adapter for LED Retrofit Modules

BBB ACCREDITED BUSINESS Click for Review
STELLA SERVICE EXCELLENT

Product Overview:

- Use with NLEDR series
- Converts to GU24 base
- No tools required
- Learn More

Item #	NRA-212
Rating	Review this item
Price	$1.70
Availability	Usually ships in 3-4 business days
Quantity	1

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Ask a Question about this Product

About our GU24 Socket Adapter for LED Retrofit Modules Back to Top

» Description
» Product Reviews
» Questions & Answers

Accessories

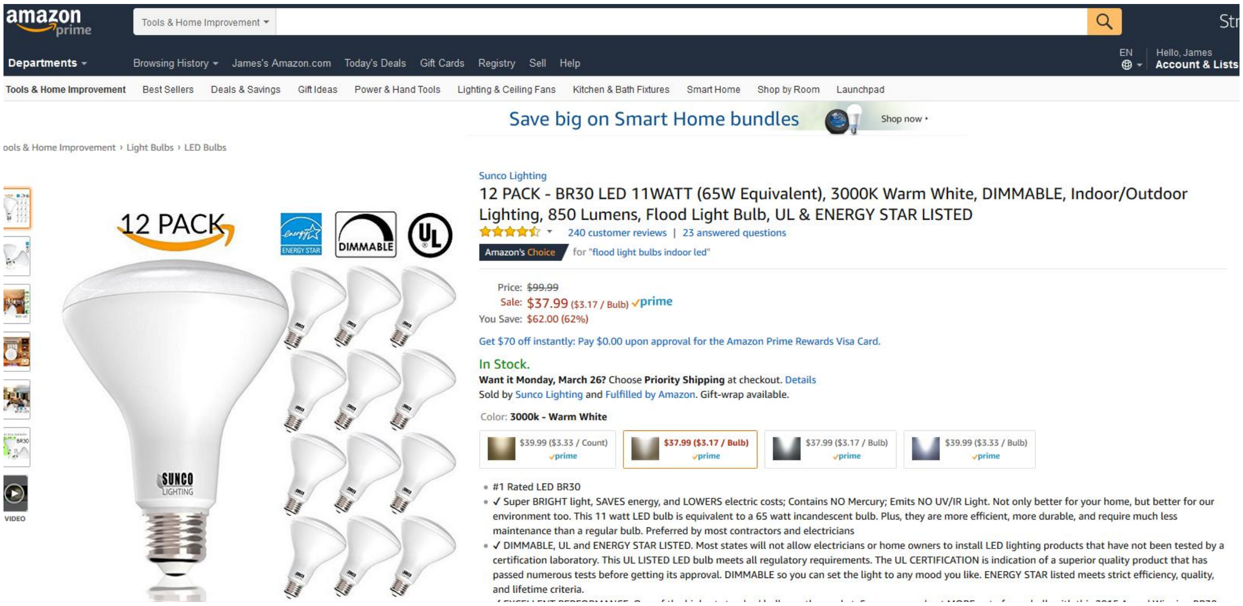
Nora Lighting LED Recessed Lights

Description Back to Top

Use this adapter to install LED retrofit modules in IC or Non-IC GU24 base housings.

- **Use**: allows Nora Lighting LED retrofit modules to connect to GU24 base IC or non-IC housings
- **Easy to Install**: no tools required. Simply remove the E26 medium screw base adapter from LED retrofit module and replace with the GU24 adapter.

LED BR30 bulb (12-pack)



Ceiling mounted occupancy sensors

LEVITON

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Renu Energy Efficient Home Commercial Electric Vehicle Home Automation Bundles Promotions

Ceiling Mount Self-Contained Occupancy Sensor, 1000W INC 500VA FL, 220VAC 50Hz, PIR, 360 Degree, 530 sq. ft. Coverage, White, ODC0S-I2W

Not yet rated. Be the first to write a review

Have a question about this product?

Price: $98.00

Get free ground shipping on all orders over $100! Here's how (restrictions apply)

Offer Details Here's how (restrictions apply).

Click the image to zoom.

2

Quantity: 1

Availability: Usually ships in 1 to 2 days

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Videos

Leviton Green Living Products

25% 20% 4x longer

0:00 / 2:22 YouTube

Product Details

Leviton's self-contained passive infrared ceiling occupancy sensor is the cost-effective choice for commercial and institutional installations, where installation of the recessed ceiling unit is difficult, inconvenient or costly. Available in 120V, 220V and 277V versions, the ODC0S-I is ideal for storage areas, small bathrooms, copy rooms, mop/sink closets or small spaces without wall switches. The self-contained ceiling sensor does not require an external control unit for power or switching the load on and off. 1000W INC 500VA FL, 220VAC 50Hz, PIR, 360-degree, 530 sq. ft. coverage, ceiling mount self-contained occupancy sensor, commercial grade - white.

* Sensor and switching relay in one unit

* 360 degrees field of view with approximately 530 sq. ft. of coverage when mounted at 8 ft.

* Adjustable Delayed OFF time setting between 20 seconds and 15 minutes allows custom adjustment for maximum savings

* LED indicator light flashes when sensor detects motion - to verify power placement and function of sensor at installation

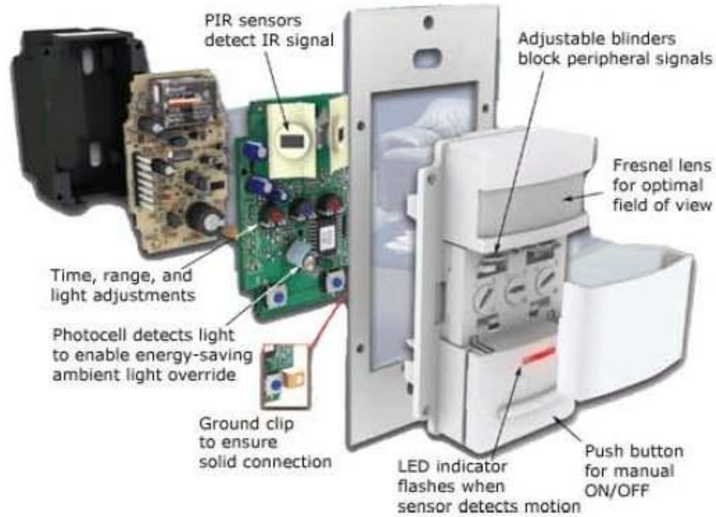
* Segmented Fresnel lens contains 79 segments for optimum sensitivity and detection performance

For California residents, click here for Proposition 65 Warning.

Switch mounted occupancy sensors

Occupancy Sensor Home | Buy Sensors

Decora Wall-Switch Infrared Occupancy Sensors



Convenient switch and occupancy sensor combo in sleek Decora style unit. Advanced passive infrared technology provides highly accurate monitoring in a variety of commercial applications. The OSSMT Multi-Tech unit combines passive infrared and ultrasonic technologies to provide maximum sensitivity with immunity to false triggering.

Specifications and Features

Ambient light override prevents lights from turning on when there is ample natural light

- ODS0D-ID (Self-Adjusting)
- ODS0D-TD (Self-Adjusting)
- ODS10
- ODS15 (Self-Adjusting)
- OSSMT
- PR150
- PR180

Manual override turns light on at any time regardless of override setting

- All Units

Dual pushbuttons provide manual ON/OFF switching for 2 separate banks from a single unit

- ODS0D-ID
- ODSOD-TD

Exclusive automatic "walk-through sensing increases energy savings by shutting lights within 2-1/2 minutes after momentary occupancy

- ODS0D-ID
- ODS0D-TD
- ODS15
- OSSMT

Unit beeps to indicate load is going to be switched off automatically

- ODS0D-ID
- ODS0D-TD
- ODS10

Choice of "Conference Room" or "Classroom" modes for maximum performance and energy savings in a variety of installations

- ODS0D-ID

Manual delayed-off-time settings: 5, 10, and 20 minutes, with 30-second test mode

- ODS0D-ID
- ODS0D-TD

Manual delayed-off-time settings: 10, 20, and 30 minutes, with 30-second test mode

- ODS10
- IPP15

Manual delayed-off-time settings: 15 seconds to 15 minutes

- PR150
- PR180

Manual delayed-off-time settings: 30 seconds to 30 minutes

- OSSMT
- OSS10

Manual delayed-off-time settings: 30 seconds, 30 minutes, 10 hour, 2 hours

- OSSNL

Three-position service switch with off, auto, on

- ODS0D-ID
- ODS0D-TD
- ODS15

Single-pole and 3-way wiring

- OSSMT
- IPP15
- PR180

Elegant Decora styling complements any interior, uses Decora wall plates

- All Units

Fits in standard wallbox; units may be ganged

- All Units

Night Light mode or "Guide Light" feature

- OSSNL
- OSS10

Night Light dim feature

- OSSNL
- OSS10

Adjustable integral blinders with 180-degree to 32-degree field-of-view

- ODS0D-ID
- ODS0D-TD
- ODS10
- ODS15
- OSSMT
- OSSNL
- OSS10
- IPP15

Manual ON/Auto OFF operation for CEC Title 24 compliance

- ODS0D-ID
- ODS0D-TD
- ODS10
- ODS15
- OSSMT
- OSS10
- IPP15

Ideal for Use In:

ODS0D-ID/ODS0D-TD - Classrooms, multimedia and conference rooms, day care centers, office, lounges

ODS10-ID - Enclosed areas: small offices, conferences rooms, storage rooms, copy rooms, closets

ODS15-ID - Commercial areas: small offices, conference rooms, classrooms, stockrooms, lounges, restrooms, warehouses

PR150-1L - Wide variety of residential applications

PR180-1L - Large rooms, home offices, and a variety of light commercial and residential applications

OSSMT - Private and executive offices, conference rooms, storage areas, restrooms, classrooms, lounges, and training areas

OSSNL/OSS10 - Hotel restrooms, hospital restrooms, conference rooms, class rooms, small offices, lounges, storage areas, and bathrooms

High Bay, Zoned Occupancy Sensor

PRODUCT DATA

LEVITON

OSFHU Passive Infrared Fixture Mount High Bay Occupancy Sensor

BASIC OPERATION

The High Bay Occupancy Sensor is designed simply to automatically turn lights ON or OFF. The sensor utilizes Passive Infrared Technology (PIR) combined with Fresnel Lenses to determine when an area is occupied. This is determined when a heat source is detected and moves from one facet in the lens to another. The sensor recognizes this as motion and provides power to the light fixture. Simultaneously a timer is started and restarts with each motion, once expired, the lights will turn OFF.

The high bay sensor maximizes energy savings, incorporating false detection algorithms to eliminate false ON's by nuisance tripping or background environmental conditions. The sensor also optimizes energy savings and safety concerns during power loss scenerios by assuming a return to last known state of operation.

APPLICATIONS

The OSFHU High Bay Occupancy Sensor is specifically designed and assembled to reduce the amount of labor required during the fixture assembly process and at time of installation.
These sensors are for use in spaces where celing heights can vary from 8 to 40 feet, such as warehouses, manufacturing facilities, production, industrial area, and all other high ceiling applications.

It comes with three interchangeable lenses for use in either a 360° high-bay or 360° low-bay general area or an aisle way. The OSFHU provides reliable coverage up to 40 ft. mounting heights. The OSFHU is also available in a model for cold storage applications with temperatures as low as -40° F.

INSTALLATION

The OSFHU mounts directly to an industrial fluorescent fixture or an electrical junction box through a standard 1/2" knockout using the provided lock-nut. Wiring is connected inside the fixture body. To improve the field-of-view for deep body fixtures, a separate offset adaptor accessory (OSFLO or OSFOA) can be used to position the sensor below the fixture body. The adapter simply snaps into a 1/2" knockout on the end of the industrial fixture to attach the sensor. The OSFHU and OSFLO/OSFOA provides the most labor savings available with quick snap, 42" wire leads, and no power required to configure.

OSFHU

Leviton Mfg. Co., Inc. Lighting & Energy Solutions
201 N. Service Rd. Melville, NY 11747-3138 Tech Line: 1-800-824-3005 Fax: 1-800-832-9538 www.leviton.com/les
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PRODUCT DATA

FEATURES

Quicksnap: built into the 1/2" nipple, this locking mechanism allows for the fastest and easiest mounting not requiring a threaded lock-nut

Reduce time and materials: easily reach the ballast at either end of the fixture without requiring more wire or connectors with the included 42" wire leads

Fast, easy time delay setting: can be set at any time without requiring power to the sensor; time delay is variable from 30s-20m

Instantly verify fixture operation and wiring connections: "instant ON" closing relay fires lamps in under 5 seconds

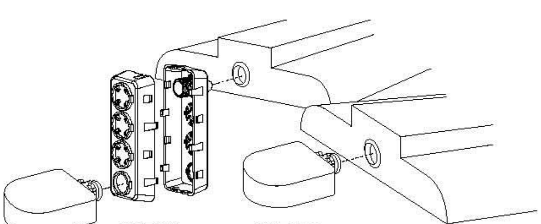
High Inrush Stability (H.I.S. Technology):
- Zero crossing circuitry optimizes relay operation for reliable, long-life operation
- Robust mechanical latching relay is durable for all load types

Auto temperature calibration: automatically adjusts the PIR sensitivity as ambient temperature rises to increase detection of heat movement through the field-of-view

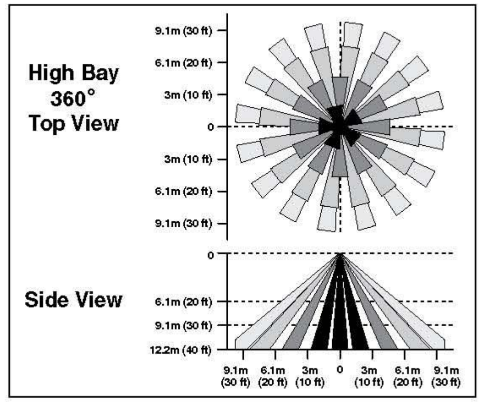
Return to last state: for safety and energy savings, the OSFHU contains a latching relay so that in the event power is lost to the device, the device will return to the last known state of the relay

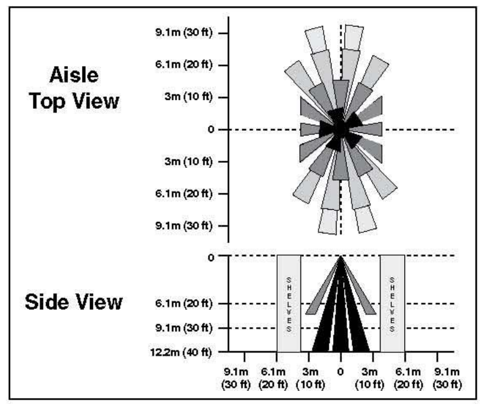
False detection intelligence: for increased energy savings and to mitigate nuisance tripping, the super bright LED indicates advanced detection has been activated and the lights will only turn ON when true occupancy has been determined

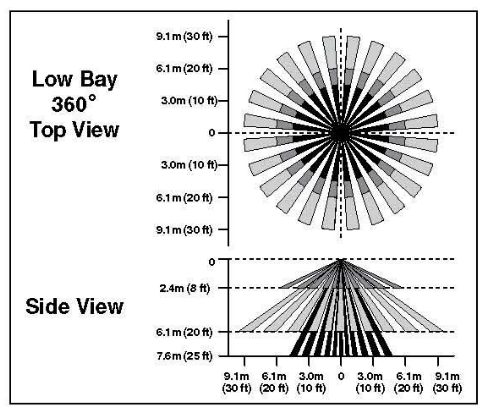
ASSEMBLY WITH OFF-SET ADAPTOR



FIELD-OF-VIEW







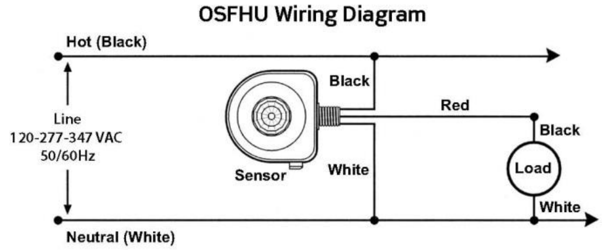
OSFHU

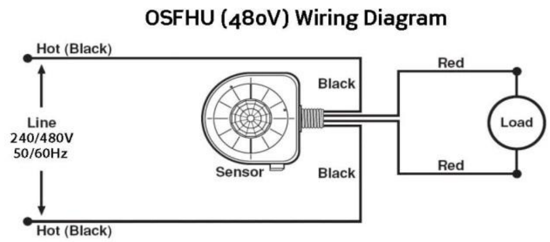
LEVITON

SPECIFICATIONS

ELECTRICAL	
Input Voltage	120-230-277-347VAC; 240/480VAC (-I4W models)
Operational Frequencies	50/60Hz
Load Rating	800VA @ 120VAC Ballast 1200VA @ 277VAC Ballast 1500VA @ 347VAC Ballast 2000VA @ 480VAC Ballast Motor: 1/4 HP Load @ 120V
Standby Power Consumption	120V - 130mW - .13W 277V - 450mW - .45W 347V - 460mW - .46W
Time Delay	30 seconds-20 minutes (factory set to 30 sec - no power required to set)
Wire Designation	-ITW/-CTW models: Line-Black, Load-Red, Neutral-White -I4W/-C4W models: Line-Black, Load-Red, Load-Red
ENVIRONMENTAL	
Operating Temperature Range	14° F to 160° F (-10° C to 71° C)
Cold Storage Operating Temperature Range	-40° F to 160° F (-40° C to 71° C)
Storage Temperature Range	-14° F to 160° F (-25° C to 71° C)
Relative Humidity	20% to 90% non-condensing
PHYSICAL	
Dimensions	OSFHU: 3.50" H x 3.50" W x 1.25" D OSFOA: 5.50" H x 2.00" W x 2.00" D OSFLO: 4.325" H x 2.00" W x 2.00" D
Construction	High-impact, injection molded plastic housing
Color	White
OTHER	
Agency Listings	UL and CUL Listed (OSFHU models)
Warranty	Limited 5-Year

WIRING DIAGRAM





OSFHU

ORDERING INFORMATION

CAT. NO.	DESCRIPTION
OSFHU-ITW	PIR Fixture Mount High Bay Sensor with 3 Interchangeable Lenses, White
OSFHU-CTW	PIR Fixture Mount High Bay Sensor with 3 Interchangeable Lenses for Cold Storage, White
OSFHU-I4W	PIR Fixture Mount High Bay Sensor with 3 Interchangeable Lenses, 480V, No Neutral, White
OSFHU-C4W	PIR Fixture Mount High Bay Sensor with 3 Interchangeable Lenses for Cold Storage, 480V, No Neutral, White
OSFOA-00W	Offset Adapter Accessory for OSFHU, 3 Position, White
OSFLO -00W	Offset Adapter Accessory for OSFHU, 1 Position, White
OSFCG -00W	Protective Cage for Fixture Mounted Sensors

NAFTA and Made in USA models available.

Leviton Mfg. Co., Inc. Lighting & Energy Solutions

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Grundfos Comfort System Hot Water Recirculator System , UP15-10 SU7P TLC, 595916, Comfort Valve

Item #: T9FB925935

Sold By: globalindustrial.com

Email Print

Usually ships in 10 to 13 days

2 reviews | Write a review

Price: $287.95

Calculate Shipping

Quantity: 1

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Product Information | Customer Review | Product Q&A

Grundfos Comfort System Hot Water Recirculator System , UP15-10 SU7P TLC, 595916, Comfort Valve

Grundfos Comfort System - Hot Water Recirculation System The water circulation system that eliminates cold water runoff at the faucet using a bypass valve and pump with a timer to control water flow. Hot Water Recirculation - Special Features- The ultimate in convenience is having hot water instantly available at sinks, appliances and bathroom faucets. The elimination of time spent waiting is especially convenient in areas where the installation of low flow showerheads and faucets are required by law. Hot water recirculation improves the efficiency and effectiveness of household appliances including washing machines and dishwashers by having hot water available instantly. Users can save energy by setting the 24 hour programmable timer to make hot water available during peak demand times, such as early morning and in the evening. The recirculation pump can be installed by a certified contractor in two hours. For the average home, hot water recirculation systems generally cost a few hundred dollars, including parts and installation. A wet rotor design for whisper-quiet and maintenance-free operation. Stainless steel rotor cladding and canister construction, an exclusive UP 15 series feature, ensures corrosion-resistance and extended product durability. A low-watt, two-pole motor combined with low-flow performance ensures minimum water heater operating costs, pipe and water heater wear and energy consumption. Significant water (and sewer) disposal savings, retaining the 12,000 to 38,000 gallons of water a typical U.S. home wastes annually waiting for hot water. Some fast-growing counties are making the installation of hot water recirculation pumps mandatory for all new construction projects.

Product Specifications	
BRAND	Grundfos
LENGTH INCHES	5-7/16
WIDTH INCHES	5-1/2
HEIGHT INCHES	6-1/4
COLOR	Red
CONSTRUCTION	Stainless
VOLTAGE	115
PHASE	1
INCLUDES	Timer and Line Cord
MANUFACTURER'S PART NUMBER	GF595916
MODEL	UP15-10 SU7P TLC
HEAD FEET	0-6
FLOW U.S. GPM	0-6-1/2
MAX. SYSTEM PRESSURE	145 PSI
MIN. FLUID TEMPERATURE	36°F (2°C)
MAX. FLUID TEMPERATURE	150°F (66°C)

365-Day Timer

TORK ElectTimer, Astro/Prog, 1 Chan, 365Day, DPDT

Electrical > Timers > Electronic Timers

Electronic Timer, Astronomic/Programmable, Channels 1, Poles 2, Contact Form DPDT, Voltage 120-277, Amps 20, HP @ 120V 1, HP @ 240V 2, Max. On/Off Cycles 99 Astronomic, Offset 299, Min. Time Setting 1 Min, Max. Time Setting 365 Days, Pulse Duration 1 to 99 Sec, Operation Mode 365 Day, NEMA Rating 3R, Enclosure Noryl(R) I/O, Color Tan, Backup Time 100 Hrs, Operating Temp. -40 to 158 F, Standards UL/CSA, Meets CA Title 24

Grainger Item #	4JNG8
Price (ea.)	**$335.25**
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Mfr. Model #	DZS100BP
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Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	1.95
Usually Ships**	Today
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Country of Origin (Country of Origin is subject to change.)	USA

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Qty.

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Tech Specs | Additional Information | Compliance & Restrictions | MSDS | Required Accessories | Optional Accessories | Alternate Products | Repair Parts

Item	Electronic Timer
Type	Astronomic/Programmable
Number of Channels	1
Number of Poles	2
Contact Form	(2) DPDT
Voltage	120-277
Amps	30
HP @ 120V	1
HP @ 240V	2
Max. On/Off Cycles	99 Astronomic, Offset 299
Min. Time Setting	1 min.
Max. Time Setting	365 Days
Pulse Duration	1 to 99 sec.
Operation Mode	365 Days
NEMA Rating	3R
Enclosure	Noryl I/O
Color	Tan
Backup Time	7 Days
Operating Temp.	-40 to 158 F

Customers Also Viewed

ElectronicTimer, Prog, DPST, 120-277V, 7Days

Brand: TORK
Grainger Item #: 4JNE8
Price: $163.00
Qty | Add to Order

ElectTimer, Astro/Prog, DPST, 120-277V, 7Day

Brand: TORK
Grainger Item #: 4JNF5
Price: $198.25
Qty | Add to Order

ElectronicTimer, Prog, SPST, 120-277V, 24Hrs

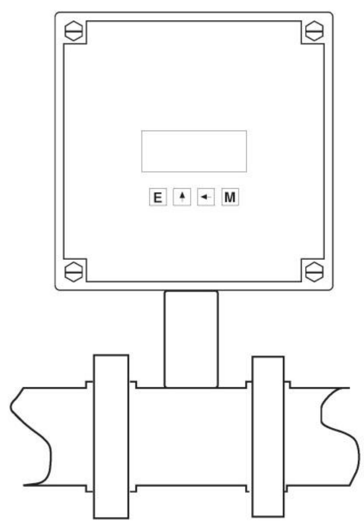
Brand: TORK
Grainger Item #: 4JNE4
Price: $103.15
Qty | Add to Order

ElectTimer, Astro/Prog, 4

Cumulative fuel oil flow meter

Sensor must be calibrated at factory for #1 diesel from .1 to 7 gph. Square plastic display is NEMA rated, round is explosion proof (not required). Display can be mounted directly on sensor. Sensor has female ½" NPT, factory can install 3/8" or other adapter, as required. Meter has flow rate and totalizer.

Battery or Loop Powered Ratemeter & Totalizer



915-BATRT-M mounted with flowmeter

Flowmetrics, Inc.
9201 Independence Avenue
Chatsworth, CA 91311

"Where Quality is Measurable"

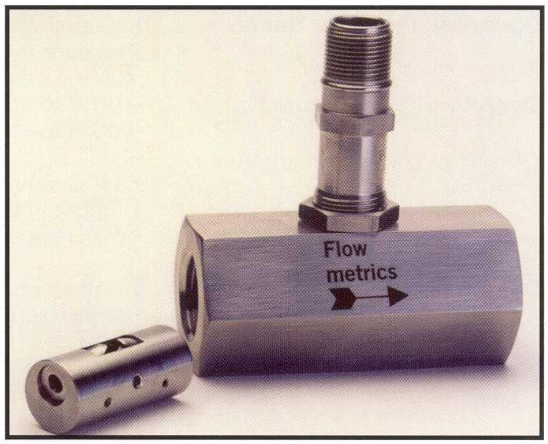
(818) 407-3420
(800) 356-6387
Fax (818) 700-1961
Email: information@flowmetrics.com

Tangential Turbine Flowmeter - FMT Series

Special Features:

- Well suited to meet a variety of process media
- Capable of measuring extremely low flow rates as .001 GPM in liquids and .001 ACFM in gases
- High output and low drag magnetic pickoffs
- Zero drag modulated carrier pickoffs*
- Bearings to suit specialized applications
- NIST traceable calibration

*Modulated carrier pickoff requires a pre-amplifier – please refer to the PA/PC/PS/LS Brochure



General:

The Flowmetrics Tangential turbine flowmeter is a unique volumetric device. This uses a dual orifice design to direct a stream of fluid tangent to a low mass/balanced rotor and a precision bearing to provide maximum sensitivity. This arrangement permits the measurement of very low flow rates in either liquid or gas service under a variety of operating conditions with high degree of precision and reliability. This geometry also eliminates the need for flow straighteners and allows for greater repeatability.

The unit produces an electrical output with pulse frequency proportional to the flowrate. These pulse can be fed into digital data display, frequency to DC analog, totalizing or into one of many recording equipments available from Flowmetrics, Inc., to provide full fluid flow measurement capability.

Flowmetrics, Inc.

"Where Quality is Measurable"

9201 Independence Avenue
Chatsworth, CA 91311
USA

(800) 356 6387 . (818) 407-3420
http://www.flowmetrics.com
FAX (818) 700-1961

June 14, 2013

Mr. Jim Fowler
Energy Audit of Alaska
Tel: 206 954 3614 /Fax:
E-mail: jim@jim-fowler.com

Our Ref: Quote # 1306221

Dear Jim,
We are pleased to quote the following flow meter & display, which will accurately Diesel #1 Fuel

1. P/N: FMT-8-7NX1-0.070-LD1L Price/each: US$ 880

Turbine Flowmeter (FMT Series):

- Process Connection: ½ " NPT (Female)
- Calibration Range: 0.50 – 3 GPH for Diesel # 1 Fuel at ambient conditions
- Accuracy: +/- 0.5% Reading
- Materials of Construction: 316 Stainless Steel except with 440c stainless steel ball bearing
- Magnetic pickup coil

2. P/N: 915BATRTM5A4 Price/each: US$ 434

Digital Display:

- Battery powered
- Displays Rate and Total simultaneously
- Mounted integral to flowmeter in a NEMA-4x enclosure

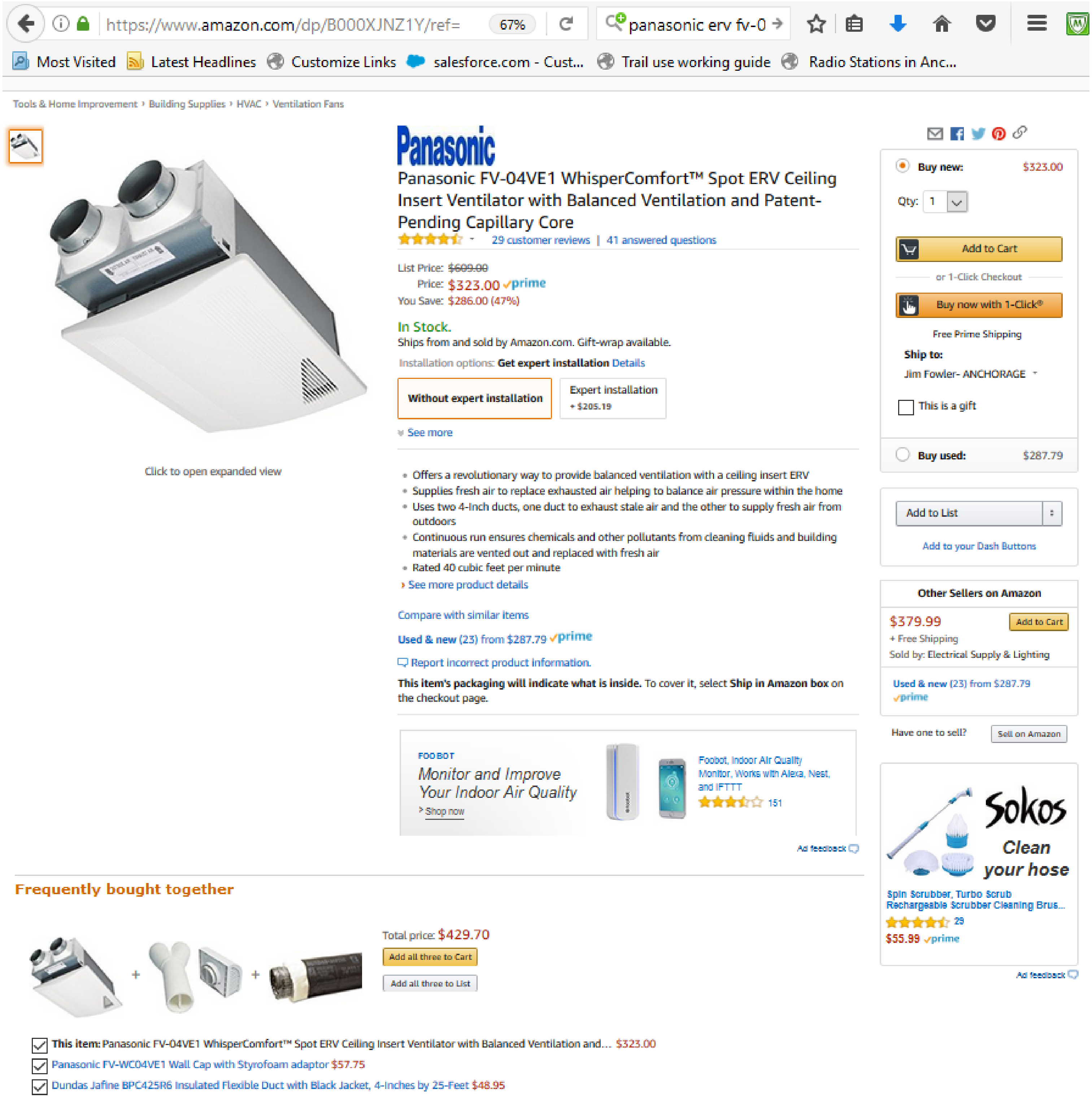
Delivery: 1 - 2 Weeks ARO
F.O.B. Factory
Quoted prices are firm for 60 days

Thank you for the opportunity to quote your requirements. Please do not hesitate to contact our office if you have any questions. We look forward to being of further assistance.

Very truly yours,

Irfan Ahmad
Sales/Application Manager
irfan@flowmetrics.com

Energy Recovery Ventilator (ERV)



Heat Recovery Ventilator (HRV)

www.energyconscious.com/venmar-us-heat-recovery-ventilator-hepa-h50100h.html?fee=5&fep=11793&g venmar hrv for sale

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Venmar US Heat Recovery Ventilator Hepa - H50100H

By VENMAR

Item Code: H50100H | Write a Review and Earn 50 Points! | Add to Registry

Mouse over the image for zoom

Special Price $1,123.31 **Regular Price:** ~~$1,392.91~~ | You Save 19%

N/A
Energy Score

In Stock at Supplier **Quantity:** 1 ADD TO CART

Availability: Ships the next business day

FREE SHIPPING

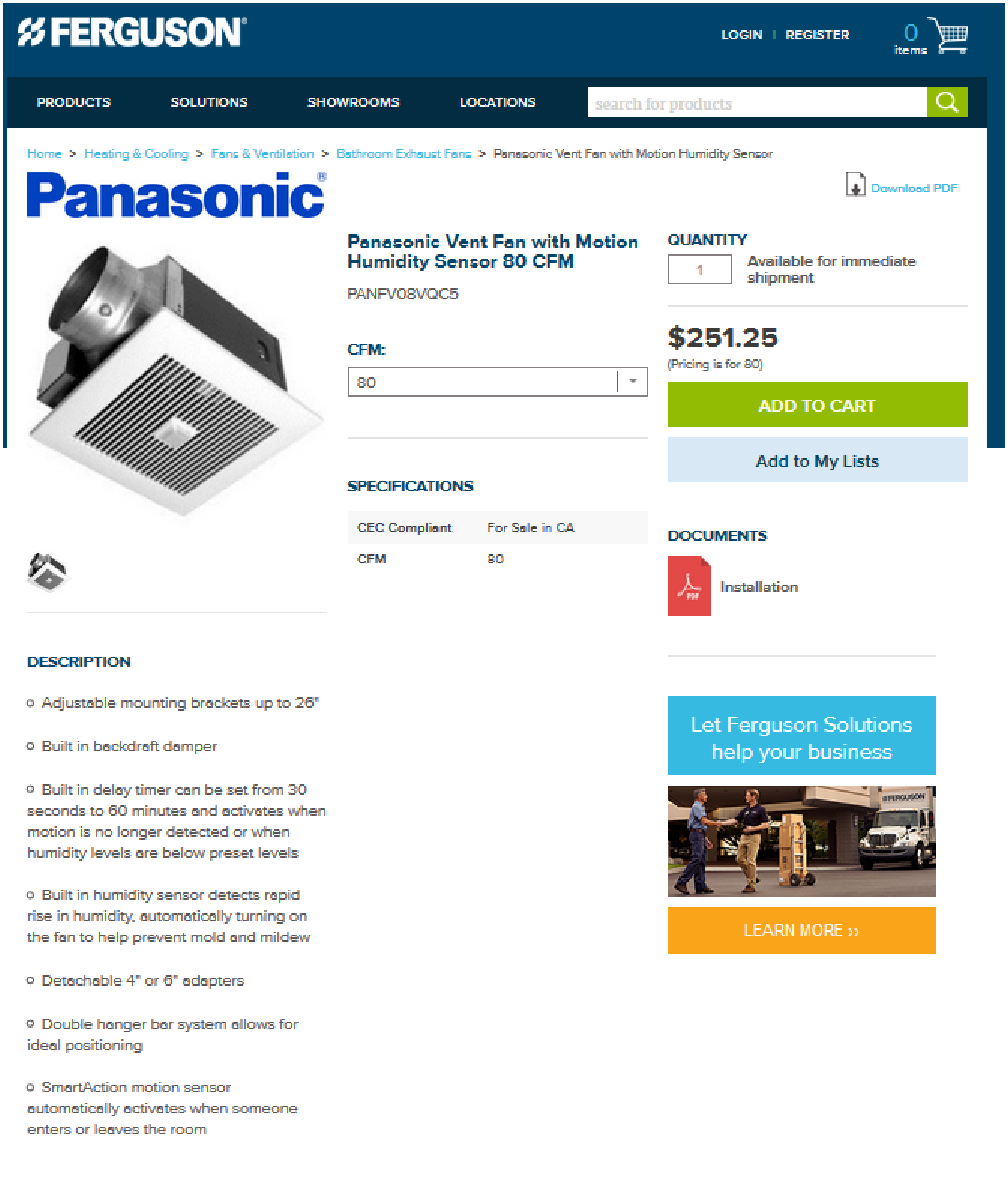
Product Description

Venmar products shipped might come with the Broan name as Venmar is owned by Broan.

The H50100H Heat recovery ventilator with HEPA filtration is our best option for optimal indoor air quality.

The HEPA filter included in this unit captures 99.97% of allergens and other microscopic particles and can help reduce the symptoms of allergies, asthma and other respiratory problems.This unit has an ultra-quiet operation coming from the advanced design of its blower which is also contributing to its high energy efficiency. Moreover, its compact size makes it quick and easy to install.

Motion and humidity sensing bathroom exhaust fan



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Panasonic

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Panasonic Vent Fan with Motion Humidity Sensor 80 CFM

PANFV08VQC5

CFM: 80

QUANTITY 1 Available for immediate shipment

$251.25

(Pricing is for 80)

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SPECIFICATIONS

CEC Compliant	For Sale in CA
CFM	80

DOCUMENTS

Installation

DESCRIPTION

- Adjustable mounting brackets up to 26"
- Built in backdraft damper
- Built in delay timer can be set from 30 seconds to 60 minutes and activates when motion is no longer detected or when humidity levels are below preset levels
- Built in humidity sensor detects rapid rise in humidity, automatically turning on the fan to help prevent mold and mildew
- Detachable 4" or 6" adapters
- Double hanger bar system allows for ideal positioning
- SmartAction motion sensor automatically activates when someone enters or leaves the room

Let Ferguson Solutions help your business

LEARN MORE ››

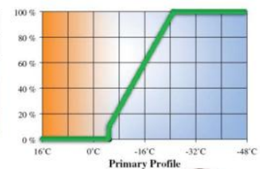
Integrated Parking Lot Controls (head bolt heater controls)
Estimated cost $250 ea. + 1 hr. installation

- IPLCs allow for individual programming of each circuit to meet differing user needs, whereas centralized controls provide the same program to all stalls.
- In IPLC-equipped parking lots, potential problems are confined to individual circuits and alert parkers to problems, whereas malfunctioning centralized controls affect many or all outlets in the lot, without automatically alerting parkers.
- IPLCs provide feedback to tell each vehicle operator if their outlet and block heater are working properly, whereas centralized controls do not.
- IPLCs deliver up to 65 percent in energy and cost savings whereas centralized controls typically deliver a maximum of 50 percent in savings.

Factory Pre-programmed Schedule

Primary Profile	
Temperature	Percent ON
> -5.0 °C	0.00 %
-5.0 °C	9.77 %
<= -25.0 °C	100.00 %

LOAD LIMIT: 1800 W (15 Amps)
INTIAL POWER DELAY = 2.05 hours

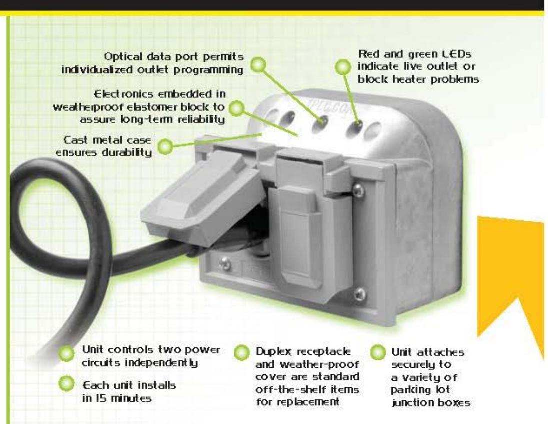


"The IPLC is the most advanced, flexible and cost effective parking lot power management device on the market today."
– *Dr. Glenn Rosendahl, Ph.D., P.Eng., President, Vantera Incorporated*

9

Save 65% in Parking Lot Power Use and Costs with the Intelligent Parking Lot Controller

About 4.8 million Canadian vehicles need their engines warmed each winter. Any parking lot operator providing block-heater outlets knows to expect high power costs from November through March, regardless of how warm or cold the winter is. Many drivers automatically plug in, even on warm days when little or no engine heat is needed to assure a start. This results in wasted power and needless expense.



Short-circuited or dead block heaters often lead irate drivers to claim receptacles are malfunctioning or breakers are tripped. NOT with the IPLC! The IPLC prevents these costly service calls, just to reset a breaker or confirm the circuit is working and the driver's block heater is faulty.

4


IPLC
Intelligent Parking Lot Controller
Developed and marketed by Vantera Incorporated
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IPLC / Vantera Incorporated
P.O. Box 334
Elie, MB, R0H-0H0
CANADA
www.iplc.com
1-866-353-2785
A Made-in-Canada Solution
Recognized as a Manitoba Hydro
Power Smart Energy Savings Solution

Refrigerated Beverage Vending Machine occupancy sensing system

optimum ENERGY PRODUCTS LTD.
Toll Free: 1.877.766.5412
info@optimumenergy.com

Order Online
VendingMiserStore.com

VendingMiser®

ENERGY MANAGEMENT SYSTEM
For Refrigerated Vending Machines

Improve the profitability of your existing cold drink machines. Vending Miser® puts you on a cost-effective refresher course for energy savings and conservation.

VendingMiser cuts energy costs down to size

VendingMiser incorporates its innovative energy-saving technology into a small, plug-and-play powerhouse that installs in minutes either on the wall or on the vending machine. It's that easy.

With VendingMiser there's no need to have new machines to achieve maximum energy savings resulting in a reduction in operating costs and greenhouse gas emissions. When equipped with the VendingMiser, refrigerated beverage vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR® qualified machines.

Power play

Compatible with all types of cold drink vending machines, the VendingMiser uses a Passive Infrared Sensor (PIR) to power down the machine when the area surrounding it is vacant. Then it monitors the room's temperature and automatically re-powers the cooling system at one- to three-hour intervals, independent of sales, to ensure that the product stays cold.

This Miser runs the bank

For a series of up to four machines, VendingMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

Refresher course

VendingMiser's microcontroller will never power down the machine while the compressor is running, eliminating compressor short-cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down. This reduces the wear and tear on your machines, extending the lifespan and prolonging your profitability. Maintenance savings is generated through reduced running time of vendor components – estimated at $40 - $80 per year, per machine. The VendingMiser has been tested and accepted for use by major bottlers.

VendingMiser reduces energy consumption an average of 46%—typically $150 per machine.

Vending Miser offers...

- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Early return on investment
- Environmental benefits

VendingMiser can also control other cooled product vending machines, such as refrigerated candy machines.

VendingMiser Technical Specifications
Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Vending Machines: Any machine, except those containing perishable goods such as dairy products

Inactivity Timeouts
Occupancy Timeout: 15 minutes
Auto Re-power: One to three hours, dynamically adjusted, based on ambient temperature

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lbs. (includes power cable)

Regulatory Approvals
Safety: UL/C-UL Listed
Information Technology Equipment (ITE) 9T79

Other energy-saving products offered by USA Technologies include VM2IQ™, CoolerMiser™, SnackMiser™ and PlugMiser™.

ENERGY STAR PARTNER

USA TECHNOLOGIES

Fore more information about VendingMiser contact Optimum Energy Products Ltd. Toll free 1.877.766.5412 or online www.VendingMiserStore.com

optimum
ENERGY PRODUCTS LTD.
Toll Free: 1.877.766.5412
info@optimumenergy.com
Order Online
VendingMiserStore.com

Frequently Asked Questions

Will VendingMiser® keep my drinks cold?
Absolutely - VendingMiser® has been tested and accepted for use by both major bottlers.

Is the VendingMiser® easy to install?
Yes! VendingMiser® is a simple external plug-and-play product. The VendingMiser® can be installed on the wall with simple hand tools or it can be attached to the vending machine without tools using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is VendingMiser® safe for all machines?
Yes! VendingMiser® is compatible with all types of cold drink vending machines. In fact, by reducing run time of the machines, VendingMiser® reduces maintenance costs.

Has VendingMiser® been field tested?
Tens of thousands of VendingMisers® are operational in the field. Typical energy savings have been independently documented to be between 35% and 45%. Measurement and verification test results as well as testimonials are available on the website.

Are there any locations not appropriate for VendingMiser®?
VendingMiser's® savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings. Our VM2IQ is more appropriate for this type of location and will typically save up to 35% energy use.

Technical Specifications

ELECTRICAL SPECIFICATIONS	
Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)
ENVIRONMENTAL SPECIFICATIONS	
Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)
COMPATIBILITY	
Vending Machines:	Any machine, except those containing perishable goods such as dairy products.
INACTIVITY TIMEOUTS	
Occupancy Timeout:	15 minutes
Auto Repower:	One to three hours, dynamically adjusted, based on ambient temperature
DIMENSIONS	
Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)
REGULATORY APPROVALS	
Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

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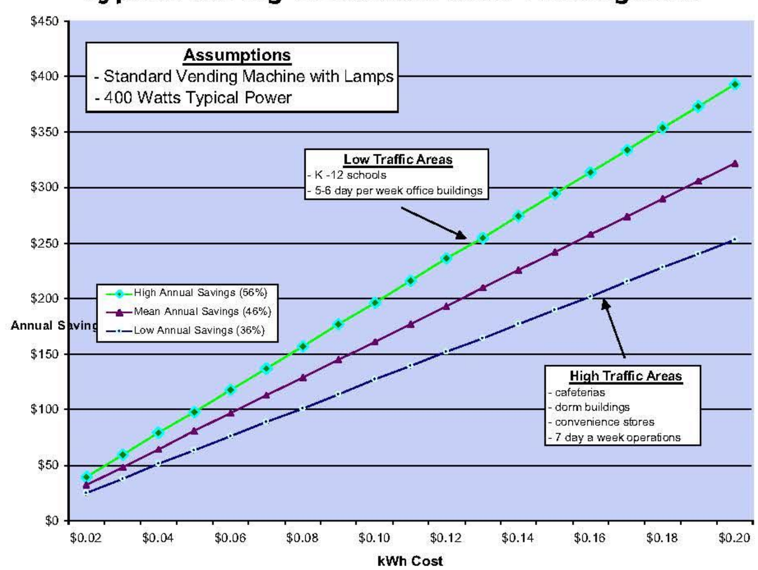
Typical Saving Generated with VendingMiser®



VendingMiser® Products

VM150	VendingMiser® with PIR Sensor
VM151	VendingMiser® only
VM160	Weatherproof VendingMiser® with PIR Sensor
VM161	Weatherproof VendingMiser® only
VM170	Easy-Install VendingMiser® with PIR Sensor
VM171	Easy-Install VendingMiser® only
VM180	Weatherproof Easy-Install VendingMiser w/PIR sensor
VM181	Weatherproof Easy-Install VendingMiser only

Fore more information about VendingMiser contact

Optimum Energy Products Ltd. Toll free 1.877.766.5412 or online www.VendingMiserStore.com

Occupancy and Motion Controls for glass front Coolers

CoolerMiser™

ENERGY MANAGEMENT SYSTEM
For Glass-Front Coolers

Start a cooling trend that saves you money and conserves energy.

CoolerMiser™ refreshes profits, reduces costs.

With CoolerMiser, achieve maximum energy savings resulting in a reduction in both operating costs and greenhouse gas emissions. CoolerMiser incorporates its innovative energy-saving technology into a small, plug-and-play powerhouse that installs in minutes.

Power sense
Compatible with all glass-front coolers that contain non-perishable goods, CoolerMiser's Passive Infrared Sensor (PIR) powers down the machine when the surrounding area is vacant. Then it monitors the room's temperature and periodically re-powers the cooling system to ensure that the product stays cold.

CoolerMiser analyzes the cooler's performance on a cycle-by-cycle basis, constantly responding to changes in load, sales and environment. It then modifies its behavior accordingly, ensuring proper operation and temperature controls.

This Miser runs the bank
For a bank of coolers, CoolerMiser can use its embedded Sensor Repeater, which allows it to be controlled from the PIR sensor of any other Miser in the bank.

CoolerMiser's electrical current sensor will never power down the machine while the compressor is running, eliminating compressor short cycling. In addition, when the machine is powered up, the cooling cycle is allowed to finish before again powering down. This reduces the wear and tear on your machines, extending the lifespan and prolonging your profitability.

According to current customer results, CoolerMiser can save an average of $100 per year, per cooler in energy costs. In addition, one CoolerMiser reduces greenhouse gas emissions by 1,600 lbs. of CO2 and 2,740 grams of NOx each year, based on occupancy and the Energy Information Administration's national average of greenhouse gas emissions and electricity generation.

CoolerMiser offers...
- A quick, inexpensive solution to energy savings and conservation
- Longer machine lifespan
- Environmental benefits
- Early return on investment
- Can control single-, double- and triple-door coolers

CoolerMiser Technical Specifications
Electrical Specifications
Input Voltage: 115 Volts
Input Frequency: 50/60 Hz
Maximum Load: 12 Amps (Steady-State)
Power Consumption: Less than 1 Watt (Standby)

Environmental Specifications
Operating Temp: -15°C to 75°C
Storage Temp: -40°C to 85°C
Relative Humidity: 95% Maximum (Non-Condensing)

Compatibility
Slide Coolers: Any cooler, except those containing perishable goods, which do not exceed 12 AMP nameplate rating

Inactivity Timeouts
Occupancy Timeout: 15 minutes
Auto Re-power: One to seven hours, dynamically adjusted, based on cooler performance and ambient temperature

Dimensions
Size: 4.5"W x 1.75"H x 3.25"D
Weight: 2.2 lbs. (includes power cable)

Other energy-saving products offered by USA Technologies include VendingMiser®, VM2IQ™, SnackMiser™ and PlugMiser™.

GSA Schedule Contract GS-35F-0021R

ENERGY STAR PARTNER

USA TECHNOLOGIES

Optimum Energy Products Ltd. Toll Free 877-766-5412 Main 403-256-3636 Fax 403-256-3431

Frequently Asked Questions

Will CoolerMiser™ keep my drinks cold?
Absolutely - CoolerMiser™ has been extensively tested in countless field and laboratory environments and does not compromise the for-sale products.

Is the CoolerMiser™ easy to install?
Yes! CoolerMiser™ is a simple external plug-and-play product. The CoolerMiser™ can be installed on the wall with simple hand tools or it can be attached without tools to the cooler using the new Easy-Install system. The Easy-Install System allows quick installation in 5 minutes.

Is CoolerMiser™ safe for all machines?
Yes! CoolerMiser™ is compatible with all types of coolers. CoolerMiser™ analyzes the cooler it controls and then modifies its behavior to match the cooler's requirements. In fact, by reducing run time of the machines, CoolerMiser™ reduces the cooler's maintenance costs.

Are there any locations not appropriate for CoolerMiser™?
CoolerMiser's savings are generated as a result of location vacancy. Therefore, a machine in a location that is occupied 24-hours, 7 days a week will likely generate little savings.

Technical Specifications

ELECTRICAL SPECIFICATIONS

Input Voltage:	115 Volts (230 Volts available)
Input Frequency:	50/60 Hz
Maximum Load:	12 Amps (Steady-State)
Power Consumption:	Less than 1 Watt (Standby)

ENVIRONMENTAL SPECIFICATIONS

Operating Temp:	-15°C to 75°C
Storage Temp:	-40°C to 85°C
Relative Humidity:	95% Maximum (Non-Condensing)

COMPATIBILITY

Slide Coolers:	Any cooler, except those containing perishable goods, which do not exceed 12 Amp nameplate rating.

INACTIVITY TIMEOUTS

Occupancy Timeout:	15 minutes
Auto Repower:	One to seven hours, dynamically adjusted, based on cooler performance and ambient temperature

DIMENSIONS

Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

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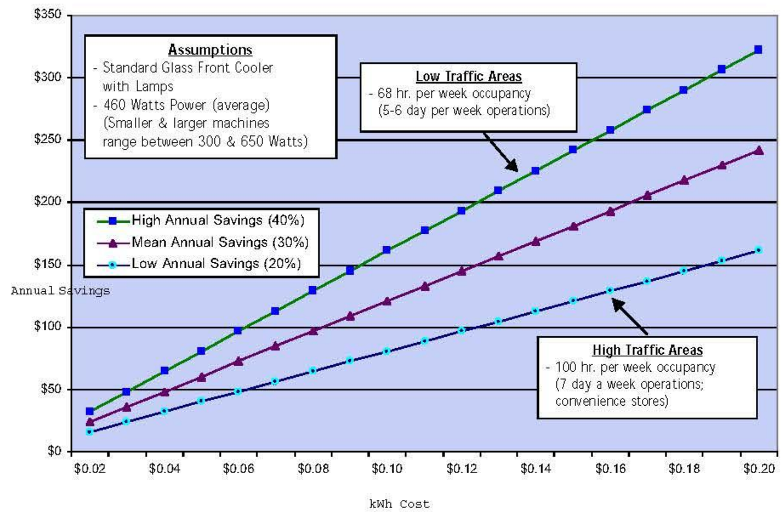
Typical Saving Generated with CoolerMiser™



CoolerMiser™ Products

CM150	CoolerMiser with PIR Sensor
CM151	CoolerMiser only
CM170	Easy-Install CoolerMiser with PIR Sensor
CM171	Easy-Install CoolerMiser only

For more information about the CoolerMiser™
Contact Optimum Energy Products Toll Free 877-766-5412 or visit www.VendingMiserStore.com

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