Executive Summary

Energy Audits of Native Village of Kwigillingok Tribally Owned Buildings

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Prepared For

Native Village of Kwigillingok
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Report Date:

October 4, 2018

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Energy Audits of Alaska

BACKGROUND

The Native Village of Kwigillingok was awarded a grant from the US DOE 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, 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. This community is governed by the Kwigillingok IRA Council (IRA).

The buildings included in this program are:

IRA Council Office
Clinic
VPSO building
Fisheries building
Post Office
ANTHC Bunkhouse

No access was available to the ANTHC bunkhouse during the initial visit, so the site survey and subsequent energy audit report will occur during and after the second visit in October 2018.

The EAA team performed site surveys of each building (other than the ANTHC bunkhouse) from December 12th through December 13th, 2017. A preliminary findings report was produced in January 2018 and final reports in October 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 it 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.

In the case of the VPSO building and the IRA Council office, the annual fuel oil delivery was estimated by the building owner. It appeared to be too low for the size, use, and occupancy of the building, so the AkWarm-C models are not calibrated to actual fuel consumption and the baseline fuel consumption is predicted by the AkWarm-C model. Also in the case of the VPSO building, there were 6 months of missing electric data in the baseline year, presumably because if a building uses less than 60 kWh in a month, there is no recording of use or charge. In these cases 50 kWh/month was used in the Akwarm-C Model. When the model is not calibrated to actual consumption, the accuracy of savings is reduced.

USE AND OCCUPANCY

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

Based on conversations with on-site staff and previous EAA experience, reasonable use and occupancy scenarios were created for each of the other buildings and the savings estimates in the energy audits are based on these use and occupancy scenarios.

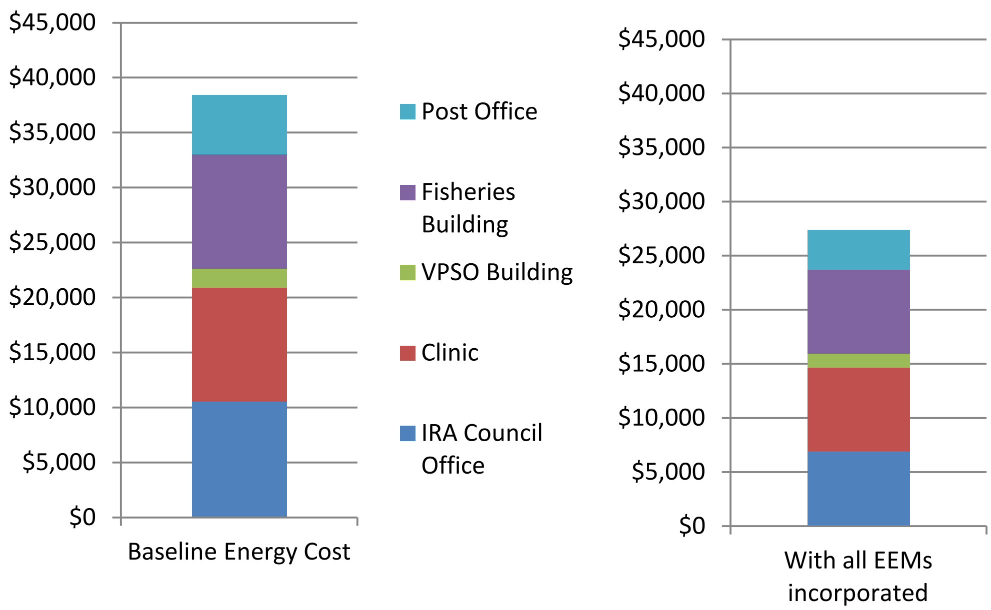
OCCUPANCY SCENARIOS USED IN AkWARM-C MODELS			
	Used as	**No. occupants**	**Operating hours**
VPSO Building	Office for VPSO, occasional holding cell for prisoner	1 officer, 1 prisoner	Officer hours: 8:00am-5:00pm, and midnight to 4:00am. Prisoner average occupancy: 52 hrs/year or 1 hour/week
IRA Council Office	Offices	14 staff including visitors	Building is in use by various occupants from 9:00am-6:00pm, Monday-Friday
Post Office	Post office	1 staff, 20-50 visitors checking mailboxes	10:00am-1:00pm and 1:30pm-5:00pm, Monday-Friday, 11:00am-3:00pm Saturday
Clinic	Health clinic	West 1/3: 2 staff East 2/3: 1 staff	3 health aides, 1 secretary 9:00am-4:00pm Monday-Friday, plus 1 part time janitor and patients
Fisheries Building	Offices and Shop	1 staff	2 office staff, 3 shop staff (intermittently in building) 8:00am-5:00pm Monday-Friday, plus public use of computers

COST OF ENERGY & POTENTIAL SAVINGS

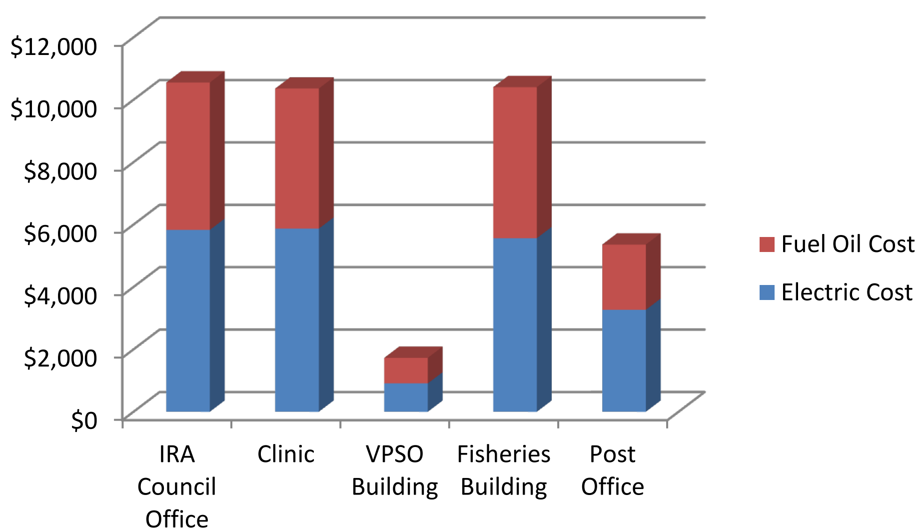
The energy costs used in the analysis are shown below; only the Clinic receives the PCE discount.

	Electricity $/kWh	Fuel Oil $/gallon
IRA Council Office	$0.67	$4.50
Clinic	$0.37	$4.50
VPSO Building	$0.67	$4.50
Fisheries Building	$0.67	$4.50
Post Office	$0.67	$4.50

As a baseline, the IRA spends $38,405 for electricity and fuel oil for these five buildings and with all of the recommended EEMs incorporated, their annual energy costs would be $27,369. There would be a 29% reduction in costs, or $11,636/year in savings. The cost to implement the recommended EEMs in all 5 buildings is $65,351 and the simple payback on that expenditure is 5.6 years. The baseline and post-EEM annual energy costs are shown below.



Annual existing energy costs are distributed across the five buildings as follows:



SUMMARY OF ENERGY EFFICIENCY MEASURES

The EEMs considered for these buildings included:

- Envelope (windows, doors, insulation, air sealing)
- HVAC (set back thermostats, boiler replacement, retro-commissioning systems, controls and control strategies, variable speed motors)
- DHW
- Lighting and lighting controls

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

EEM SAVINGS SUMMARY						
	IRA Council	**Clinic**	**VPSO**	**Fisheries**	**Post Office**	**TOTALS**
Envelope	$1,718					**$1,718**
HVAC related	$888	$3,093	$126	$1,873	$422	**$6,402**
Lighting	$1,075	$412	$318	$101	$1,573	**$3,479**
Other	$37					**$37**
TOTALS	**$3,718**	**$3,505**	**$444**	**$1,974**	**$1,995**	**$11,636**

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

EEM COST SUMMARY						
	IRA Council	**Clinic**	**VPSO**	**Fisheries**	**Post Office**	**TOTALS**
Envelope	$19,779					**$19,779**
HVAC related	$497	$16,498	$2	$12,601	$252	**$29,850**
Lighting	$3,706	$4,107	$538	$765	$5,606	**$14,722**
Other	$1000					**$1,000**
TOTALS	**$24,982**	**$20,605**	**$540**	**$13,366**	**$5,858**	**$65,351**

Comprehensive Energy Audit
For ANTHC Bunkhouse

Prepared For
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Site Survey Date:
October 9, 2018

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Energy Audits of Alaska

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

Revision Tracking

New Release – May 17, 2019
Copy-edited Version – May 24, 2019

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 but may be used for comparative purposes by the auditor or his designees.

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: Darrel John and Richard John, the tribal administrator and finance officer 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. Thanks to Megan the school principal, who provided lodging.

Project Location

ANTHC Bunkhouse

NORTH

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1. SUMMARY

This report was prepared for the Native Village of Kwigillingok (NVK). The current owner of the ANTHC Bunkhouse is the Alaska Native Tribal Health Consortium (ANTHC) but NVK is anticipating that the building will become tribal property at some time in the future and this energy audit is intended to help understand the operating costs of the existing building as well as potential energy efficiency measures.

NVK wished to have two scenarios evaluated for the building's future use:

- Continuing as it has been used from 2010 through 2017; that is, the building is used for 2-3 months during the summer months for construction crews of 2-4 people
- Use as an office building year round, for 7 people

The operating costs for the building under these two use-scenarios are shown below, before and after the recommended EEMs are incorporated:

	Use as itinerant crew housing			Use as full time office		
	Existing conditions	With all EEMs incorporated	Savings	Existing conditions	With all EEMs incorporated	Savings
Electric use (kWh)	2,603	1,402	1,201	8,210	3,733	4,477
Oil use (gallons)	350	314	36	804	584	220
Energy cost	$3,734	$2,724	$1,010	$10,074	$5,827	$4,247

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 October 9, 2018. The outside temperature was 50F, the relative humidity was 86% and it was raining.

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

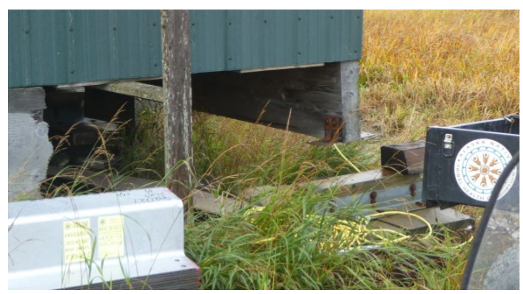
The 13 page summary is designed to contain all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost and their estimated annual savings and simple payback. The summary discusses the subject building 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 was vacant during 2018 but as been used as itinerant housing for construction crews since 2010 for 2-3 summer months, for 2-4 people. Its windows are currently boarded for security purposes.
b. If used as either an office or itinerant crew housing, the zoning in this building is inadequate. The Toyo and electric wall convectors do not distribute heat evenly to all spaces so unless doors are left open (which is unlikely if used as itinerant housing) there will be no heat to many rooms. This could be rectified by adding a boiler and hydronic distribution system or a furnace and attic ducted distribution system (much less efficient distribution than hydronic), both of which are expensive and not considered in this analysis.



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:

   - Program the Toyo stoves to set back space temperatures when the building is unoccupied or during night time periods when occupants are sleeping.
   - Repair unsafe foundation support, photos above right.

- Seal all wall, floor and ceiling penetrations and repair unsafe electrical issues, see photo at right.

d. If the building is used as itinerant crew housing and all of the recommended EEMs are incorporated, there will be a 27% reduction in energy costs, totaling $1,125, with a simple payback of 16.3 years on the $18,359 implementation cost.
e. If the building is used as a full time office and all of the recommended EEMs are incorporated, there will be a 42.2% reduction in energy costs totaling $4362, with a simple payback of 4.0 years on the $17,561 implementation cost.
f. No fuel oil delivery data was available for this building; therefore the fuel oil consumption figures in this analysis were 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.
g. Electric consumption data was provided for one year, but given that the use and occupancy of the building is so variable, this data (found in Appendix B) was not used other than to confirm the reasonableness of the projected AkWarm-C consumption figures.
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 qualified electricians. A labor rate of $125/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], the total predicted energy costs for the two occupancy scenarios are shown below.

	Use as itinerant crew housing		Use as full time office	
	Existing conditions	With all EEMs incorporated	Existing conditions	With all EEMs incorporated
Electric use (kWh)	2,603	1,402	8,210	3,733
Oil use (gallons)	350	314	804	584
Energy cost	$3,734	$2,724	$10,074	$5,827

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. The electricity and fuel oil costs used in this analysis and shown in the table below were obtained from the AkWarm-C library which is based on figures from the Alaska Department of Commerce.

[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.

	Unit Cost	Cost/MMBTU
Electricity	$0.67	$196.30
Fuel Oil	$5.69	$43.11

Figure 1.1.a – Use as itinerant crew housing

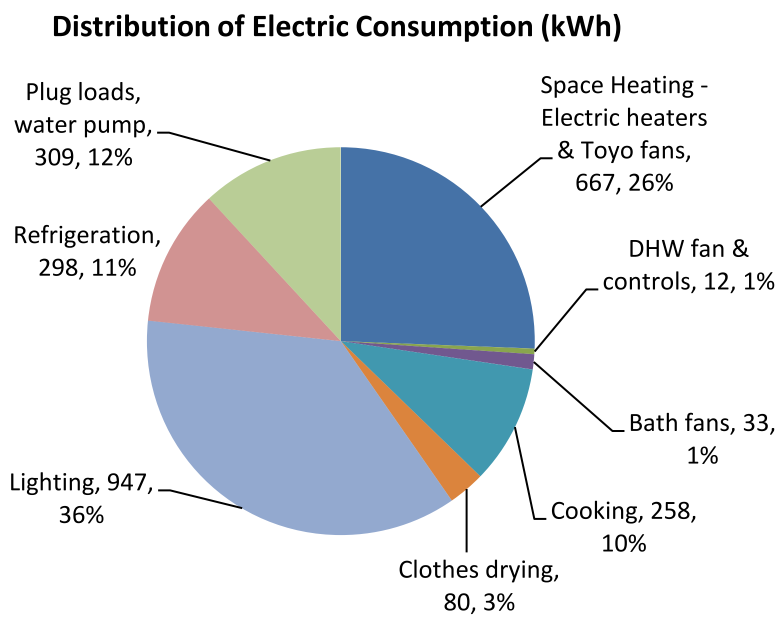


Figure 1.1.b – Use as office building

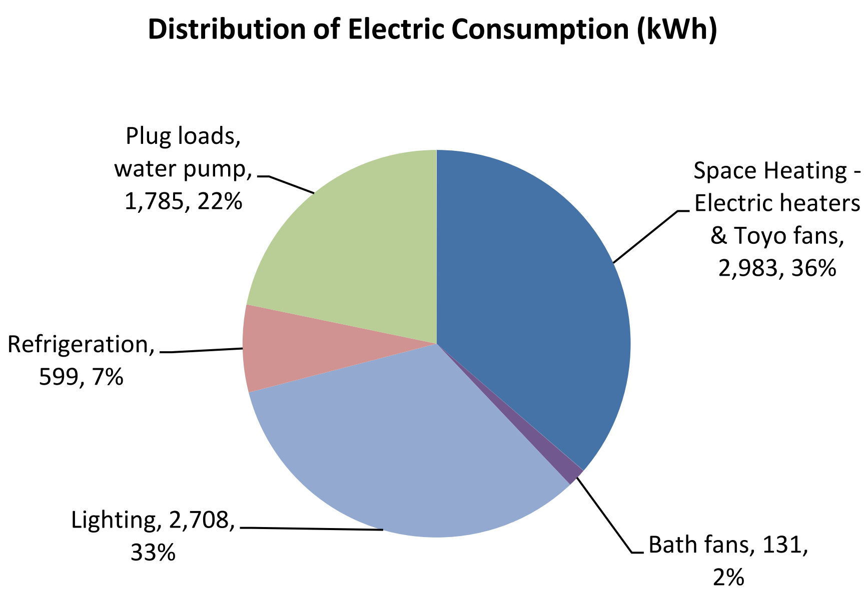


Figure 1.2.a – Use as itinerant crew housing

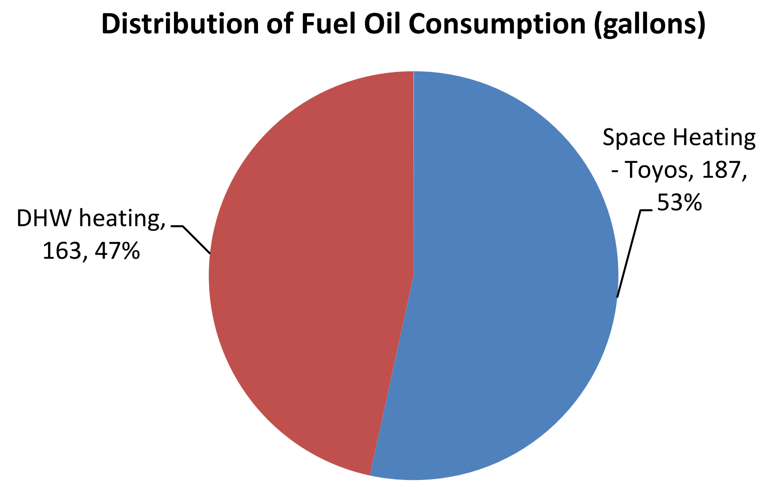
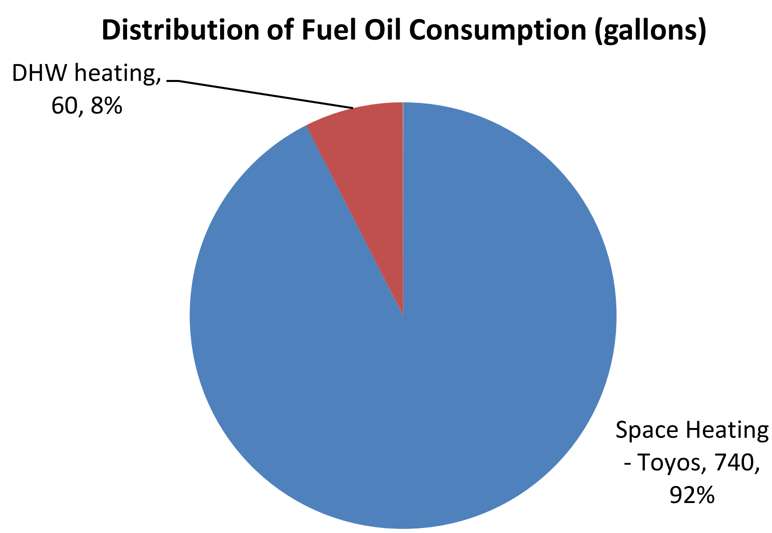


Figure 1.2.b – Use as office building



Based on these breakdowns, it is clear that efficiency efforts should be focused primarily on lighting and space heating for both scenarios.

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.

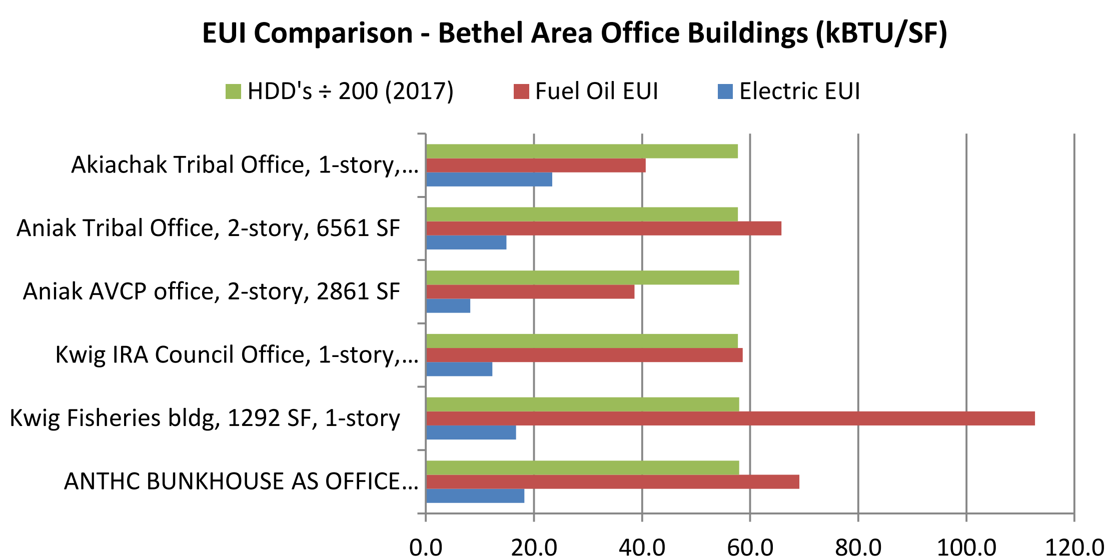
Building Benchmarks – Itinerant Crew Housing			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	35.8	3.09	$2.43
With Proposed Retrofits	30.1	2.59	$1.77
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned 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 Benchmarks – Office Building			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	87.3	7.53	$6.56
With Proposed Retrofits	58.5	5.05	$3.79
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

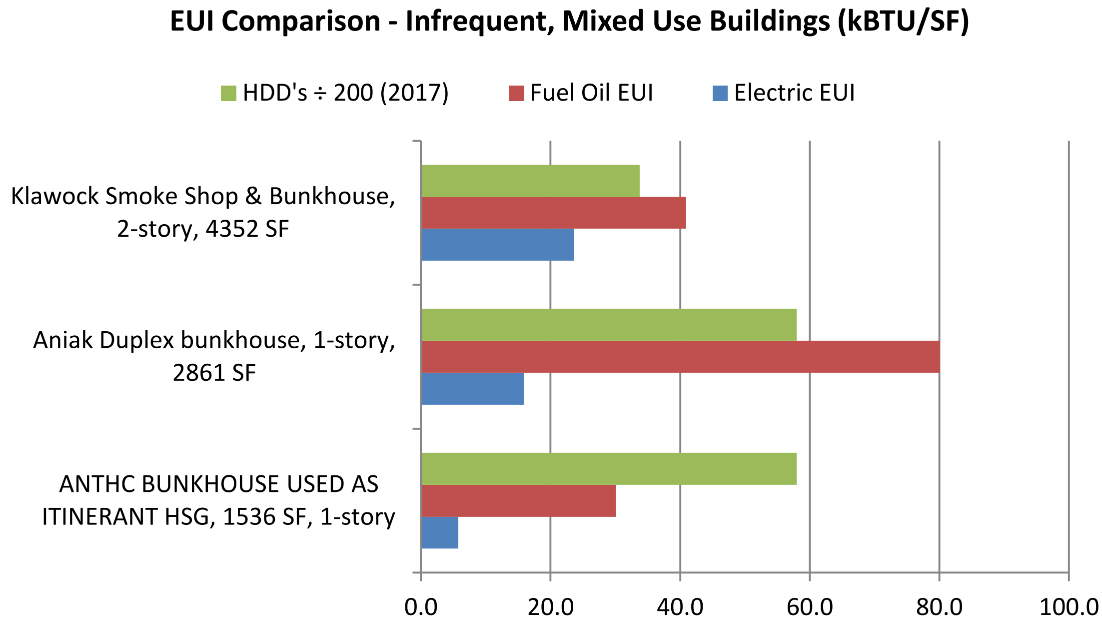
The subject building's heating and electric energy utilization indexes (EUIs) are compared to similar use buildings in the region in the bar charts below. The Heating Degree Days[2] (HDDs) bars are intended to normalize the effect of weather differences.

As seen in the chart below comparing office buildings, the subject building has the second highest heating and electric EUIs, indicating that it is not efficient in either area when compared to similar use buildings in the region.



[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.

As seen in the chart below comparing infrequently and mixed use buildings, the subject building has the lowest heating and electric EUIs of all the comparison buildings. This is likely attributed to its very low use (i.e. 3 months/year) rather than any factors related to efficiency.



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 BTU's of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of these tables.

Figure 1.3.a – Use as itinerant crew housing

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
HVAC related	$5,450	$412	13.2
Envelope	$10,266	$290	35.4
Lighting	$2,643	$423	6.2
Totals	**$18,359**	**$1,125**	**16.3**

Figure 1.3.b – Use as office building

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
HVAC related	$4,652	$2,543	1.8
Envelope	$10,266	$820	12.5
Lighting	$2,643	$999	2.6
Totals	**$17,561**	**$4,362**	**4.0**

Figure 1.4.a – Use as itinerant crew housing

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	2,603	8,884	1,402	4,785	46.1%
Gallons Oil	350	46,200	314	41,448	10.3%
Energy Cost	$3,734		$2,724		27.0%

Figure 1.4.b – Use as office building

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	8,210	28,021	3,733	12,741	54.5%
Gallons Oil	804	106,128	584	77,088	27.4%
Energy Cost	$10,074		$5,827		42.2%

Tables 1.1 below and Table 4.1 in section 4 summarize the energy efficiency measures analyzed for the ANTHC Bunkhouse. Estimates of annual energy and maintenance savings, installed costs, SIR, CO2 savings, and simple paybacks are shown for each EEM. The $1 cost indicates that there is no appreciable cost to implement the EEM (such as programming a Toyo stove), but AkWarm-C does not allow a $0 cost entry.

Table 1.1.a – Use as itinerant crew housing
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: Table lamp INC A-type 60w	Replace with 3 LED 9W Module StdElectronic	$39 / 0.1 MMBTU	$15	21.72	0.4	217.3
2	Lighting - Power Retrofit: Outdoors HPS 70w wall pack	Replace with 2 LED 17W Module StdElectronic	$106 + $10 Maint. Savings / 0.5 MMBTU	$400	2.44	3.5	552.2
3	HVAC And DHW	1.) Remove the (2) electric wall convectors and replace with another Toyo Stove @ installed cost of $3000. 2.) At EOL replace the clothes washer with a front loading, Energy Star Version @ cost of $800 installed.	$362 / 0.8 MMBTU	$3,800	1.09	10.5	1,982.8
4	Lighting - Power Retrofit: FLOUR T8-2 24x24 surf wrap	Replace with LED 15W Module StdElectronic	$11 + $5 Maint. Savings / 0.0 MMBTU	$124	1.07	7.8	60.6
	TOTAL, cost-effective measures		**$518 + $15 Maint. Savings / 1.4 MMBTU**	**$4,339**	**1.29**	**8.1**	**2,812.9**
The following measures (if any are listed) were *not* found to be cost-effective but are still recommended:							
5	Lighting - Power Retrofit: FLUOR T8-2 surf wrap, 4lamp fixt w/2 removed	Replace with 20 LED (2) 15W Module (2) StdElectronic	$151 + $100 Maint. Savings / 0.0 MMBTU	$2,104	0.99	8.4	849.9
6	Ceiling w/ Attic: Attic	Add R-42 blown cellulose insulation to attic space with Energy Truss.	$290 / 6.6 MMBTU	$10,266	0.67	35.4	1,088.7
7	Ventilation	Replace 3 bathroom fans with units with integral humidity and occupancy sensor @ $300 ea parts + 2 hrs labor each @ $125/hr	$50 / 0.8 MMBTU	$1,650	0.39	32.9	213.0
	TOTAL, all measures		**$1,010 + $115 Maint. Savings / 8.9 MMBTU**	**$18,359**	**0.83**	**16.3**	**4,964.4**

Table 1.1.b – Use as office building 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: Living/Bedrooms	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Living/Bedrooms space.	$901 / 15.5 MMBTU	$1	11685.15	0.0	3,794.7
2	Setback Thermostat: Bathrooms	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Bathrooms space.	$139 / 2.4 MMBTU	$1	1808.84	0.0	587.4
3	Lighting - Power Retrofit: Outdoors HPS 70w wall pack	Replace with 2 LED 17W Module StdElectronic	$420 + $10 Maint. Savings / 2.1 MMBTU	$400	9.05	0.9	2,192.2
4	HVAC And DHW	1.) Remove the (2) electric wall convectors and replace with another Toyo Stove @ installed cost of $3000.	$1,171 / -0.8 MMBTU	$3,000	4.36	2.6	6,681.0
5	Ventilation	Replace 3 bathroom fans with units with integral humidity and occupancy sensor @ $300 ea parts + 2 hrs labor each @ $125/hr	$332 / 6.4 MMBTU	$1,650	2.65	5.0	1,342.6
6	Lighting - Power Retrofit: FLOUR T8-2 24x24 surf wrap	Replace with LED 15W Module StdElectronic	$30 + $5 Maint. Savings / 0.0 MMBTU	$124	2.35	3.5	171.0
7	Lighting - Power Retrofit: FLUOR T8-2 surf wrap, 4lamp fixt w/2 removed	Replace with 20 LED (2) 15W Module (2) StdElectronic	$434 + $100 Maint. Savings / 0.0 MMBTU	$2,104	2.09	3.9	2,450.8
8	Ceiling w/ Attic: Attic	Add R-42 blown cellulose insulation to attic space with Energy Truss.	$820 / 18.6 MMBTU	$10,266	1.88	12.5	3,078.7
	TOTAL, cost-effective measures		**$4,247 + $115 Maint. Savings / 44.2 MMBTU**	**$17,546**	**3.34**	**4.0**	**20,298.4**
The following measures (if any are listed) were *not* found to be cost-effective from a financial perspective but are still recommended:							
9	Lighting - Power Retrofit: Table lamp INC A-type 60w	Replace with 3 LED 9W Module StdElectronic	$0 / 0.0 MMBTU	$15	0.00	999.9	0.0
	TOTAL, all measures		**$4,247 + $115 Maint. Savings / 44.2 MMBTU**	**$17,561**	**3.34**	**4.0**	**20,298.4**

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 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.a – Use as itinerant crew housing

Annual Energy Cost Estimate											
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Cooking**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$1,508	$0	$937	$22	$173	$53	$635	$201	$206	$0	**$3,734**
With Proposed Retrofits	$921	$0	$893	$6	$173	$53	$274	$201	$206	$0	**$2,724**
Savings	$587	$0	$44	$17	$0	$0	$362	$0	$0	$0	**$1,010**

Table 1.2.b – Use as office building

Annual Energy Cost Estimate											
Description	**Space Heating**	**Space Cooling**	**Water Heating**	**Ventilation Fans**	**Cooking**	**Clothes Drying**	**Lighting**	**Refrigeration**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$6,203	$0	$369	$88	$0	$0	$1,815	$403	$1,196	$0	**$10,074**
With Proposed Retrofits	$3,041	$0	$369	$22	$0	$0	$797	$403	$1,196	$0	**$5,827**
Savings	$3,162	$0	$0	$66	$0	$0	$1,018	$0	$0	$0	**$4,247**

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

    d. Keep refrigeration coils clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the ANTHC Bunkhouse. 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 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 ANTHC Bunkhouse 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.

As previously mentioned, simulation models were created for each of the two use and occupancy scenarios considered in this analysis.

ANTHC Bunkhouse used as itinerant crew housing, is classified as being made up of the following activity areas:

1) Living/Bedrooms: 1,336 square feet
2) Bathrooms: 200 square feet

The Bunkhouse used as an office building is classified as being made up of the following activity areas:

1) Offices: 1,336 square feet
2) Bathrooms: 200 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. Costs are considered to be accurate within +/-30% in this level of audit; 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:

- 3413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #1 and #2 fuel oil

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. ANTHC BUNKHOUSE - EXISTING CONDITIONS

3.1. Building Description

The 1,536 square foot ANTHC Bunkhouse was constructed sometime around 1980. For the itinerant crew housing scenario it was considered to have a normal occupancy of 3 people and be occupied only from June through August from 5:30 pm until 7:30 am on weekdays and all weekend. For the office building scenario it was considered to have a normal occupancy of 7 people and be occupied from 8:30 am - 5:00 pm Monday through Friday year round.

Description of Building Shell

This building is constructed on wood posts and glulam beams supported by wood pads in ground contact. The southwest corner of the building is no longer supported (photo at right) and should be repaired. The glulam beams presumably support 2” x 12” floor joists assumed to have at least R-19 batt insulation in the joist cavities. The walls are constructed with 2” x 6” studs also assumed to have R-19 batt in the stud cavities. Interior walls are finished with gypsum and exterior walls are finished with painted metal siding.

The windows appear to have been recently replaced, and according to a label on one unit, they utilize double glazing in vinyl frames with an insulation value of U-0.3. All of the windows have been boarded up, presumably for security purposes. There are numerous wall penetrations and several floor penetrations which should be sealed.

The painted metal roof deck is supported by plywood sheathing supported by wood trusses in a vented attic. R-19 fiberglass batt has been installed in the attic but several areas have been compressed and/or disturbed.

Description of Heating and Cooling Plants

Toyotomi Laser 73 #1

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	15 MBH to 40 MBH, 87% thermal efficiency when new de-rated to 80% for age, 280w pre-heat consumption

(2) Electric Wall Convectors

Nameplate Information:	Broan model 192-B, Cadet model 1402
Fuel Type:	Electricity
Input Rating:	2 kW and 4 kW
Steady State Efficiency:	100 %
Idle Loss:	0 %
Heat Distribution Type:	Air
Notes:	240V 4.17 amps

Toyotomi Water Heater

Nameplate Information:	Toyotomi Water Heater model# BS-36UFF
Fuel Type:	#1 Oil
Input Rating:	148,000 BTU/hr
Steady State Efficiency:	87 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	148 MBH input, 87% AFUE

Toyotomi Laser 73 #2

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	80 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	15 MBH to 40 MBH, 87% thermal efficiency when new, de-rated to 80% for age, 280w pre-heat consumption

Space Heating and Cooling Distribution Systems

There is no distribution system in this building other than by the fans of the Toyo stove or electric wall convectors in the room in which they are located. There is no cooling in this building.

Building Ventilation System

There is no mechanical ventilation; fresh air is supplied by operable windows.

HVAC Controls

Integral thermostats control the electric wall convectors and remote bulb thermostats control the Toyo stoves.

Domestic Hot Water System

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

Lighting

The interior lighting consists of 2 lamp, 48" fixtures utilizing T8 florescent lamps and electronic ballasts. No lighting controls appear to be in use. Exterior lighting consists of what appear to be 70w HPS wall packs.

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: Kwig Power Company - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.6700/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

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.

Annual Energy Costs by End Use

Figure 3.1.a – Use as itinerant crew housing

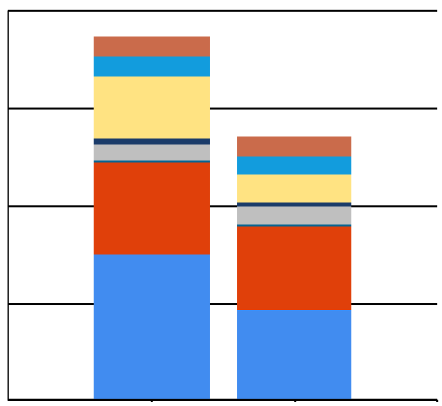


Figure 3.1.b – Use as office building

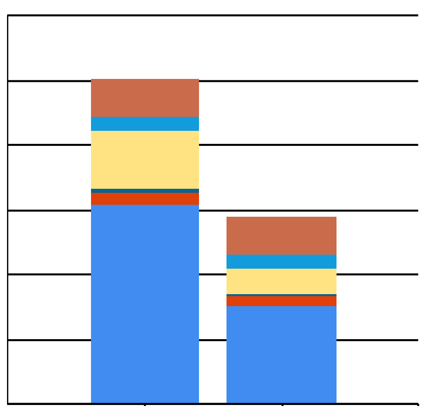


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Annual Energy Costs by Fuel Type
Figure 3.2.a – Use as itinerant crew housing

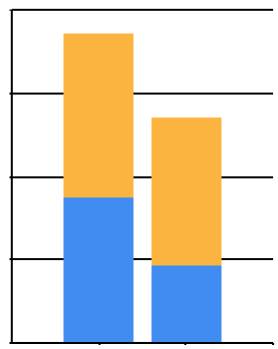


Figure 3.2.b – Use as office building

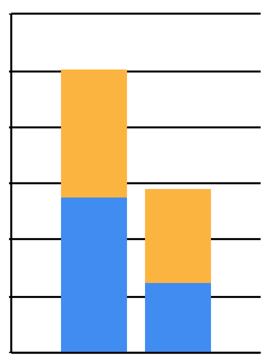


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing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

Annual Space Heating Cost by Component
Figure 3.3.a – Use as itinerant crew housing

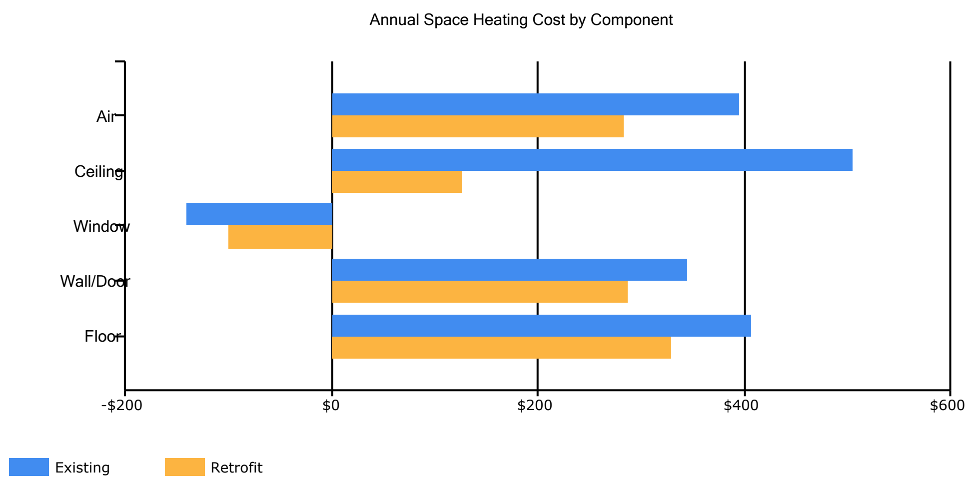
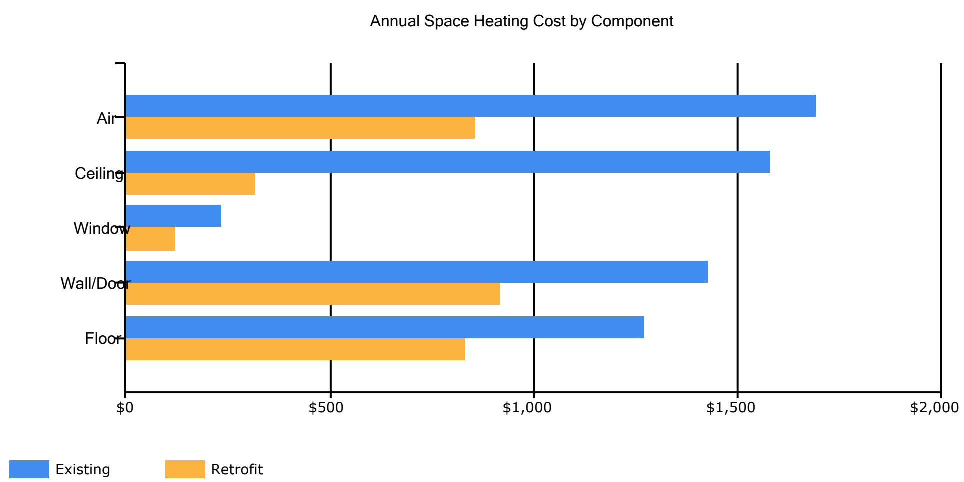


Figure 3.3.b – Use as office building



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.

Use as itinerant crew housing

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	116	95	56	6	0	71	43	51	31	37	59	102
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	1	1	1	1	1	1	1	1	1	1	1	1
Ventilation_Fans	0	0	0	0	0	11	11	11	0	0	0	0
Cooking	0	0	0	0	0	84	87	87	0	0	0	0
Clothes_Drying	0	0	0	0	0	26	27	27	0	0	0	0
Lighting	0	0	0	0	0	309	319	319	0	0	0	0
Refrigeration	25	23	25	25	25	25	25	25	25	25	25	25
Other_Electrical	5	5	5	5	5	86	89	89	5	5	5	5

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	30	25	16	4	2	19	13	14	10	11	16	27
DHW	14	13	14	13	14	13	14	14	13	14	13	14

Use as office building

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	427	379	361	266	171	98	65	73	123	248	342	430
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	11	10	11	11	11	11	11	11	11	11	11	11
Cooking	0	0	0	0	0	0	0	0	0	0	0	0
Clothes_Drying	0	0	0	0	0	0	0	0	0	0	0	0
Lighting	236	215	236	229	236	229	236	236	229	236	229	161
Refrigeration	51	46	51	49	51	49	51	51	49	51	49	51
Other_Electrical	157	143	157	152	157	152	157	157	152	157	152	92

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	104	93	88	66	43	26	18	20	32	61	84	105
DHW	5	5	5	5	5	5	5	5	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):

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.

ANTHC Bunkhouse EUI Calculations

Table 3.4.a – Use as itinerant crew housing

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	2,603 kWh	8,885	3.340	29,675
#1 Oil	350 gallons	46,162	1.010	46,623
Total		**55,047**		**76,299**
BUILDING AREA		1,536	Square Feet	
BUILDING SITE EUI		36	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		50	**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 3.4.b – Use as office building

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	8,210 kWh	28,021	3.340	93,590
#1 Oil	804 gallons	106,087	1.010	107,148
Total		**134,108**		**200,739**
BUILDING AREA		1,536	Square Feet	
BUILDING SITE EUI		87	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		131	**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.a – Use as itinerant crew housing

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**35.8**	**3.09**	**$2.43**
With Proposed Retrofits	**30.1**	**2.59**	**$1.77**
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. **EUI/HDD: Energy Use Intensity per Heating Degree Day.** **ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.**			

Table 3.5.b – Use as office building

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	**87.3**	**7.53**	**$6.56**
With Proposed Retrofits	**58.5**	**5.05**	**$3.79**
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.a – Use as itinerant crew housing
ANTHC Bunkhouse, Kwigillingok, 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: Table lamp INC A-type 60w	Replace with 3 LED 9W Module StdElectronic	$39 / 0.1 MMBTU	$15	21.72	0.4	217.3
2	Lighting - Power Retrofit: Outdoors HPS 70w wall pack	Replace with 2 LED 17W Module StdElectronic	$106 + $10 Maint. Savings / 0.5 MMBTU	$400	2.44	3.5	552.2
3	HVAC And DHW	1.) Remove the (2) electric wall convectors and replace with anothe Toyo Stove @ installed cost of $3000. 2.) At EOL replace the clothes washer with a front loading, Energy Star Version @ cost of $800 installed.	$362 / 0.8 MMBTU	$3,800	1.09	10.5	1,982.8
4	Lighting - Power Retrofit: FLOUR T8-2 24x24 surf wrap	Replace with LED 15W Module StdElectronic	$11 + $5 Maint. Savings / 0.0 MMBTU	$124	1.07	7.8	60.6
	TOTAL, cost-effective measures		**$518 + $15 Maint. Savings / 1.4 MMBTU**	**$4,339**	**1.29**	**8.1**	**2,812.9**
The following measures (if any are listed) were *not* found to be cost-effective but are still recommended:							
5	Lighting - Power Retrofit: FLUOR T8-2 surf wrap, 4lamp fixt w/2 removed	Replace with 20 LED (2) 15W Module (2) StdElectronic	$151 + $100 Maint. Savings / 0.0 MMBTU	$2,104	0.99	8.4	849.9
6	Ceiling w/ Attic: Attic	Add R-42 blown cellulose insulation to attic space with Energy Truss.	$290 / 6.6 MMBTU	$10,266	0.67	35.4	1,088.7
7	Ventilation	Replace 3 bathroom fans with units with integral humidity and occupancy sensor @ $300 ea parts + 2 hrs labor each @ $125/hr	$50 / 0.8 MMBTU	$1,650	0.39	32.9	213.0
	TOTAL, all measures		**$1,010 + $115 Maint. Savings / 8.9 MMBTU**	**$18,359**	**0.83**	**16.3**	**4,964.4**

Table 4.1.b – Use as office building
ANTHC Bunkhouse, Kwigillingok, 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: Living/Bedrooms	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Living/Bedrooms space.	$901 / 15.5 MMBTU	$1	11685.15	0.0	3,794.7
2	Setback Thermostat: Bathrooms	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Bathrooms space.	$139 / 2.4 MMBTU	$1	1808.84	0.0	587.4
3	Lighting - Power Retrofit: Outdoors HPS 70w wall pack	Replace with 2 LED 17W Module StdElectronic	$420 + $10 Maint. Savings / 2.1 MMBTU	$400	9.05	0.9	2,192.2
4	HVAC And DHW	1.) Remove the (2) electric wall convectors and replace with anothe Toyo Stove @ installed cost of $3000.	$1,171 / -0.8 MMBTU	$3,000	4.36	2.6	6,681.0
5	Ventilation	Replace 3 bathroom fans with units with integral humidity and occupancy sensor @ $300 ea parts + 2 hrs labor each @ $125/hr	$332 / 6.4 MMBTU	$1,650	2.65	5.0	1,342.6
6	Lighting - Power Retrofit: FLOUR T8-2 24x24 surf wrap	Replace with LED 15W Module StdElectronic	$30 + $5 Maint. Savings / 0.0 MMBTU	$124	2.35	3.5	171.0
7	Lighting - Power Retrofit: FLUOR T8-2 surf wrap, 4lamp fixt w/2 removed	Replace with 20 LED (2) 15W Module (2) StdElectronic	$434 + $100 Maint. Savings / 0.0 MMBTU	$2,104	2.09	3.9	2,450.8
8	Ceiling w/ Attic: Attic	Add R-42 blown cellulose insulation to attic space with Energy Truss.	$820 / 18.6 MMBTU	$10,266	1.88	12.5	3,078.7
	TOTAL, cost-effective measures		**$4,247 + $115 Maint. Savings / 44.2 MMBTU**	**$17,546**	**3.34**	**4.0**	**20,298.4**
The following measures (if any are listed) were *not* found to be cost-effective but are still recommended:							
9	Lighting - Power Retrofit: Table lamp INC A-type 60w	Replace with 3 LED 9W Module StdElectronic	$0 / 0.0 MMBTU	$15	0.00	999.9	0.0
	TOTAL, all measures		**$4,247 + $115 Maint. Savings / 44.2 MMBTU**	**$17,561**	**3.34**	**4.0**	**20,298.4**

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.a Insulation Measures- **use as itinerant crew housing**

Rank	Location	Existing Type/R-Value		Recommendation Type/R-Value	
6	Ceiling w/ Attic: Attic	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: R-15 Batt:FG or RW, 3.5 inches Bottom Insulation Layer: None Top Insulation Layer: None Modeled R-Value: 18.6		Add R-42 blown cellulose insulation to attic space with Energy Truss.	
Installation Cost	$10,266	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$290
Breakeven Cost	$6,836	**Simple Payback (yrs)**	35	**Energy Savings (MMBTU/yr)**	6.6 MMBTU
		Savings-to-Investment Ratio	0.7		
Auditors Notes:					

4.3.1.b Insulation Measures- **use as office building**

Rank	Location	Existing Type/R-Value		Recommendation Type/R-Value	
8	Ceiling w/ Attic: Attic	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: R-15 Batt:FG or RW, 3.5 inches Bottom Insulation Layer: None Top Insulation Layer: None Modeled R-Value: 18.6		Add R-42 blown cellulose insulation to attic space with Energy Truss.	
Installation Cost	$10,266	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$820
Breakeven Cost	$19,332	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	18.6 MMBTU
		Savings-to-Investment Ratio	1.9		
Auditors Notes:					

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.a Heating/Cooling/Domestic Hot Water Measure – **use as itinerant crew housing**

Rank	Recommendation				
3	1.) Remove the (2) electric wall convectors and replace with anothe Toyo Stove @ installed cost of $3000. 2.) At EOL replace the clothes washer with a front loading, Energy Star Version @ cost of $800 installed.				
Installation Cost	$3,800	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$362
Breakeven Cost	$4,148	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	1.1		
Auditors Notes:					

4.4.1.b *Heating/Cooling/Domestic Hot Water Measure –* ***use as office building***

Rank	Recommendation				
4	1.) Remove the (2) electric wall convectors and replace with anothe Toyo Stove @ installed cost of $3000.				
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$1,171
Breakeven Cost	$13,075	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	-0.8 MMBTU
		Savings-to-Investment Ratio	4.4		
Auditors Notes:					

4.4.2.a *Ventilation System Measures –* ***use as itinerant crew housing***

Rank	Description			Recommendation	
7				Replace 3 bathroom fans with units with integral humidity and occupancy sensor @ $300 ea parts + 2 hrs labor each @ $125/hr	
Installation Cost	$1,650	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$50
Breakeven Cost	$649	**Simple Payback (yrs)**	33	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	0.4		
Auditors Notes:					

4.4.2.b *Ventilation System Measures –* ***use as office building***

Rank	Description			Recommendation	
5				Replace 3 bathroom fans with units with integral humidity and occupancy sensor @ $300 ea parts + 2 hrs labor each @ $125/hr	
Installation Cost	$1,650	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$332
Breakeven Cost	$4,366	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	6.4 MMBTU
		Savings-to-Investment Ratio	2.6		
Auditors Notes:					

*4.4.3 Night Setback Thermostat Measures- **use as office building** (not recommended for use as itinerant crew housing since occupancy is so low)*

Rank	Building Space			Recommendation	
1	Living/Bedrooms			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Living/Bedrooms space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$901
Breakeven Cost	$11,685	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	15.5 MMBTU
		Savings-to-Investment Ratio	11,685.2		
Auditors Notes:					

Rank	Building Space			Recommendation	
2	Bathrooms			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Bathrooms space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$139
Breakeven Cost	$1,809	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	2.4 MMBTU
		Savings-to-Investment Ratio	1,808.8		
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.

*4.5.1.a Lighting Measures – Replace Existing Fixtures/Bulbs – **use as itinerant crew housing***

Rank	Location	Existing Condition		Recommendation	
1	Table lamp INC A-type 60w	3 INCAN A Lamp, Std 60W with Manual Switching		Replace with 3 LED 9W Module StdElectronic	
Installation Cost	$15	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$39
Breakeven Cost	$326	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	21.7		
Auditors Notes: Replace (3) 60w A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

Rank	Location		Existing Condition		Recommendation	
2	Outdoors HPS 70w wall pack		2 HPS 70 Watt Magnetic with Manual Switching		Replace with 2 LED 17W Module StdElectronic	
Installation Cost		$400	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$106
Breakeven Cost		$975	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	0.5 MMBTU
			Savings-to-Investment Ratio	2.4	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Replace (2) 70w HPS fixtures with new 17w LED fixture(s) with integral photocell sensor @ parts cost of $75 ea + 1 hr labor ea. @ $125/hr. Maintenance savings $5/fixture						

Rank	Location		Existing Condition		Recommendation	
4	FLOUR T8-2 24x24 surf wrap		FLUOR (2) T8 F32T8 32W U-Tube Standard Instant EfficMagnetic with Manual Switching		Replace with LED 15W Module StdElectronic	
Installation Cost		$124	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$11
Breakeven Cost		$133	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	1.1	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Re-wire (1) fixtures to bypass or remove ballast and provide line voltage to end caps (new end caps may be required) @ .75 hrs labor/fixture @ $125/hr. Replace (2) 32w T8 U-shaped lamps with 15w T8 LED U-shaped lamps @ $15/lamp. Maintenance savings of $5/fixture.						

Rank	Location		Existing Condition		Recommendation	
5	FLUOR T8-2 surf wrap, 4lamp fixt w/2 removed		20 FLUOR (2) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 20 LED (2) 15W Module (2) StdElectronic	
Installation Cost		$2,104	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$151
Breakeven Cost		$2,091	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr)**	$100
Auditors Notes: Re-wire (20) fixtures to bypass or remove ballast and provide line voltage to end caps (new end caps may be required) @ .75 hrs labor/fixture @ $125/hr. Replace (40) 32w T8 lamps with 15w T8 LED lamps @ $15/lamp. Maintenance savings of $5/fixture.						

4.5.1.b Lighting Measures – Replace Existing Fixtures/Bulbs – ***use as office building***

Rank	Location		Existing Condition		Recommendation	
3	Outdoors HPS 70w wall pack		2 HPS 70 Watt Magnetic with Manual Switching		Replace with 2 LED 17W Module StdElectronic	
Installation Cost		$400	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$420
Breakeven Cost		$3,619	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	2.1 MMBTU
			Savings-to-Investment Ratio	9.0	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Replace (2) 70w HPS fixtures with new 17w LED fixture(s) with integral photocell sensor @ parts cost of $75 ea + 1 hr labor ea. @ $125/hr. Maintenance savings $5/fixture						

Rank	Location	Existing Condition		Recommendation	
6	FLOUR T8-2 24x24 surf wrap	FLUOR (2) T8 F32T8 32W U-Tube Standard Instant EfficMagnetic with Manual Switching		Replace with LED 15W Module StdElectronic	
Installation Cost	$124	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$30
Breakeven Cost	$291	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.3	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Re-wire (1) fixtures to bypass or remove ballast and provide line voltage to end caps (new end caps may be required) @ .75 hrs labor/fixture @ $125/hr. Replace (2) 32w T8 U-shaped lamps with 15w T8 LED U-shaped lamps @ $15/lamp. Maintenance savings of $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
7	FLUOR T8-2 surf wrap, 4lamp fixt w/2 removed	20 FLUOR (2) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 20 LED (2) 15W Module (2) StdElectronic	
Installation Cost	$2,104	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$434
Breakeven Cost	$4,397	**Simple Payback (yrs)**	4	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.1	**Maintenance Savings ($/yr)**	$100
Auditors Notes: Re-wire (20) fixtures to bypass or remove ballast and provide line voltage to end caps (new end caps may be required) @ .75 hrs labor/fixture @ $125/hr. Replace (40) 32w T8 lamps with 15w T8 LED lamps @ $15/lamp. Maintenance savings of $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
9	Table lamp INC A-type 60w	3 INCAN A Lamp, Std 60W with Manual Switching		Replace with 3 LED 9W Module StdElectronic	
Installation Cost	$15	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$
Breakeven Cost	$	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: Replace (3) 60w A-type incandescent bulbs with 9w A-type LED bulbs @ $5 ea. No labor, owner to install.					

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 (qty 3)	unknown	e100	e60w/115/1	bathrooms

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
Potable water pressure pump	Grundfos SCALA2	13 @ 89'	550w/115/1	

HEAT PLANT SCHEDULE

SYMBOL	MFGR/MODEL	EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
Qty 2	Toyo Laser 73	80%	76w/115/1	15 to 40 MBH output, nominal 87% efficient de-rated to 80% for age and condition
Qty 1	Cadet model 1402	100%	4kW/240/1	electric wall convector
Qty 1	Broan model 192-B	100%	2kW/240/1	electric wall convector

HOT WATER HEATER SCHEDULE

SYMBOL	MFGR/MODEL	GALLONS	MOTOR DATA HP/VOLTS/PH	ELEMENT SIZE
HWH-1	Toyotomi model# BS-36UFF	on-demand	98w/115/1	Nominal capacity 148 MBH

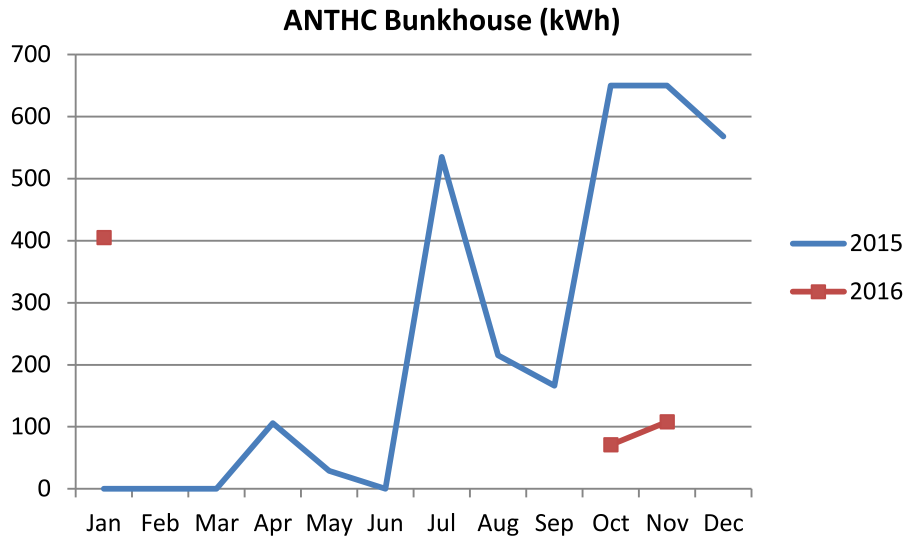
PLUMBING FIXTURES				
SYMBOL	FIXTURE	GPF	QUANTITY	REMARKS
	W.C.	vacuum	3	tank type, manual flush
	Showers	e2.0	3	low flow, push timer valve
	Lavatory	e2.0	3	manually operated

PLUG LOAD SUMMARY				
SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	1	200w	
	CRT TV	1	250w	
	Personal printers	1	85w	
	Personal coffee machine	2	1200w	
	Electric grill	1	1500w	
	Electric Teapot	1	1000w	
	Microwaves	2	1500w	
	1 cubic foot refrigerator (dorm size)	1	150 kWh/yr	
	Hotpoint refrigerator, model CTX16CPCLWH	1	600 kWh/yr	Older than 15 years
	GE refrigerator, model TB14SWC	1	600 kWh/yr	Older than 20 years
	Electrolux refrigerator, model FFTR1814TW0	1	450 kWh/yr	2017
	Alliance clothes washer model AWS45NW	1	9.8A/120/1	
	Whirlpool clothes dryer model LE5700XSW0	1	27A/240/1	
	GE electric stove/oven, model RB754ON1WH	1	8.3kW/208/1	
	White Westinghouse electric stove/oven, model	1	e8.3kW/208/1	no nameplate

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 but only 11 months of electric consumption data over a 2-year period was provided and no fuel oil delivery data was provided. Consequently, no insights can be obtained from this data, although the kWh used in the high-use (occupied) months below correspond very closely to the kWh projected by the AkWarm-C model for the itinerant crew housing scenario. The data provided is shown below.

Figure B.1 – Electric data provided



Source data - kWh

ANTHC Bunkhouse		
	2015	**2016**
Jan	0	405
Feb	0	
Mar	0	
Apr	106	
May	29	
Jun	0	
Jul	535	
Aug	215	
Sep	166	
Oct	650	71
Nov	650	108
Dec	568	
TOTALS	**2,919**	**584**

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 – USED AS ITINERANT CREW HOUSING

General Project Information

PROJECT INFORMATION	AUDITOR INFORMATION
Building: ANTHC Bunkhouse	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok **Client Name:** Richard John	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350 **Auditor FAX:**
Client Phone: (907) 588-8114 **Client FAX:**	**Auditor Comment:**

Design Data

Building Area: 1,536 square feet	**Design Space Heating Load:** Design Loss at Space: 53,202 Btu/hour with Distribution Losses: 53,202 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 81,101 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 3 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days

Utility Information

Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.670/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Cooking	Clothes Drying	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$1,508	$0	$937	$22	$173	$53	$635	$201	$206	$0	**$3,734**
With Proposed Retrofits	$921	$0	$893	$6	$173	$53	$274	$201	$206	$0	**$2,724**
Savings	$587	$0	$44	$17	$0	$0	$362	$0	$0	$0	**$1,010**

Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	35.8	3.09	$2.43
With Proposed Retrofits	30.1	2.59	$1.77

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.

ENERGY AUDIT REPORT – PROJECT SUMMARY – USED AS OFFICE BUILDING

General Project Information

PROJECT INFORMATION	AUDITOR INFORMATION
Building: ANTHC Bunkhouse	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Richard John	
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 588-8114	**Auditor Comment:**
Client FAX:	

Design Data

Building Area: 1,536 square feet	**Design Space Heating Load:** Design Loss at Space: 46,413 Btu/hour with Distribution Losses: 46,413 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 70,752 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 7 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days

Utility Information

Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.670/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

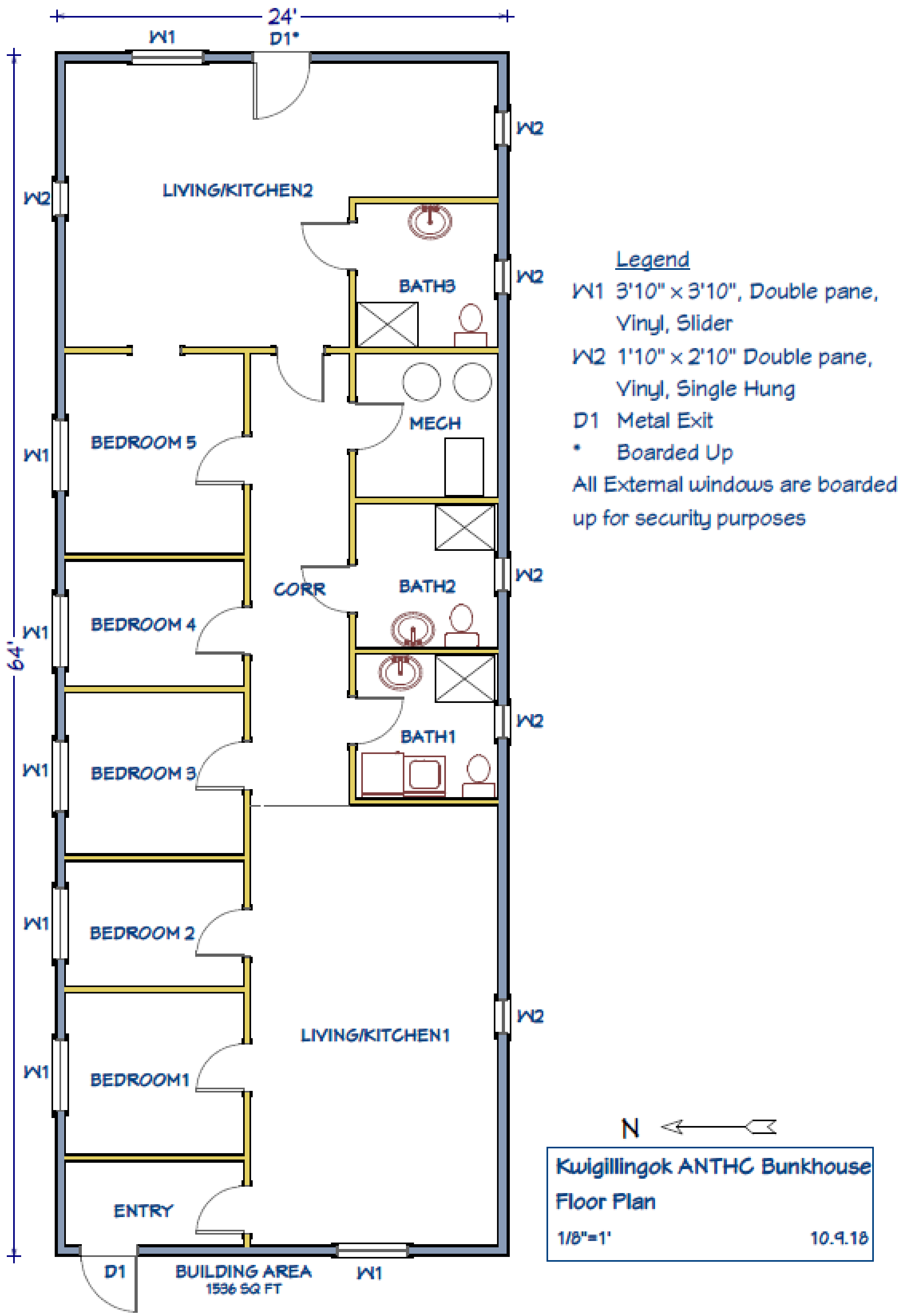
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Cooking	Clothes Drying	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$6,203	$0	$369	$88	$0	$0	$1,815	$403	$1,196	$0	**$10,074**
With Proposed Retrofits	$3,041	$0	$369	$22	$0	$0	$797	$403	$1,196	$0	**$5,827**
Savings	$3,162	$0	$0	$66	$0	$0	$1,018	$0	$0	$0	**$4,247**

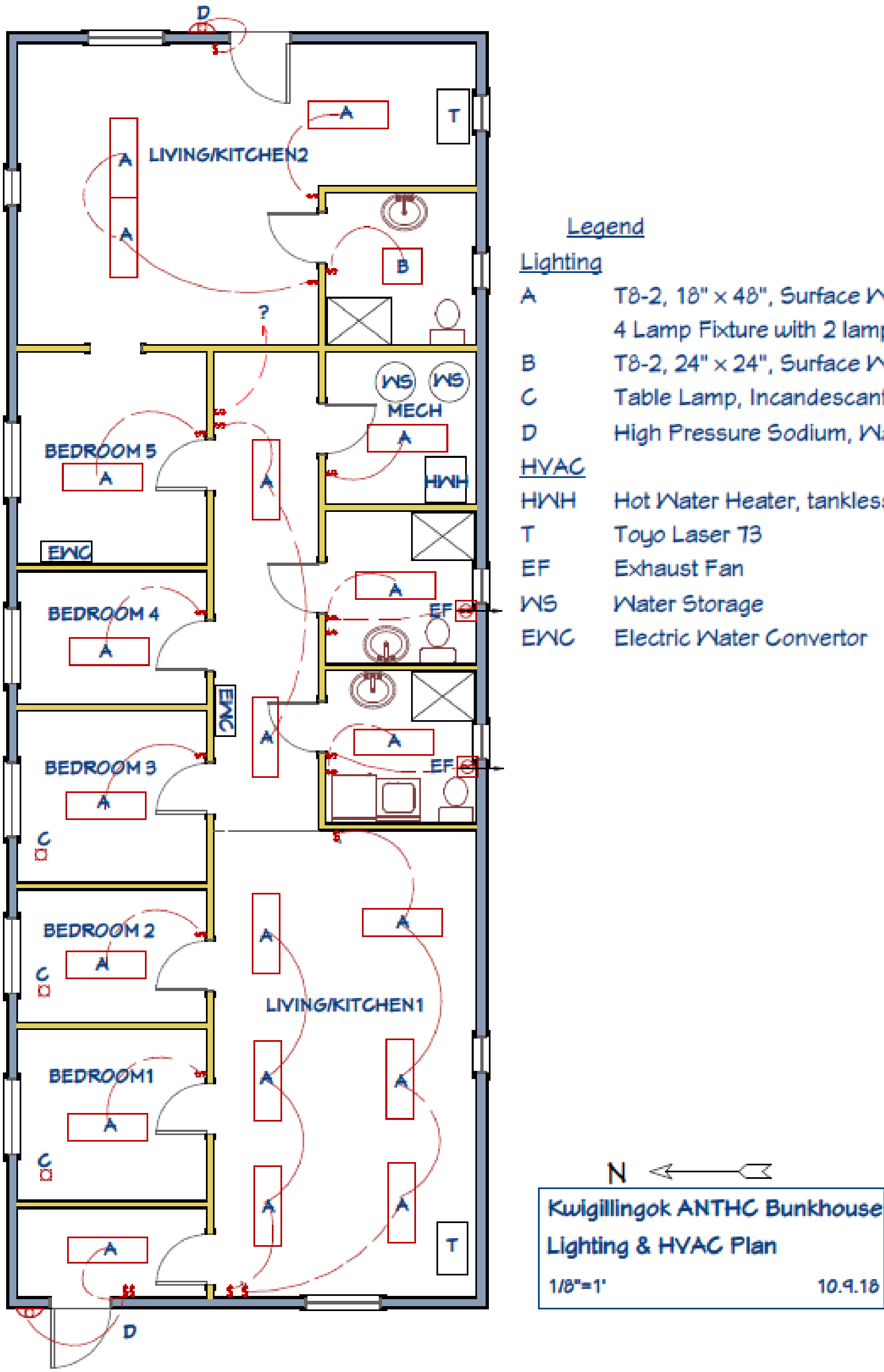
Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	87.3	7.53	$6.56
With Proposed Retrofits	58.5	5.05	$3.79

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

Lighting

A	T8-2, 18" x 48", Surface Wrap 4 Lamp Fixture with 2 lamps removed
B	T8-2, 24" x 24", Surface Wrap
C	Table Lamp, Incandescant, A-type, 60w
D	High Pressure Sodium, Wall Pack, 70w

HVAC

HWH	Hot Water Heater, tankless
T	Toyo Laser 73
EF	Exhaust Fan
WS	Water Storage
EWC	Electric Water Convertor

Appendix E – Photographs

No IR images were taken as the building was unheated.

The southwest corner of the building is unsupported and there are a number of foundational supports in need of repair.

Attic insulation has been compressed, but is in generally good condition.

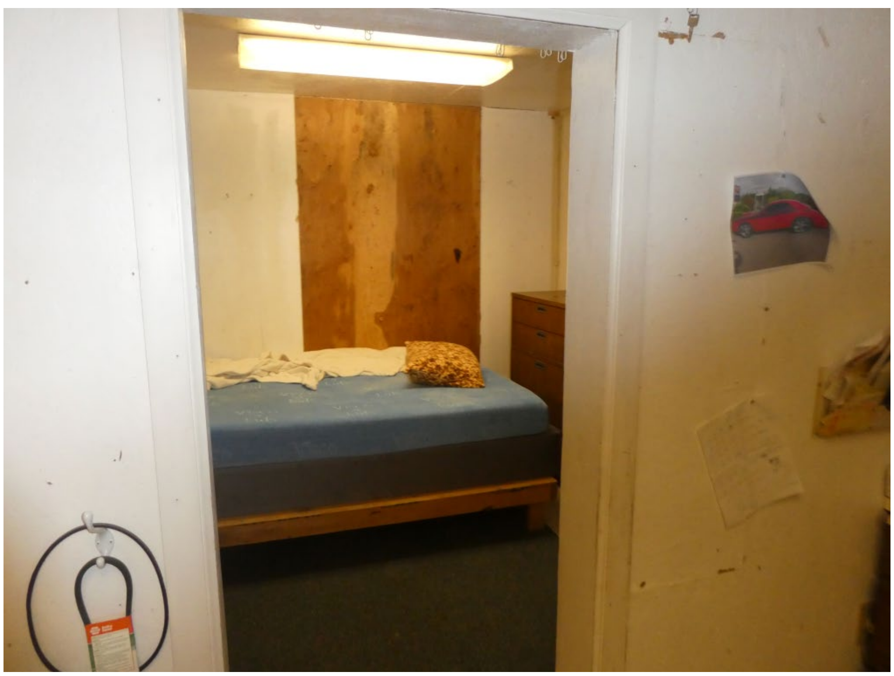
All envelope penetrations should be sealed, and unsafe electrical conditions rectified.

Penetrations in floor should be sealed.

Electric wall convector in corridor, not clear if this unit is in use.

Potable water pressure pump and storage in mechanical room.

On-demand hot water heater.



Typical bunk room.

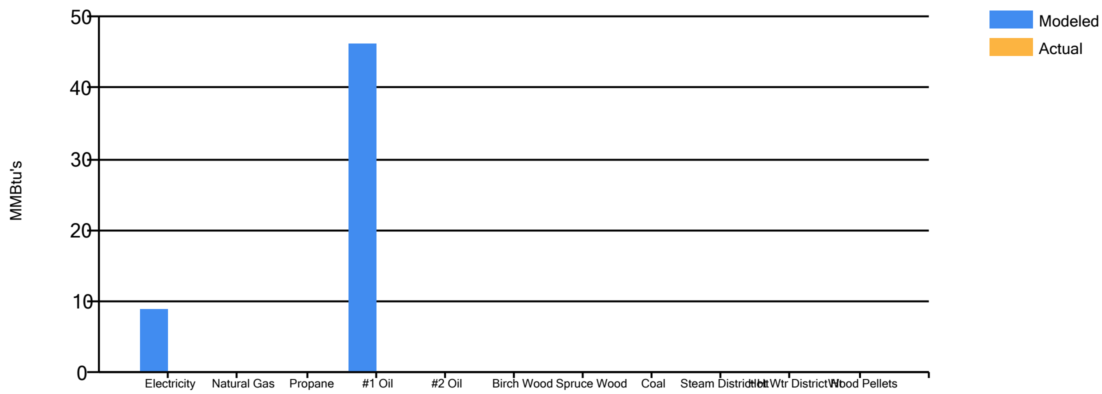
Front kitchen area, one of two kitchens.

Rear living room, one of two living areas.

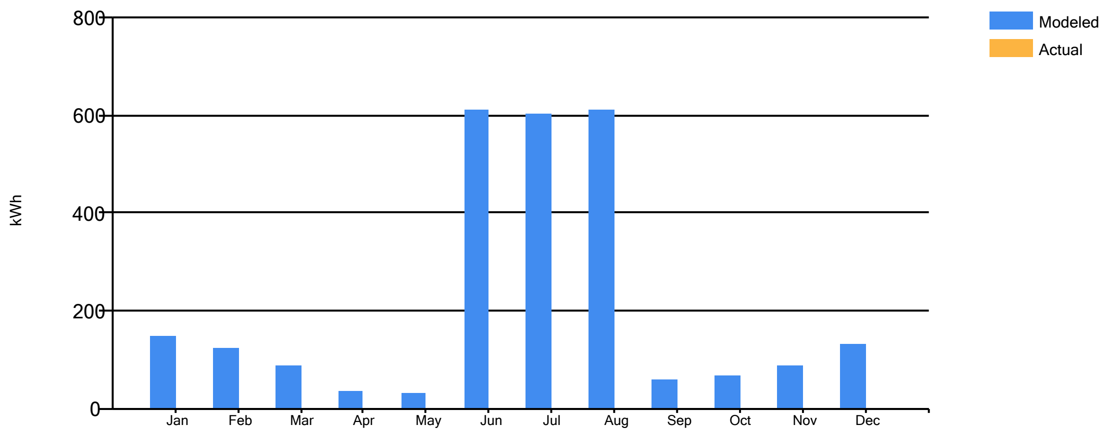
Appendix F – Actual Fuel Use versus Modeled Fuel Use

The Blue bars below are AkWarm's prediction of fuel use as itinerant crew housing:

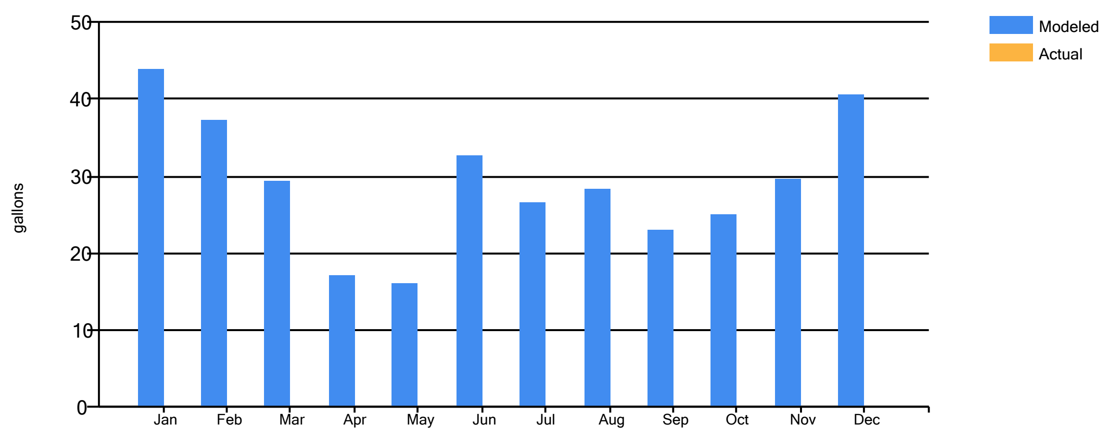
Annual Fuel Use



Electricity Fuel Use

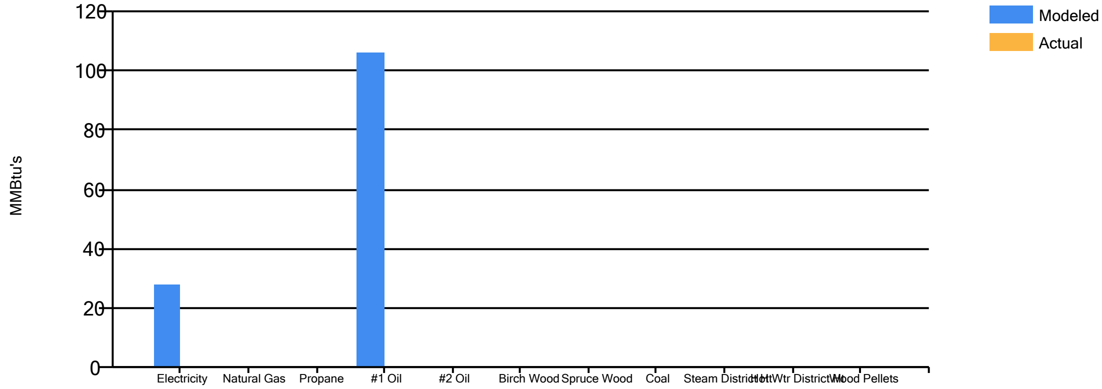


#1 Fuel Oil Fuel Use

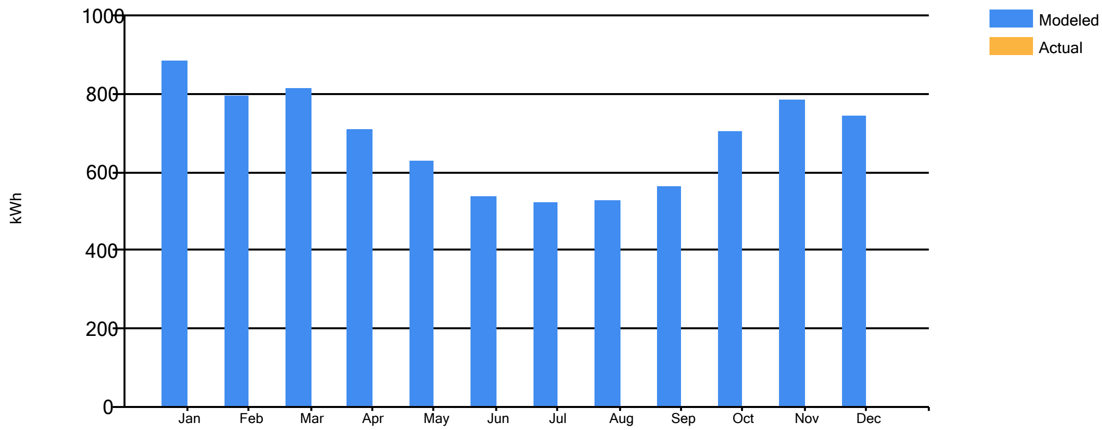


The Blue bars below are AkWarm's prediction of fuel use as <u>an office building:</u>

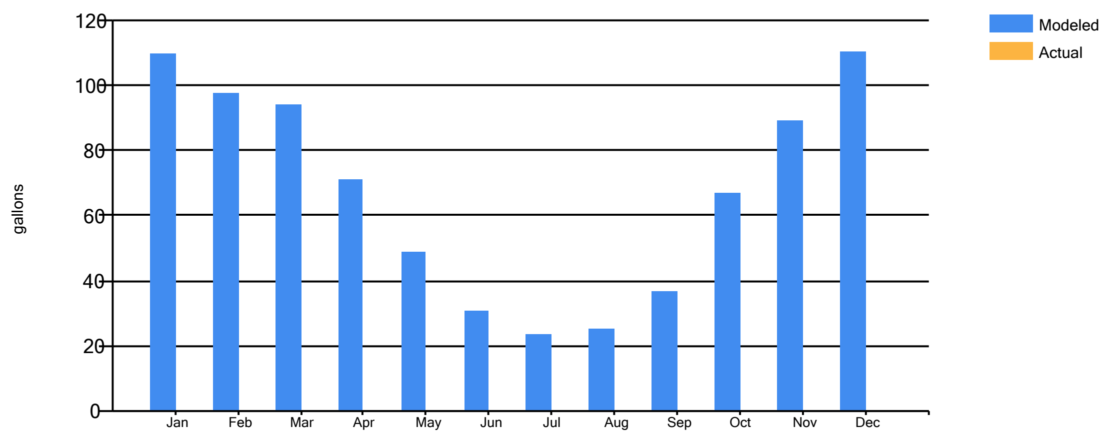
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix G – Abbreviations used in this Document

A	Amps
AHU	Air Handling Unit
ANTHC	Alaska Native Tribal Health Consortium
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
NVK	Native Village of Kwigillingok
O & M	Operations and Maintenance
OSA	Outside Air
PLMD	Plug Load Management Device (occupancy sensing power strip)
PPM	Parts per million
REF	Return Air Fan
ROI	Return on Investment
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 Kwigillingok Clinic

Prepared For
Native Village of Kwigillingok
Darrel T. John, Tribal Administrator
P.O. Box 90
Kwigillingok, AK 99622
kwigtribe@gmail.com
907-588-8114

Site Survey Date:
December 12, 2017

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 – October 5, 2018
New Release – October 1, 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 ensure 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: Darrel and Richard John, the Tribal Administrator and Finance officer, Victoria Amik in the Post Office, Sherie the tribal police officer, 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. Thanks to Megan, the school principal, who provided lodging.

Project Location

Post office
Clinic
IRA Council Office
Jail
Fisheries Building
NORTH

Building contact:
Richard John
Finance Director
907-588-8114
kwigaccting@gmail.com

1. SUMMARY

This report was prepared for the Native Village of Kwigillingok, owner of the Clinic. 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 December 12 and 13, 2017. The outside temperature varied between 28F and 35F 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 9-page summary is designed to contain all the information the building owner/operator needs 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 wish 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 staff. The following ECMs and maintenance issues should be rectified immediately:

- The combustion intake vent in the furnace room was covered with cardboard during the site survey (photo at right); this is a serious safety issue and should be corrected immediately. The furnace and hot water heater require unrestricted combustion air for proper operation.
- There should be no combustible materials in the furnace room. The photo below, right, shows cardboard boxes adjacent to the hot water heater burner.

- Plug load management devices (PLMDs, see Appendix J and Section 1.7.5 below) should be utilized on the exam room computers that are left on when the room is unoccupied.
- The erratic year-over-year electric consumption in this building (see Appendix B) indicates uncontrolled and/or unknown electric loads. Electric consumption decreased by 21% between 2015 and 2016, but then increased by 53% between 2016 and 2017. This should be investigated.

b. If all recommended EEMs are incorporated in this building, there will be a 25.3% reduction in energy costs, totaling $3,504, with a simple payback of 5.9 years on the $20,605 implementation cost.

c. It was assumed in this analysis that electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by qualified electricians. 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. Install a cumulative fuel oil meter on the oil line serving the furnace and hot water heater and record consumption monthly.

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 calibrated AkWarm-C© energy model, the total predicted energy costs are $10,360 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$5,864 for Electricity
$4,496 for #1 Oil

Predicted Annual Fuel Use

Fuel Use	Existing Building	With Proposed Retrofits
Electricity	15,764 kWh	13,260 kWh
#1 Oil	999 gallons	623 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. The clinic receives a PCE discount on the cost of electricity and energy savings calculations are based on this reduced rate.

	Unit Cost	Cost/MMBTU
Electricity (PCE)	$0.372	$108.99
Fuel Oil	$4.50	$34.09

Figure 1.1

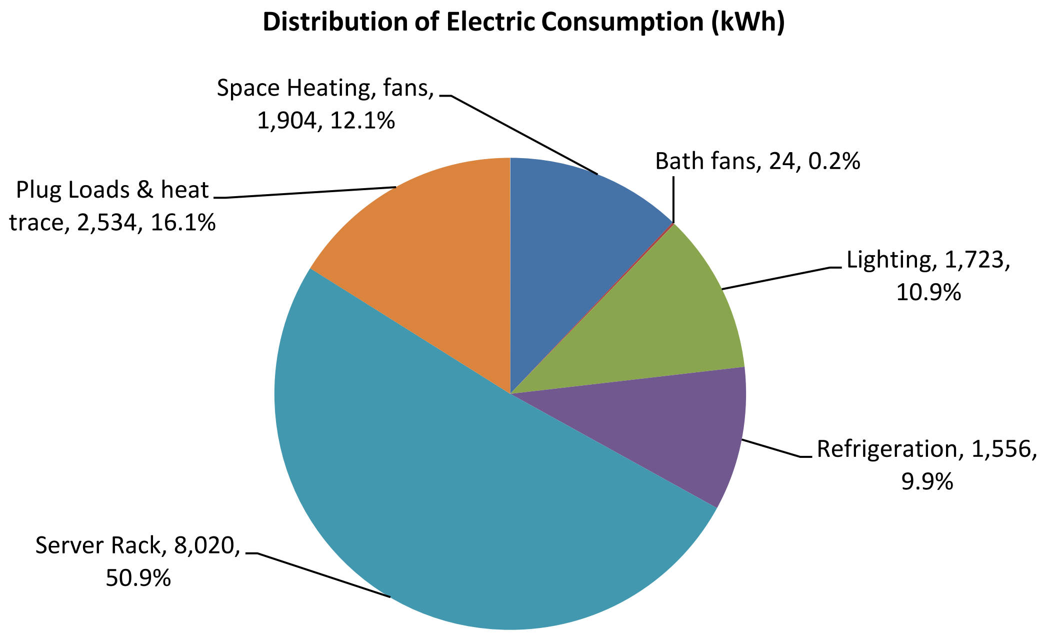
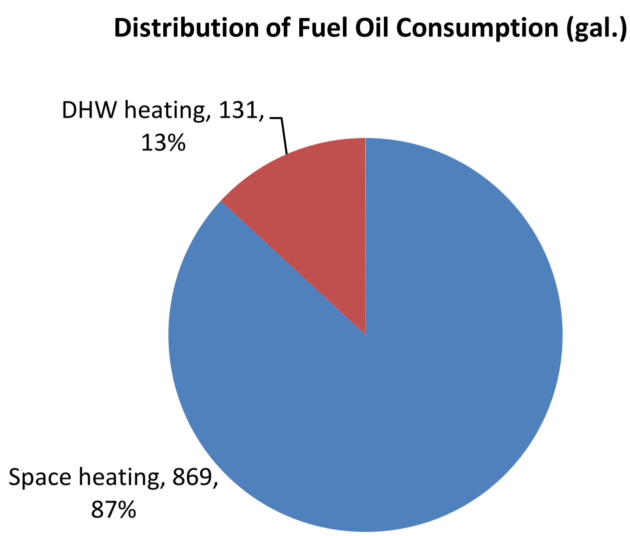


Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on space heating and the server rack. The server rack and the electric heat traces are unknown loads; the server rack was estimated to consume 915w of power, running continually and the heat traces 100w during the winter months. These loads should be evaluated further to determine how accurate they are and if additional savings can be found. If these loads are inaccurate, then there are other "ghost" loads that should be discovered.

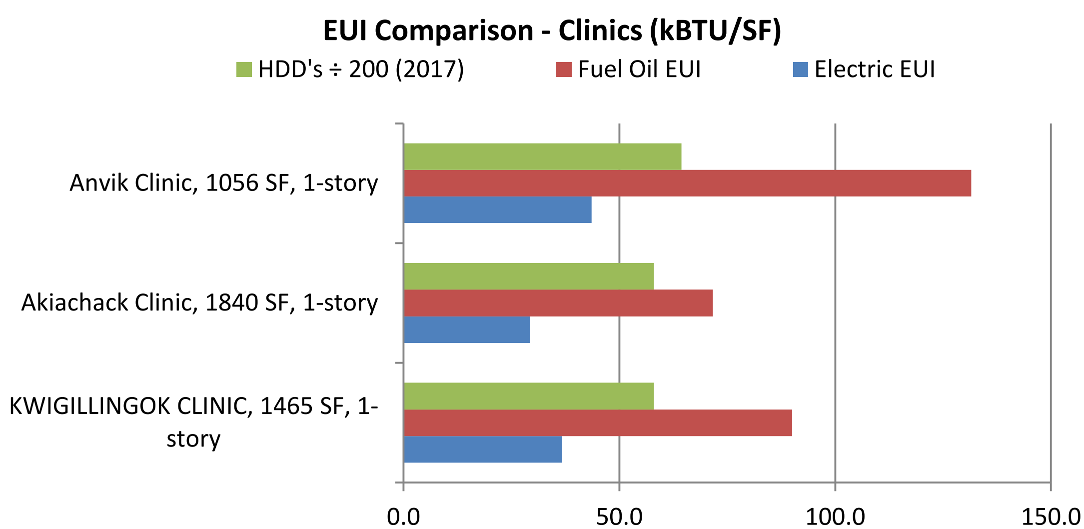
1.4 Benchmark Summary

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	126.7	10.93	$10.28
With Proposed Retrofits	87.0	7.50	$5.28
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[1] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart below, the subject building's electric and fuel EUIs are both slightly below the average of all three buildings. Additional discussion is provided in Appendix B.



[1] 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.

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 recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of Figure 1.3 and are not included in the cost savings in Figure 1.4.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
HVAC related	$16,498	$3,093	5.3
Lighting	$4,107	$412	10.0
Totals	**$20,605**	**$3,505**	**5.9**

Figure 1.4

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	15,762	53,796	13,260	45,256	15.9%
Gallons Oil	998	131,736	623	82,236	37.6%
Energy Cost	$10,360		$7,736		25.3%

Tables 1.1 below and Table 4.1 in section 4 summarize the energy efficiency measures analyzed for the Clinic. Estimates of annual energy and maintenance savings, installed costs, SIR, CO2 savings, and simple paybacks are shown for each EEM. The $1 cost indicates that there is no appreciable cost to implement the EEM, but 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	Setback Thermostat: Storage, pharmacy, bathroom, closet, furnace	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Storage, pharmacy, bathroom, closet, furnace space.	$212 / 5.5 MMBTU	$1	2809.15	0.0	1,164.4
2	Setback Thermostat: Low use exam rooms, 3 & 4	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Low use exam rooms, 3 & 4 space.	$196 / 5.1 MMBTU	$1	2597.65	0.0	1,076.7

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**
3	Ventilation	Cost of occupancy sensor included in lighting EEM	$67 / 1.7 MMBTU	$1	882.90	0.0	385.3
4	Setback Thermostat: All other spaces	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the All other spaces space.	$675 / 17.5 MMBTU	$300	29.84	0.4	3,710.6
5	Lighting - Power Retrofit: Exterior Lights HPS Wall Pack 70w	Replace with 2 LED 20W Module StdElectronic	$123 + $10 Maint. Savings / 1.1 MMBTU	$450	2.50	3.4	1,161.4
6	HVAC And DHW	At the End of life of existing furnace replace with an 85% thermal efficiency model at cost of $12,000; Add R-9 insulating blanket to hot water tank at a cost of $195; At end of life of hot water heater replace with higher efficiency model at a cost of $4000	$1,193 + $750 Maint. Savings / 26.9 MMBTU	$16,195	1.90	8.3	7,485.8
7	Lighting - Power Retrofit: Waiting Room T8-4	Replace with 4 LED (2) 15W Module (2) StdElectronic	$65 + $20 Maint. Savings / 0.2 MMBTU	$535	1.31	6.3	711.7
8	Lighting - Power Retrofit: Exam Room 3 T8-4	Replace with LED (4) 15W Module (2) StdElectronic	$8 + $5 Maint. Savings / 0.0 MMBTU	$174	1.07	13.2	88.8
9	Lighting - Power Retrofit: Exam Room 3 T8-3	Replace with LED (3) 15W Module StdElectronic	$6 + $5 Maint. Savings / 0.0 MMBTU	$154	1.01	14.1	64.7
	TOTAL, cost-effective measures		**$2,546 + $790 Maint. Savings / 58.0 MMBTU**	**$17,811**	**2.71**	**5.3**	**15,849.4**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
10	Lighting - Power Retrofit: Office T8-4	Replace with 2 LED (2) 15W Module (2) StdElectronic	$31 + $10 Maint. Savings / 0.1 MMBTU	$268	0.93	6.6	337.6
11	Lighting - Power Retrofit: Exam Room 4,2,1 T8-4 on OS	Replace with 8 LED (2) 15W Module (2) StdElectronic	$28 + $40 Maint. Savings / 0.1 MMBTU	$1,070	0.92	15.7	308.0
12	Lighting - Power Retrofit: Storage T8-4	Replace with LED (2) 15W Module (2) StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$134	0.76	19.1	22.1

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
13	Lighting - Power Retrofit: Storage T8-2	Replace with LED (2) 15W Module (2) StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$134	0.74	19.6	20.1
14	Lighting - Power Retrofit: Pharmacy T12-2 x 24"	Replace with LED (2) 8W Module StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$134	0.73	20.0	18.9
15	Lighting - Combined Retrofit: Bathroom T8-2	Replace with LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$15 + $5 Maint. Savings / 0.0 MMBTU	$384	0.72	19.5	161.2
16	Lighting - Power Retrofit: Pharmacy T8-2	Replace with LED (2) 15W Module StdElectronic	$0 + $5 Maint. Savings / 0.0 MMBTU	$134	0.54	27.6	-1.6
17	Lighting - Power Retrofit: Storage, Furnace, Janitor CFL-PL 13w	Replace with 3 LED (2) 15W Module StdElectronic	$1 + $10 Maint. Savings / 0.0 MMBTU	$402	0.39	38.1	5.9
18	Lighting - Power Retrofit: Entry T8-2	Replace with LED (2) 15W Module StdElectronic	-$1 + $5 Maint. Savings / 0.0 MMBTU	$134	0.25	34.8	-12.6
	TOTAL, all measures		**$2,624 + $880 Maint. Savings / 58.2 MMBTU**	**$20,605**	**2.44**	**5.9**	**16,709.1**

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 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	$4,622	$0	$582	$9	$642	$579	$3,927	$0	**$10,360**
With Proposed Retrofits	$2,569	$0	$350	$4	$307	$579	$3,927	$0	**$7,736**
Savings	$2,053	$0	$233	$4	$335	$0	$0	$0	**$2,624**

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 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 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	
Assure that all schedule timers (lighting, pumps, heat traces, etc.) 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 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. At their end of useful life (EOL), replace refrigeration equipment and commercial cooking equipment with Energy Star versions.

   d. Keep refrigeration coils clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Clinic. 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 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 Clinic 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.

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

1) Low use exam rooms, 3 & 4: 223 square feet
2) Storage, pharmacy, bathroom, closet, furnace: 254 square feet
3) All other spaces: 988 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 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. CLINIC EXISTING CONDITIONS

3.1. Building Description

The 1,4650-square-foot Clinic was constructed around 1997. It has a normal occupancy of three health aides, a secretary, and part-time janitor, plus visitors. It operates from 9:00am until 4:00pm, Monday through Friday.

Description of Building Shell

No drawings or plans were available for this building, so the details below are assumed or based on observation. This building is constructed on driven steel pilings supporting floor beams on a 28' span. The floor joists are presumed to have R-38 fiberglass batt insulation in their cavities. The walls are constructed with 2" x 6" studs 16" OC, whose stud cavities are presumably filled with R-19 batt. Exterior walls are finished with horizontal vinyl siding over plywood sheathing and interior walls are finished with painted gypsum. The windows utilize double glazing, ¾" thick, in vinyl frames and are in good condition. The painted metal roof covers either an unvented attic or a hot roof, presumably supported by wood trusses and estimated to have at least an R-38 insulation value. Overall, the building shell is in good condition.

Description of Heating and Cooling Plants

MPI Monitor 441

Nameplate Information:	MPI Monitor 441, Serial No: 8093685
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	77 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 87% de-rated to 77% due to age and condition

HWH

Nameplate Information:	Bock Hot Water Heater 32E - 32 Gallon
Fuel Type:	#1 Oil
Input Rating:	104,000 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	1 %
Heat Distribution Type:	Water
Boiler Operation:	All Year
Notes:	Nominal thermal efficiency when new 80% de-rated to 60% due to age and condition

Furnace

Nameplate Information:	Metzger Machine Model WHBO-12A Serial No. 984014320
Fuel Type:	#1 Oil
Input Rating:	140,000 BTU/hr
Steady State Efficiency:	60 %
Idle Loss:	1 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 85%, de-rated to 60% due to age and condition

Space Heating and Cooling Distribution Systems

The furnace is the primary heat source in this building, the Monitor stove is secondary and used only during the coldest months of the year. Heat from the furnace is distributed to diffusers in each room by overhead ductwork.

Building Ventilation System

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

HVAC Controls

A single manual thermostat controls the furnace. The Monitor stove has its own thermostat and internal controls.

Domestic Hot Water System

DHW is provided by a 32-gallon, oil-fired storage hot water heater located in the furnace room. There is a DHW re-circulation pump in the furnace room, but it was valved-off and turned off during the site survey and does not appear to be in use.

Lighting

The interior lighting consists mainly of 4-lamp, 24" x 48" recessed troffer fixtures utilizing T8 florescent lamps and electronic ballasts. Most have had two lamps removed and most rooms utilize switch-mounted occupancy sensors. Exterior lighting consists of what appear to be 70w HPS wall packs controlled by a 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) 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: Kwig Power Company - Commercial – Sm – with the PCE discount

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 (PCE)	$ 0.3720/kWh
#1 Oil	$ 4.50/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 Kwigillingok pays approximately $10,360 annually for electricity and other fuel costs for the Clinic.

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

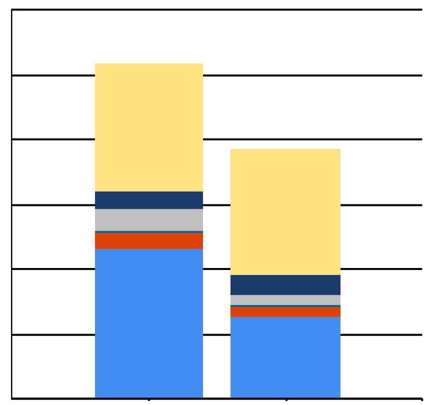


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

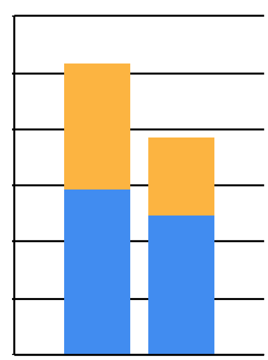
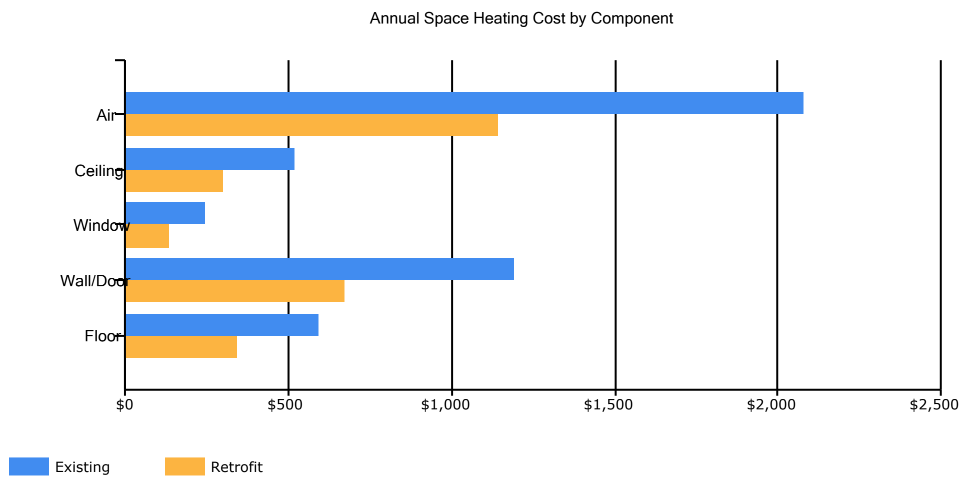


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, how much annual space heating cost is caused by the heat loss through the walls/doors. For each component, the space heating cost

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, 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	300	268	257	186	100	42	21	26	60	141	224	279
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	2	2	2	2	2	2	2	2	2	2	2	2
Lighting	146	133	146	142	146	142	146	146	142	146	142	146
Refrigeration	132	120	132	128	132	128	132	132	128	132	128	132
Other_Electrical	1000	912	1000	766	792	766	792	792	766	1000	968	1000

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	130	116	113	84	48	25	16	18	33	66	99	121
DHW	11	10	11	11	11	11	11	11	11	11	11	11

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 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
Clinic 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	15,764 kWh	53,803	3.340	179,703
#1 Oil	999 gallons	131,883	1.010	133,202
Total		**185,686**		**312,904**
BUILDING AREA		1,465	Square Feet	
BUILDING SITE EUI		127	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		214	**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	**126.7**	**10.93**	**$10.28**
With Proposed Retrofits	**87.0**	**7.50**	**$5.28**
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
Clinic, Kwigillingok, 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: Storage, pharmacy, bathroom, closet, furnace	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Storage, pharmacy, bathroom, closet, furnace space.	$212 / 5.5 MMBTU	$1	2809.15	0.0	1,164.4
2	Setback Thermostat: Low use exam rooms, 3 & 4	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Low use exam rooms, 3 & 4 space.	$196 / 5.1 MMBTU	$1	2597.65	0.0	1,076.7
3	Ventilation	Cost of occupancy sensor included in lighting EEM	$67 / 1.7 MMBTU	$1	882.90	0.0	385.3
4	Setback Thermostat: All other spaces	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the All other spaces space.	$675 / 17.5 MMBTU	$300	29.84	0.4	3,710.6
5	Lighting - Power Retrofit: Exterior Lights HPS Wall Pack 70w	Replace with 2 LED 20W Module StdElectronic	$123 + $10 Maint. Savings / 1.1 MMBTU	$450	2.50	3.4	1,161.4
6	HVAC And DHW	At the End of life of existing furnace replace with an 85% thermal efficiency model at cost of $12,000; Add R-9 insulating blanket to hot water tank at a cost of $195; At end of life of hot water heater replace with higher efficiency model at a cost of $4000	$1,193 + $750 Maint. Savings / 26.9 MMBTU	$16,195	1.90	8.3	7,485.8

Table 4.1 Clinic, Kwigillingok, 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
7	Lighting - Power Retrofit: Waiting Room T8-4	Replace with 4 LED (2) 15W Module (2) StdElectronic	$65 + $20 Maint. Savings / 0.2 MMBTU	$535	1.31	6.3	711.7
8	Lighting - Power Retrofit: Exam Room 3 T8-4	Replace with LED (4) 15W Module (2) StdElectronic	$8 + $5 Maint. Savings / 0.0 MMBTU	$174	1.07	13.2	88.8
9	Lighting - Power Retrofit: Exam Room 3 T8-3	Replace with LED (3) 15W Module StdElectronic	$6 + $5 Maint. Savings / 0.0 MMBTU	$154	1.01	14.1	64.7
	TOTAL, cost-effective measures		**$2,546 + $790 Maint. Savings / 58.0 MMBTU**	**$17,811**	**2.71**	**5.3**	**15,849.4**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
10	Lighting - Power Retrofit: Office T8-4	Replace with 2 LED (2) 15W Module (2) StdElectronic	$31 + $10 Maint. Savings / 0.1 MMBTU	$268	0.93	6.6	337.6
11	Lighting - Power Retrofit: Exam Room 4,2,1 T8-4 on OS	Replace with 8 LED (2) 15W Module (2) StdElectronic	$28 + $40 Maint. Savings / 0.1 MMBTU	$1,070	0.92	15.7	308.0
12	Lighting - Power Retrofit: Storage T8-4	Replace with LED (2) 15W Module (2) StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$134	0.76	19.1	22.1
13	Lighting - Power Retrofit: Storage T8-2	Replace with LED (2) 15W Module (2) StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$134	0.74	19.6	20.1

Table 4.1 Clinic, Kwigillingok, 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
14	Lighting - Power Retrofit: Pharmacy T12-2 x 24"	Replace with LED (2) 8W Module StdElectronic	$2 + $5 Maint. Savings / 0.0 MMBTU	$134	0.73	20.0	18.9
15	Lighting - Combined Retrofit: Bathroom T8-2	Replace with LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$15 + $5 Maint. Savings / 0.0 MMBTU	$384	0.72	19.5	161.2
16	Lighting - Power Retrofit: Pharmacy T8-2	Replace with LED (2) 15W Module StdElectronic	$0 + $5 Maint. Savings / 0.0 MMBTU	$134	0.54	27.6	-1.6
17	Lighting - Power Retrofit: Storage, Furnace, Janitor CFL-PL 13w	Replace with 3 LED (2) 15W Module StdElectronic	$1 + $10 Maint. Savings / 0.0 MMBTU	$402	0.39	38.1	5.9
18	Lighting - Power Retrofit: Entry T8-2	Replace with LED (2) 15W Module StdElectronic	-$1 + $5 Maint. Savings / 0.0 MMBTU	$134	0.25	34.8	-12.6
	TOTAL, all measures		**$2,624 + $880 Maint. Savings / 58.2 MMBTU**	**$20,605**	**2.44**	**5.9**	**16,709.1**

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

Rank	**Recommendation**				
6	At the End of life of existing furnace replace with an 85% thermal efficiency model at cost of $12,000; Add R-9 insulating blanket to hot water tank at a cost of $195; At end of life of hot water heater replace with higher efficiency model at a cost of $4000				
Installation Cost	$16,195	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$1,193
Breakeven Cost	$30,814	**Simple Payback (yrs)**	8	**Energy Savings (MMBTU/yr)**	26.9 MMBTU
		Savings-to-Investment Ratio	1.9	**Maintenance Savings ($/yr)**	$750
Auditors Notes:					

4.4.2 Ventilation System Measures

Rank	**Description**			**Recommendation**	
3				Cost of occupancy sensor included in lighting EEM	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$67
Breakeven Cost	$883	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.7 MMBTU
		Savings-to-Investment Ratio	882.9		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	**Building Space**			**Recommendation**	
1	Storage, pharmacy, bathroom, closet, furnace			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Storage, pharmacy, bathroom, closet, furnace space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$212
Breakeven Cost	$2,809	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	5.5 MMBTU
		Savings-to-Investment Ratio	2,809.1		
Auditors Notes:					

Rank	Building Space			Recommendation	
2	Low use exam rooms, 3 & 4			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Low use exam rooms, 3 & 4 space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$196
Breakeven Cost	$2,598	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	5.1 MMBTU
		Savings-to-Investment Ratio	2,597.6		
Auditors Notes:					

Rank	Building Space			Recommendation	
4	All other spaces			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the All other spaces space.	
Installation Cost	$300	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$675
Breakeven Cost	$8,953	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	17.5 MMBTU
		Savings-to-Investment Ratio	29.8		
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	
5	Exterior Lights HPS Wall Pack 70w	2 HPS 70 Watt StdElectronic with Manual Switching		Replace with 2 LED 20W Module StdElectronic	
Installation Cost	$450	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$123
Breakeven Cost	$1,125	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	1.1 MMBTU
		Savings-to-Investment Ratio	2.5	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Replace (2) 70w HPS lamps with new 20w "corncob" LED lamps (ballast may need to be bypassed) @ parts cost of $100 ea + 1 hr labor ea. @ $125/hr. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
7	Waiting Room T8-4	4 FLUOR (2) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Manual Switching		Replace with 4 LED (2) 15W Module (2) StdElectronic	
Installation Cost	$535	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$65
Breakeven Cost	$703	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
		Savings-to-Investment Ratio	1.3	**Maintenance Savings ($/yr)**	$20
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (4) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (8) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
8	Exam Room 3 T8-4	FLUOR (4) T8 4' F32T8 32W Standard (2) Program StdElectronic with Manual Switching		Replace with LED (4) 15W Module (2) StdElectronic	
Installation Cost	$174	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$8
Breakeven Cost	$186	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.1	**Maintenance Savings ($/yr)**	$5

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (4) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
9	Exam Room 3 T8-3	FLUOR (3) T8 4' F32T8 32W Standard Program StdElectronic with Occupancy Sensor		Replace with LED (3) 15W Module StdElectronic	
Installation Cost	$154	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$6
Breakeven Cost	$156	**Simple Payback (yrs)**	14	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr)**	$5

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (3) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
10	Office T8-4	2 FLUOR (2) T8 4' F32T8 32W Standard (2) Program StdElectronic with Occupancy Sensor		Replace with 2 LED (2) 15W Module (2) StdElectronic	
Installation Cost	$268	**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	$31
Breakeven Cost	$249	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.9	**Maintenance Savings ($/yr)**	$10

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (2) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
11	Exam Room 4,2,1 T8-4 on OS	8 FLUOR (2) T8 4' F32T8 32W Standard (2) Program StdElectronic with Occupancy Sensor		Replace with 8 LED (2) 15W Module (2) StdElectronic	
Installation Cost	$1,070	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$28
Breakeven Cost	$979	**Simple Payback (yrs)**	16	**Energy Savings (MMBTU/yr)**	0.1 MMBTU
		Savings-to-Investment Ratio	0.9	**Maintenance Savings ($/yr)**	$40

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage in (8) fixtures (may need to replace end caps) @ 0.75 hrs/fixture @ $125/hr. Replace (16) 32w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
12	Storage T8-4	FLUOR (2) T8 4' F32T8 32W Standard (2) Instant StdElectronic with Occupancy Sensor		Replace with LED (2) 15W Module (2) StdElectronic	
Installation Cost	$134	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$2
Breakeven Cost	$102	**Simple Payback (yrs)**	19	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.8	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
13	Storage T8-2	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Occupancy Sensor		Replace with LED (2) 15W Module (2) StdElectronic	
Installation Cost	$134	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$2
Breakeven Cost	$99	**Simple Payback (yrs)**	20	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.7	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
14	Pharmacy T12-2 x 24"	FLUOR (2) T12 2' F20T12 20W Standard Magnetic with Manual Switching		Replace with LED (2) 8W Module StdElectronic	
Installation Cost	$134	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$2
Breakeven Cost	$98	**Simple Payback (yrs)**	20	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.7	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 20w lamps with 8.5w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
15	Bathroom T8-2	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$384	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$15
Breakeven Cost	$275	**Simple Payback (yrs)**	20	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.7	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Install occupancy sensor for a cost of $250-.					

Rank	Location	Existing Condition		Recommendation	
16	Pharmacy T8-2	FLUOR T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$134	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$
Breakeven Cost	$72	**Simple Payback (yrs)**	28	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.5	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
17	Storage, Furnace, Janitor CFL-PL 13w	3 FLUOR (2) CFL, Plug-in 13W Twin Tube Magnetic with Occupancy Sensor		Replace with 3 LED (2) 15W Module StdElectronic	
Installation Cost	$402	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$1
Breakeven Cost	$156	**Simple Payback (yrs)**	38	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.4	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.					

Rank	Location	Existing Condition		Recommendation	
18	Entry T8-2	FLUOR T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED (2) 15W Module StdElectronic	
Installation Cost	$134	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	-$1
Breakeven Cost	$33	**Simple Payback (yrs)**	35	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.2	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w 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

PUMP SCHEDULE				
SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
DHW re-circ pump	Grundfos UPS 25-64 SF	16 @ 14	180w/115/1	not in use

HEAT PLANT SCHEDULE				
SYMBOL	MFGR/MODEL	EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
F-1	Metzger Machine Model WHBO-12A	85%	e.25/115/1	140 MBH, Serial No. 984014320; de-rated to 60% thermal efficiency based on age
M-1	Monitor 441	87%	80w/115/1	de-rated to 82% thermal efficiency based on age

HOT WATER HEATER SCHEDULE				
SYMBOL	MFGR/MODEL	GALLONS	CAPACITY	REMARKS
HWH-1	Bock model 32E	32	104 MBH	Serial No. 00042025T

PLUMBING FIXTURES				
SYMBOL	FIXTURE	GPF	QUANTITY	REMARKS
	Lavatory	1.5	1	manual
	tub/shower	2	1	
	W.C.	1.6	1	tank, manual flush

PLUG LOAD SUMMARY				
SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	5	200w	
	Laptop	1	85w	
	large copy/scan/fax machines	1	1250 w	
	Paper shredder	1	500w	

	Flat screen TV	1	80w	
	personal coffee machine	1	500w	
	2 burner electric hotplate	1	1250w	
	Microwave	1	1500w	
	Whirlpool ET4WSKXSQ00	1	556 kWh/yr	manufactured 2006
	Panasonic MPR-215F-PA pharmaceutical refrigerator	1	e500w	
	Server, UPS, Hubs, ethernet switches	1	est 915 w	

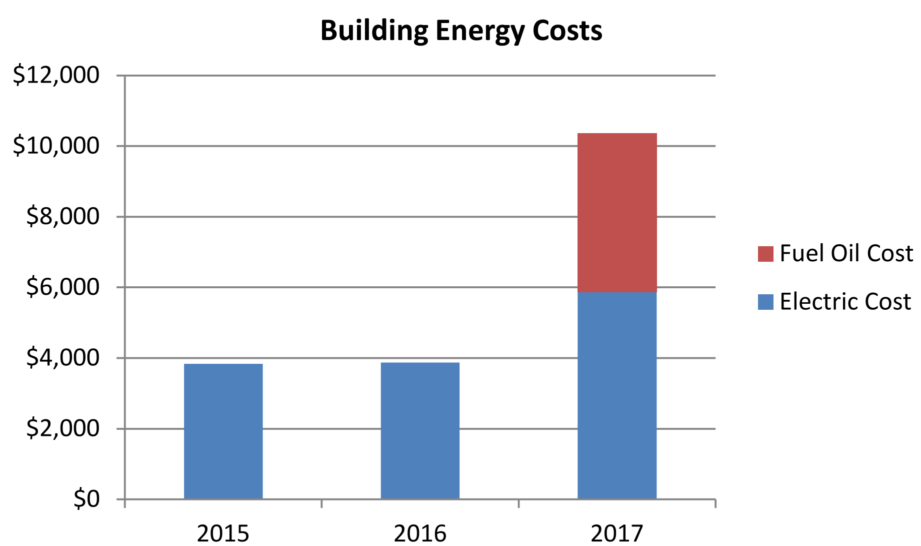
Appendix B – Benchmark Analysis and Utility Source Data

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 into 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 fuel oil delivery only for 2017 was provided. Figures B.1 and B.2 show the 3-year summary of consumption and costs for electricity and 1-year for fuel oil for this facility. The shaded cells represent data used in the AkWarm-C model.

Figure B.1 – Total Building Energy Consumption and Costs

KWIG CLINIC						
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use	Fuel oil Cost	Total kBTU's of Energy	Total Utility Cost
2015	12,998	$3,835	998	$4,491	166,825	$10,360
2016	10,281	$3,875				
2017	15,762	$5,869				

Figure B.2 - Costs



Electricity: The erratic year-over-year electric consumption in this building indicates uncontrolled and unknown electric loads. Electric consumption decreased by 21% between 2015 and 2016, but then increased by 53% between 2016 and 2017. The likely sources of the 53% increase are the heat traces or well pump or tank heat and Figure B.3 indicates that the increase is not seasonal in nature.

Figure B.3 – 3 Years of monthly Electric Consumption

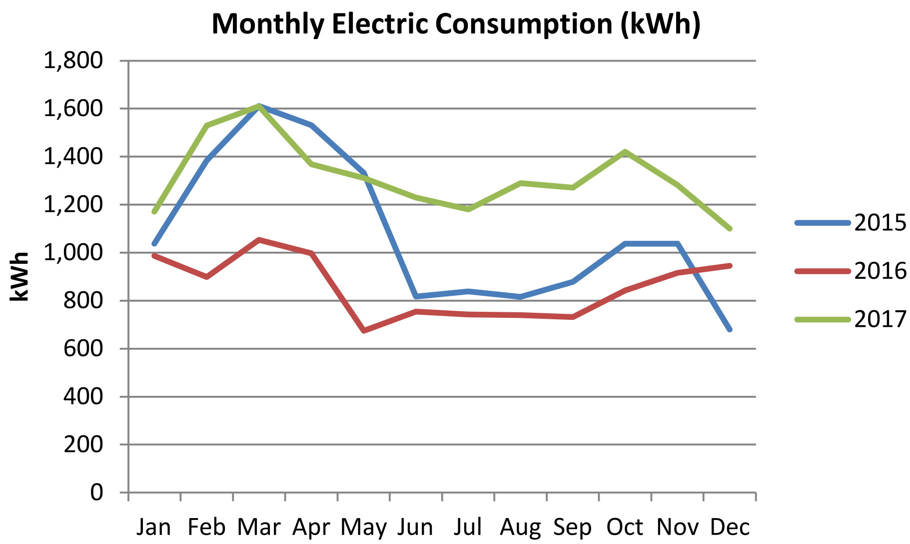
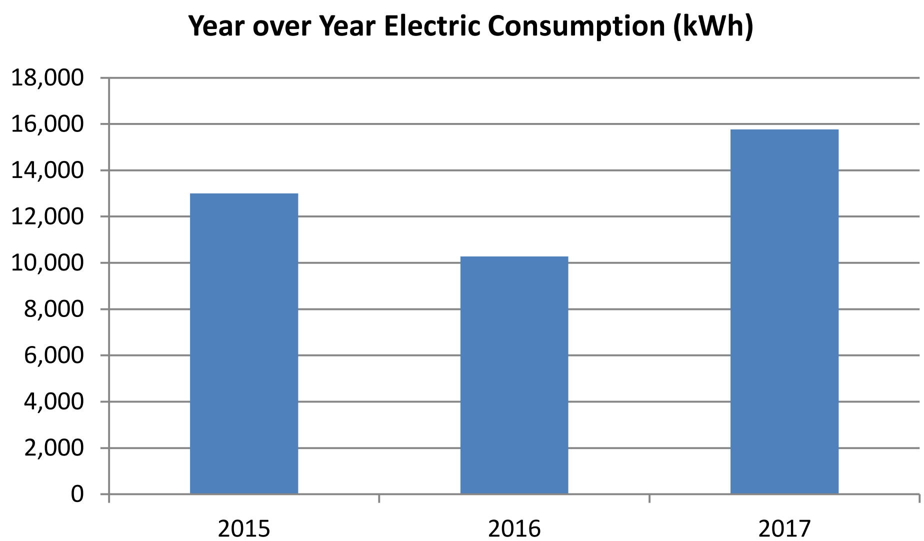


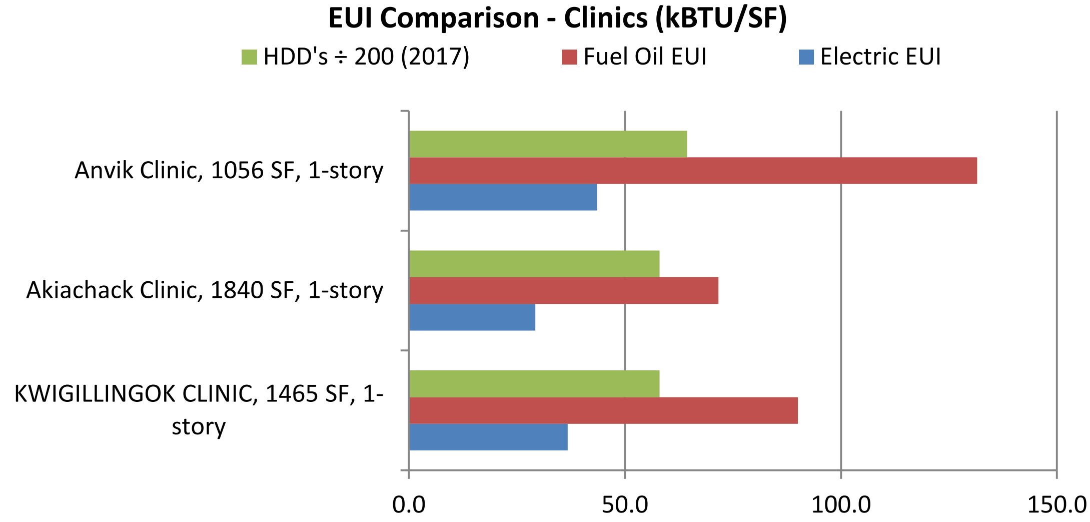
Figure B.4 – 3 years of Annual Electric Consumption



Fuel Oil: Since only one year of fuel oil delivery data was provided, no comparative or historical benchmarking can be performed on this building.

Comparing EUIs: Figure B.5 and the discussion in Section 1.5 above show this building's heating EUI and electric EUI fall right into the middle of the three comparison buildings. Although Anvik has slightly more HDDs (i.e. a more severe climate) than the subject building, its heating EUI is much higher. This is attributed to a malfunctioning HVAC control system which had zone valves stuck open, an overheated building, and open windows in the winter time.

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 consistency of data, periods for which data was available, and current use and occupancy of the building versus historical use and occupancy. The benchmark baseline periods selected for this building are 2017 for electricity and fuel oil deliveries. The shaded 2017 electric consumption figures below were used to calibrate the electric side of the AkWarm© model.

Figure B.6 – Benchmark Utility Data

ELECTRIC							FUEL OIL						
	2015		2016		2017			2015		2016		2017	
	kWh	Cost	kWh	Cost	kWh	Cost		gallons	Cost	gallons	Cost	gallons	Cost
Jan	1,037	$216	987	$353	1,171	$443	Jan	0	$0	0	$0	0	$0
Feb	1,384	$372	898	$322	1,530	$579	Feb	0	$0	0	$0	0	$0
Mar	1,611	$433	1,053	$377	1,610	$609	Mar	0	$0	0	$0	0	$0
Apr	1,531	$411	997	$357	1,368	$518	Apr	0	$0	0	$0	0	$0
May	1,332	$358	674	$241	1,311	$496	May	0	$0	0	$0	0	$0
Jun	817	$219	755	$270	1,230	$608	Jun	0	$0	0	$0	0	$0
Jul	839	$233	742	$373	1,180	$457	Jul	0	$0	0	$0	0	$0
Aug	816	$292	740	$280	1,290	$498	Aug	0	$0	0	$0	0	$0
Sep	878	$314	732	$277	1,271	$398	Sep	0	$0	0	$0	0	$0
Oct	1,037	$371	842	$319	1,420	$445	Oct	0	$0	0	$0	0	$0
Nov	1,037	$371	916	$347	1,281	$401	Nov	0	$0	0	$0	0	$0
Dec	679	$243	945	$358	1,100	$416	Dec	0	$0	0	$0	0	$0
Total	**12,998**	**$3,835**	**10,281**	**$3,875**	**15,762**	**$5,869**	**Total**	**0**	**$0**	**0**	**$0**	**998**	**$4,491**

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:

- 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 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**

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: Clinic	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Richard John	
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 588-8114	**Auditor Comment:**
Client FAX:	

Design Data

Building Area: 1,465 square feet	**Design Space Heating Load:** Design Loss at Space: 40,363 Btu/hour with Distribution Losses: 46,987 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 71,627 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 5 people	**Design Indoor Temperature:** 71 deg F (building average)
Actual City: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days

Utility Information

Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: : $0.372/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

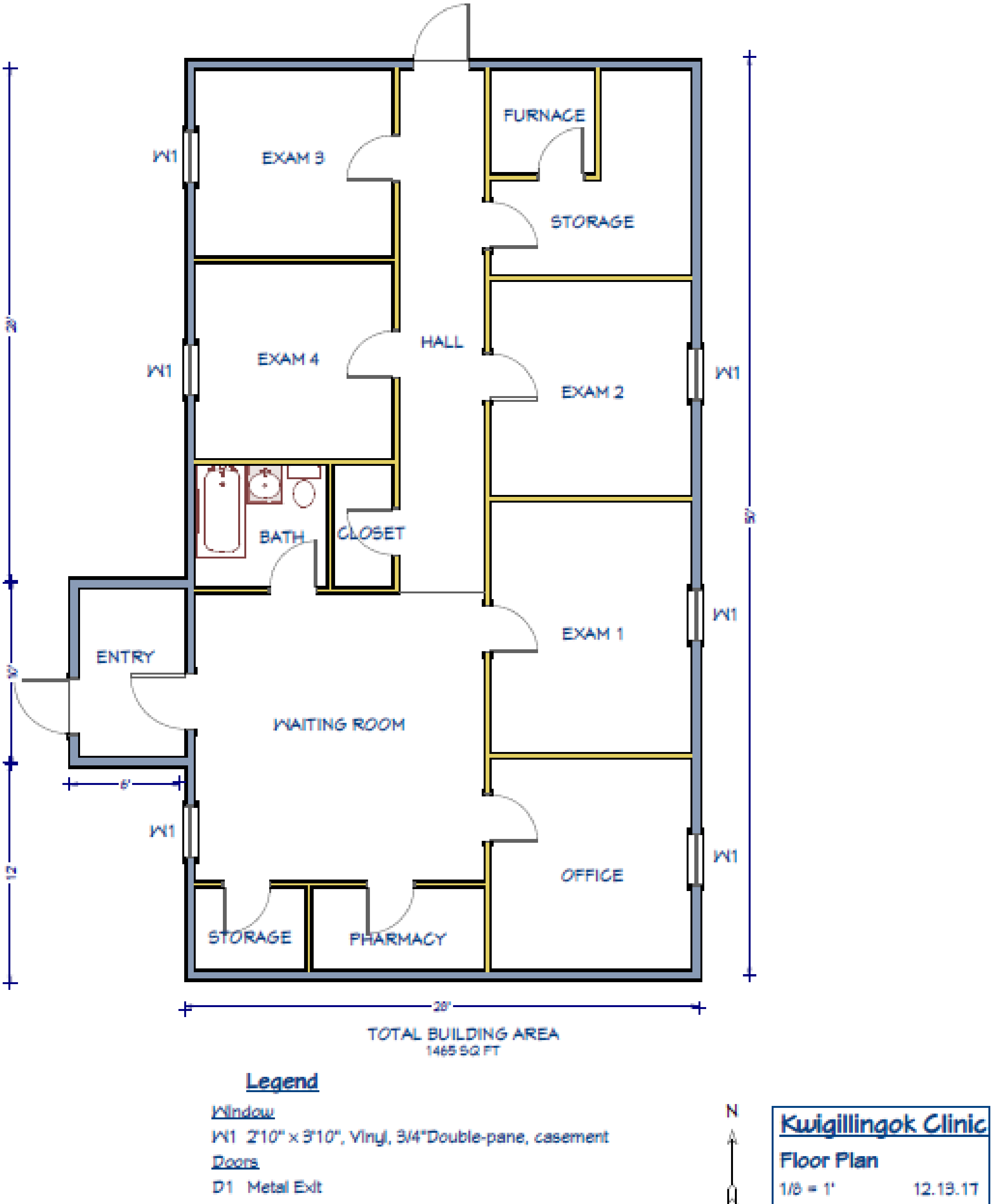
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$4,622	$0	$582	$9	$642	$579	$3,927	$0	**$10,360**
With Proposed Retrofits	$2,569	$0	$350	$4	$307	$579	$3,927	$0	**$7,736**
Savings	$2,053	$0	$233	$4	$335	$0	$0	$0	**$2,624**

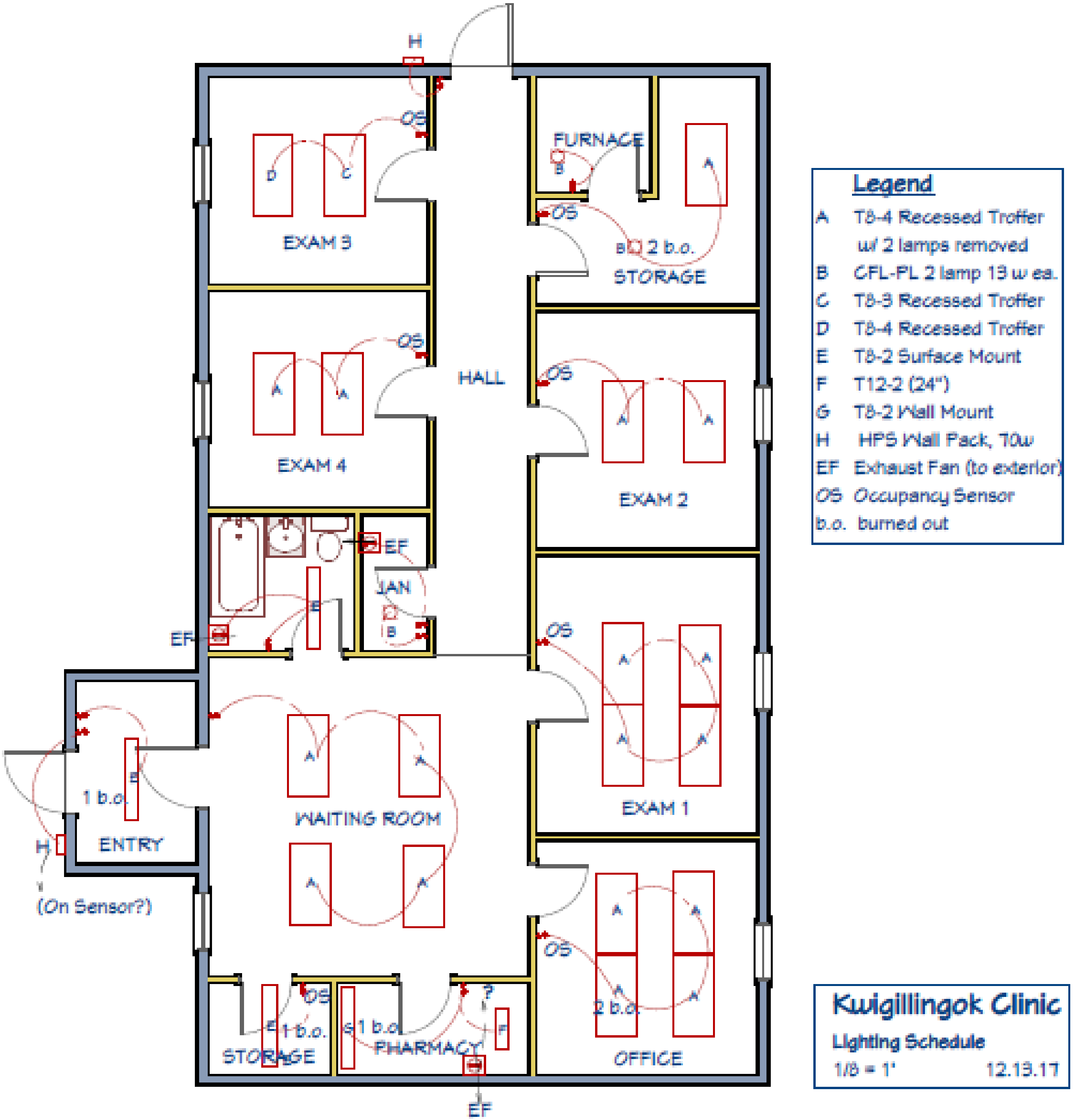
Building Benchmarks

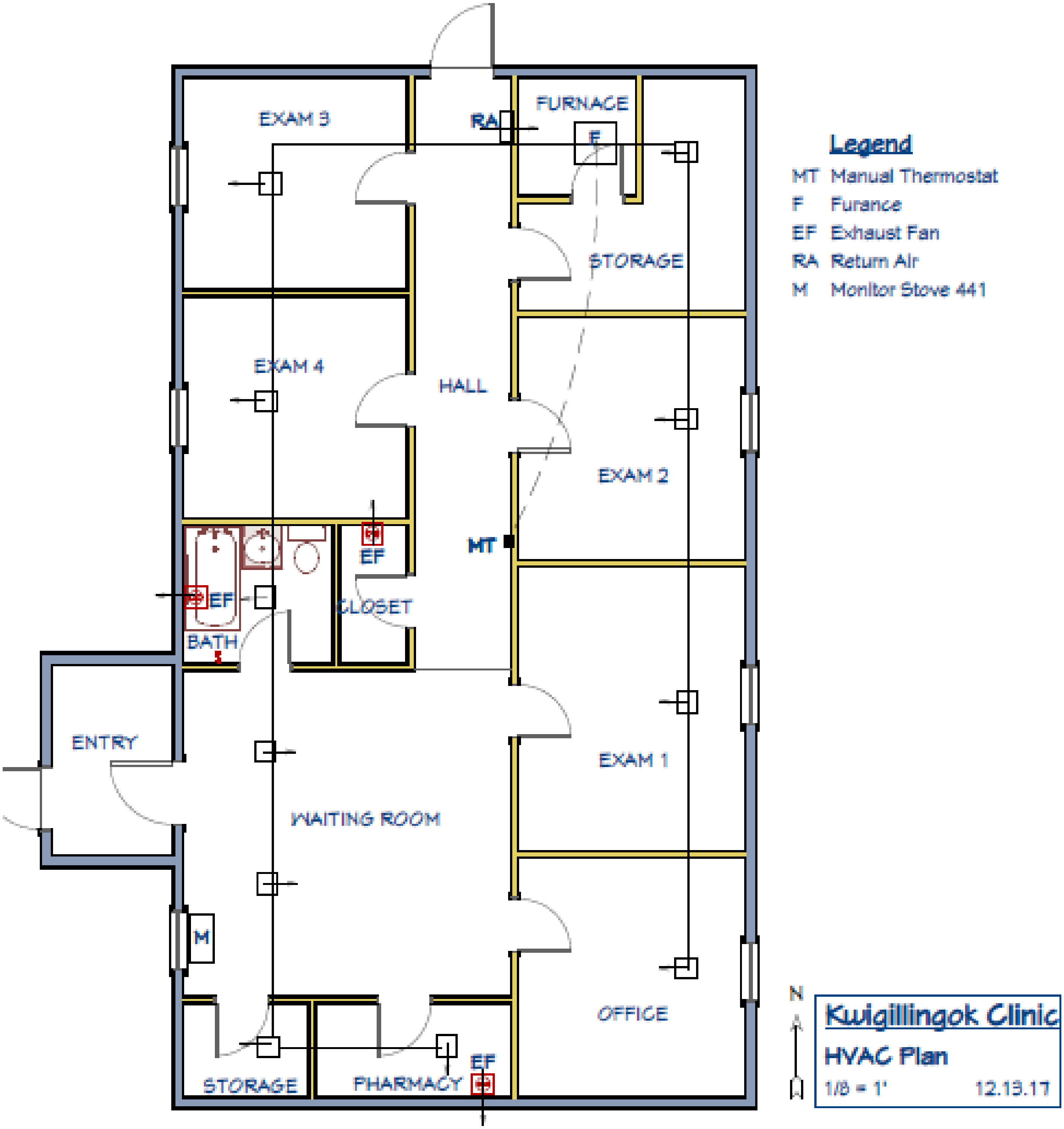
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	126.7	10.93	$10.28
With Proposed Retrofits	87.0	7.50	$5.28

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




H
EXAM 3
OS
D
C
FURNACE
B
A
OS
B 2 b.o.
STORAGE
EXAM 4
OS
A
A
HALL
OS
A
A
EXAM 2
EF
JAN
B
EF
B
OS
A
A
A
A
EXAM 1
E
1 b.o.
ENTRY
H
(On Sensor?)
A
A
WAITING ROOM
A
A
OS
A
A
A
A
2 b.o.
OFFICE
OS
E
1 b.o.
STORAGE
G
1 b.o.
PHARMACY
?
F
EF
Legend
A T8-4 Recessed Troffer w/ 2 lamps removed
B CFL-PL 2 lamp 13 w ea.
C T8-3 Recessed Troffer
D T8-4 Recessed Troffer
E T8-2 Surface Mount
F T12-2 (24")
G T8-2 Wall Mount
H HPS Wall Pack, 70w
EF Exhaust Fan (to exterior)
OS Occupancy Sensor
b.o. burned out
Kwigillingok Clinic
Lighting Schedule
1/8 = 1'
12.13.17


EXAM 3
RA
FURNACE
F
Legend
MT Manual Thermostat
F Furance
EF Exhaust Fan
RA Return Air
M Monitor Stove 441
STORAGE
EXAM 4
HALL
EXAM 2
MT
EF
EF
CLOSET
BATH
ENTRY
EXAM 1
WAITING ROOM
M
OFFICE
N
Kwigillingok Clinic
HVAC Plan
1/8 = 1' 12.13.17
EF
STORAGE
PHARMACY

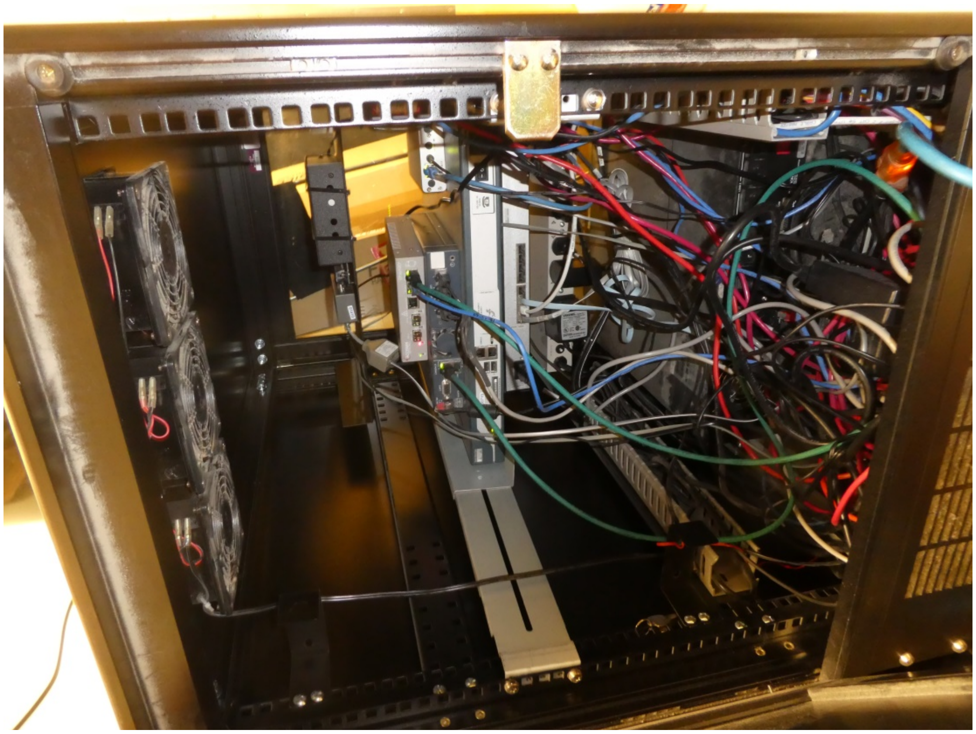
Appendix E – Photographs

Underside of clinic, wastewater exit shown

Waiting room/lobby

One of the exam rooms

Furnace thermostat



Server located in furnace room

Hot water heater; all combustible materials should be removed from furnace room

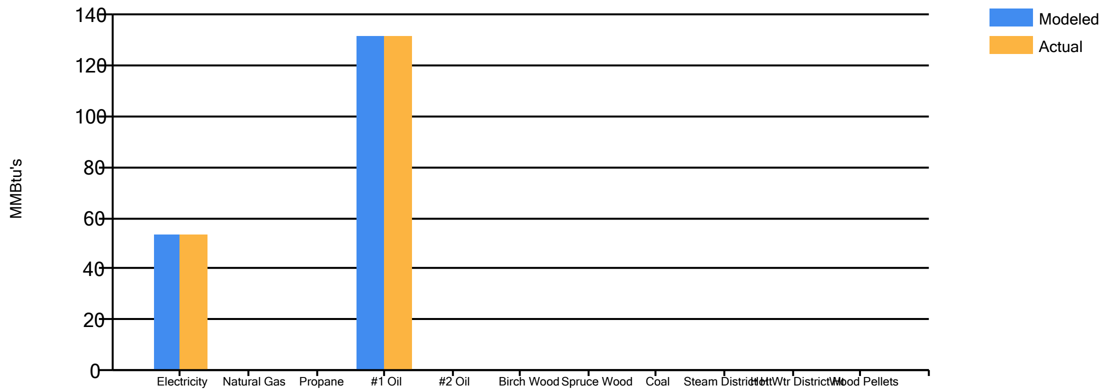
DWH re-circulation pump; valves are closed and switch is off

Heat trace controls

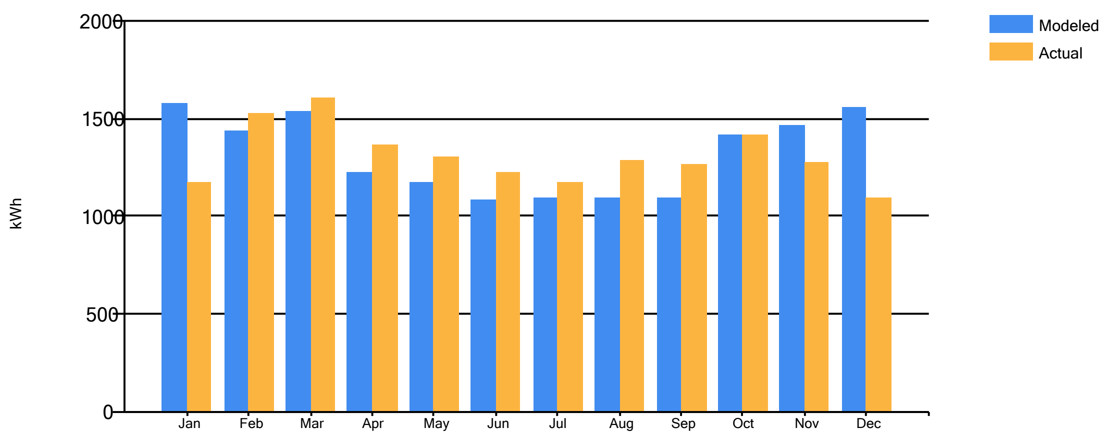
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

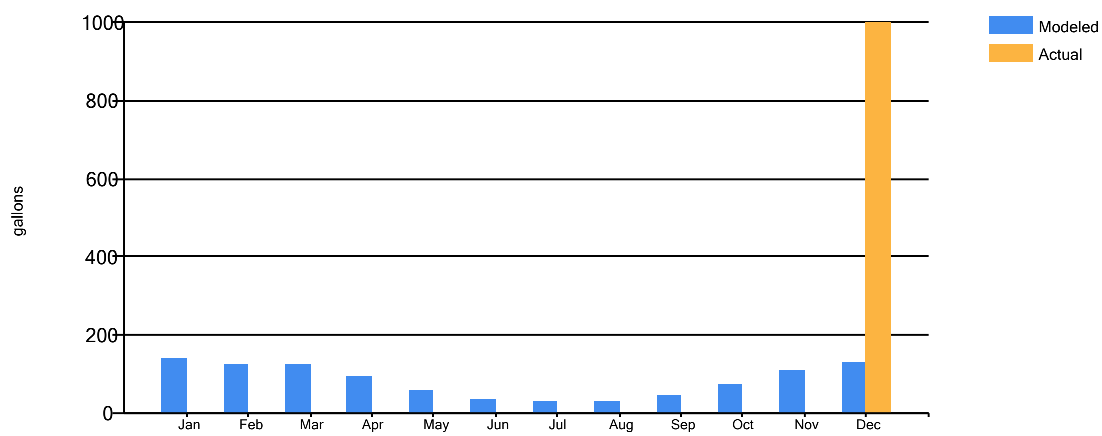
Annual Fuel Use



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 the Fisheries Building

Prepared For
Native Village of Kwigillingok
Darrel T. John, Tribal Administrator
P.O. Box 90
Kwigillingok, AK 99622
kwigtribe@gmail.com
907-588-8114

Site Survey Date:
December 12, 2017

Prepared By:
James Fowler, PE, CEM
Energy Audits of Alaska
200 W 34th Ave, Suite 1018
Anchorage, AK 99503
jim@jim-fowler.com

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 – October 4, 2018
New Release – October 2, 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: Darrel and Richard John, the Tribal Administrator and Finance officer, Victoria Amik in the Post Office, Sherie the tribal police officer, 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. Thanks to Megan the school principal, who provided lodging.

Project Location

Post office
Clinic
IRA Council Office
Jail
Fisheries Building NORTH

Building contact:
Richard John
Finance Director
907-588-8114
kwigaccting@gmail.com

1. SUMMARY

This report was prepared for the Native Village of Kwigillingok, owner of the Fisheries 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 December 12th and 13th, 2017. The outside temperature varied between 28F and 35F 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 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.

<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

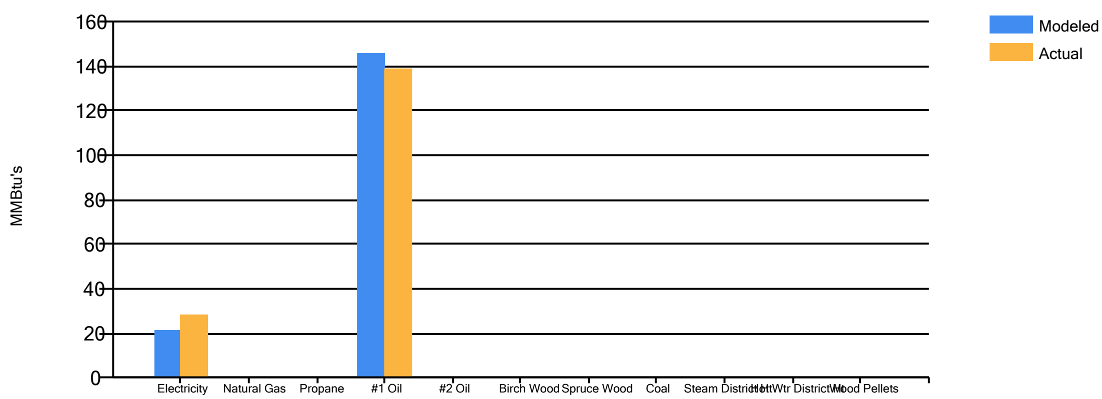
a. ECMs are no cost or low cost energy conservation measures typically implemented by the building owner or the owner’s staff. The following ECMs are recommended:

- Remove the "hold" on the programmable thermostat located in the SW office; correct the time clock and confirm that it is programmed to set back temperatures during unoccupied hours.
- Program the Toyo stoves in the garage to set back temperatures during unoccupied hours, re-program after every power outage.

b. <u>If all the recommended EEMs are incorporated in this building, there will be a 16% reduction in energy costs, totaling $1,974, with a simple payback of 6.8 years on the $13,366 implementation cost</u>.

c. **Baseline adjustment**: The lighting in this building was upgraded to LED fixtures in late 2017. In order to calibrate the AkWarm-C model, the lighting was entered as 32w T8 fluorescents, the model was then calibrated to 2016 electric and oil consumption. The baseline was then adjusted, by replacing the florescent T8's with 14w LED T8's in the model. This resulted in lower electric consumption and higher oil consumption as shown in the bar chart below. This was the new, adjusted baseline used to calculate savings.

d.



a. It was assumed in this analysis, that electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by qualified electricians. <u>It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician</u>.

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 adjusted baseline AkWarm-C© energy model, the total predicted energy costs are $9,198 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

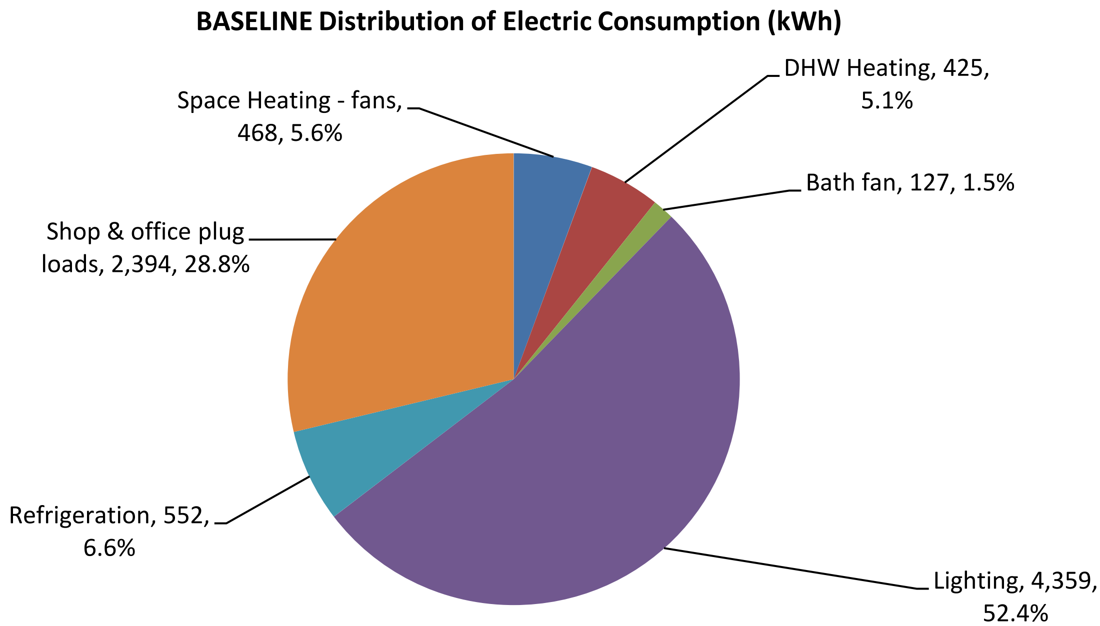
$4,236 for Electricity
$4,962 for #1 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	6,322 kWh	5,655 kWh
#1 Oil	1,103 gallons	874 gallons

The table below shows the relative costs per MMBTU for electricity and fuel oil and the pie charts in Figure 1.1 show the baseline and adjusted baseline (after installation of the LEDs). Figure 1.2 shows the breakdown of fuel oil energy use in this building.

	Unit Cost	Cost/MMBTU
Electricity	$0.67	$196.30
Fuel Oil	$4.50	$34.09

Figure 1.1



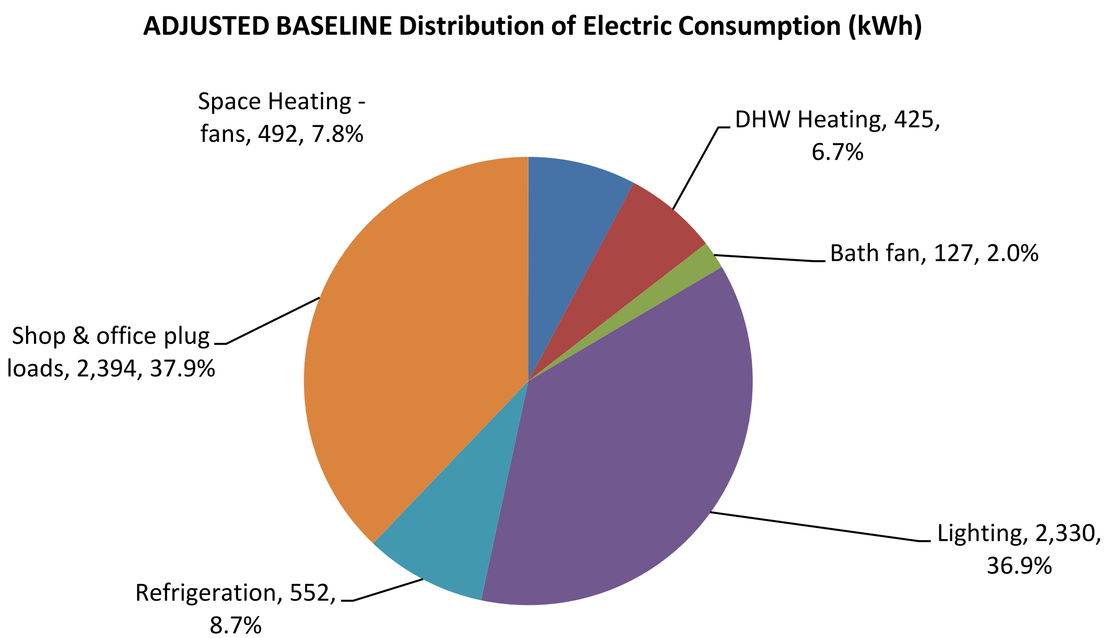
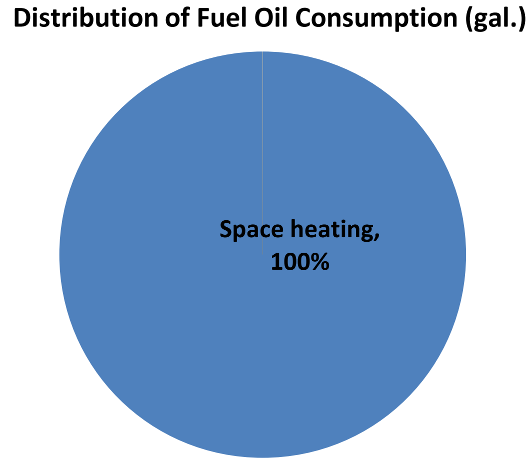


Figure 1.2



Based on this breakdown, it is clear that efficiency efforts should be focused primarily on managing plug loads and lighting. Since most of the lighting has already been converted to LEDs, the recommended EEMs focus on lighting controls.

1.4 Benchmark Summary

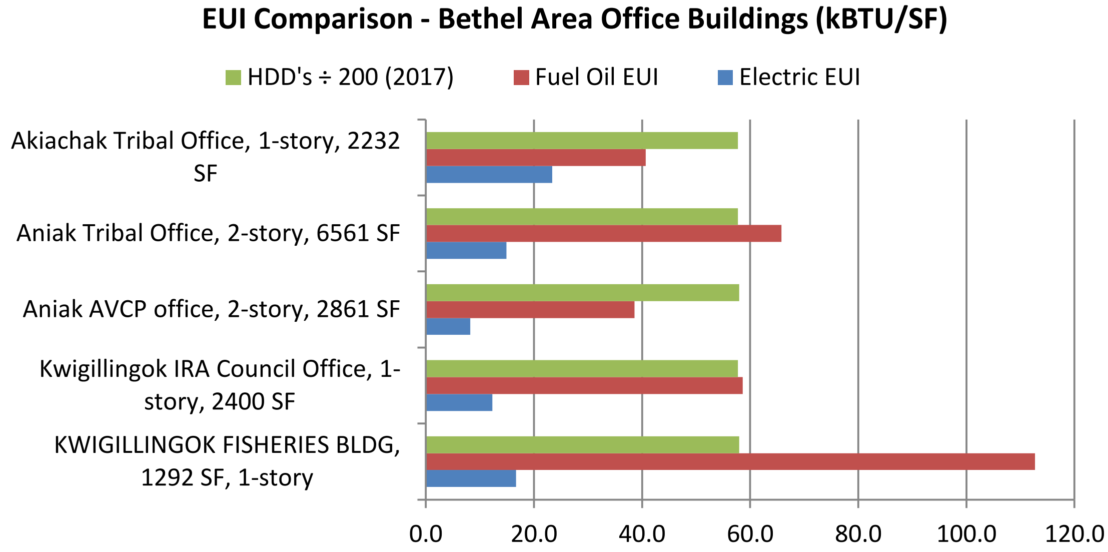
Benchmark figures facilitate the comparison of energy use between different buildings. The table below lists several benchmarks for the audited building. More details can be found in section 3.2.2 and Appendix B.

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	129.4	11.15	$7.12
With Proposed Retrofits	104.3	8.99	$5.98
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[1] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart the subject building's heating EUI is more than double the average and its electric EUI is 25% below the average of the comparison buildings. The likely reason for the very high heating EUI is the building's force air heating system, which is less efficient than a hydronic boiler system, and the use of the garage with its overhead door, for maintenance and repair work. Additional discussion is provided in Appendix B.

[1] 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.



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 BTU's 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.)
HVAC related	$12,601	$1,873	6.7
Lighting & Lighting controls	$765	$101	7.6
Totals	**$13,366**	**$1,974**	**6.8**

Figure 1.4

	Existing conditions (adjusted baseline)		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	6,322	21,577	5,655	19,301	10.6%
Gallons Oil	1,103	145,596	874	115,368	20.8%
Energy Cost	$9,198		$7,723		16.0%

Tables 1.1 below and Table 4.1 in section 4 summarize the energy efficiency measures analyzed for the Fisheries Building. Estimates of annual energy and maintenance savings, installed costs, SIR, CO2 savings, and simple paybacks are shown for each EEM. The $1 cost indicates that there is no appreciable cost to implement the EEM, but 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	Setback Thermostat: Fisheries Building - Office	Implement a Heating Temperature Unoccupied Setback to 64.0 deg F for the Fisheries Building - Office space.	$600 / 16.7 MMBTU	$1	8076.30	0.0	2,838.6
2	Ventilation	Add occupancy sensor to bathroom exhaust fan for $150 materials and $250 labor cost.	$124 / 2.5 MMBTU	$400	3.99	3.2	607.3
3	Lighting - Controls Retrofit: Office 1 T8-2 LED	Remove Manual Switching and Add new Occupancy Sensor and Improve Daylight Sensor	$48 / -0.1 MMBTU	$250	1.59	5.2	260.4
4	HVAC And DHW	At end of life of existing furnace, replace with higher efficiency model at an incremental cost of $2,000; total cost of replacement estimated to be $12,000. Add insulation blanket to hot water heater, estimated cost $200 installed.	$641 + $500 Maint. Savings / 13.4 MMBTU	$12,000	1.50	10.5	3,125.8
5	Lighting - Combined Retrofit: Hall CFL-2-A type 23W	Replace with LED 9W and Remove Manual Switching and Add new Occupancy Sensor	$39 / 0.0 MMBTU	$260	1.22	6.7	207.1
	TOTAL, cost-effective measures		**$1,452 + $500 Maint. Savings / 32.4 MMBTU**	**$12,911**	**2.20**	**6.6**	**7,039.3**
The following measures were *not* found to be cost-effective from a financial perspective, but are still recommended:							
6	Lighting - Controls Retrofit: Bathroom T8-2 LED	Remove Manual Switching and Add new Occupancy Sensor	$14 / 0.0 MMBTU	$250	0.62	18.3	73.1
7	Lighting - Power Retrofit: Utility CFL-A type	Replace with LED 8W Module StdElectronic	$0 / 0.0 MMBTU	$5	0.03	445.2	0.1

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
	TOTAL, all measures		$1,466 + $500 Maint. Savings / 32.4 MMBTU	$13,166	2.17	6.7	7,112.5

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	$5,291	$0	$286	$85	$1,561	$369	$1,606	$0	**$9,198**
With Proposed Retrofits	$3,994	$0	$286	$43	$1,433	$369	$1,606	$0	**$7,731**
Savings	$1,296	$0	$0	$42	$128	$0	$0	$0	**$1,466**

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	
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 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 and commercial cooking equipment with Energy Star versions.
    d. Keep refrigeration coils clean.
    e. Keep heating coils and fan filters in furnaces and Toyo stoves clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Fisheries 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 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 Fisheries 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.

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

1) Fisheries Building - Office: 541 square feet
2) Fisheries Building - Garage: 751 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.

Adjusted Baseline

In the case of this building, as previously mentioned, the lighting was upgraded to LED lamps in late 2017. In the AkWarm-C energy model, the lighting was entered as 32w T8 fluorescents, the model was then calibrated to 2016 electric and oil consumption. The baseline was then adjusted, by replacing the florescent T8's with 14w LED T8's in the model. This adjusted baseline model was then capable of predicting the impact of theoretical EEMs. The calibrated model is considered to represent the adjusted baseline and 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:

- 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 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. Fisheries Building EXISTING CONDITIONS

3.1. Building Description

This single story, 1,292 square foot Fisheries Building was constructed in 2005. It has a normal occupancy of 2 office staff and 3 shop staff as well as a continual stream of visitors using the public-use computers. The office staff and public computer users occupy the building from 8:00am until 5:00pm Monday through Friday and the shop staff are in the building intermittently during those same hours.

Description of Building Shell

There were no drawings or building plans available, so the details below are either assumed or based on observation. This building is constructed on a triodetic foundation supporting 6" x 12" glue lam beams which support the 2" x 12" floor joists. R-38 fiberglass batt is presumed to fill the joist cavities. The walls are constructed with 2" x 6" wood studs 16" OC, also presumably filled with R-21 batt. Exterior walls are finished with vertical, painted metal siding and interior walls are finished with gypsum. Windows utilize double glazing in vinyl frames, presumably with low-E coatings, given the building's age. The painted metal roof decking is presumed to cover a hot roof, with an estimated 8" of rigid foam insulation. Overall, the building shell is in very good condition.

Description of Heating and Cooling Plants

Furnace

Nameplate Information:	American Standard Model No. AHV1M087A936SAA Serial No. 6084523DX
Fuel Type:	#1 Oil
Input Rating:	105,000 BTU/hr
Steady State Efficiency:	72 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 82.4%, de-rated to 72% due to age and condition

Shop1 - Toyo-73

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	83 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 87%, de-rated to 83% due to age and condition

HWH

Nameplate Information:	In-Sink-Erator Model: W-152 Serial: 06068673247
Fuel Type:	Electricity
Input Rating:	0 BTU/hr
Steady State Efficiency:	100 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

Shop2 -Toyo-73

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	83 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 87%, de-rated to 83% due to age and condition

Space Heating and Cooling Distribution Systems

Heat is distributed to the office area by a forced air system utilizing supply and return air ductwork located above the ceiling and diffusers in each room. The Toyo stoves provide heat only to the garage where they are located.

Building Ventilation System

There is no mechanical ventilation system, ventilation is provided by operable windows.

HVAC Controls

A single programmable thermostat located in the southwest office controls the furnace. Its time setting was an hour off and the programming was manually over-ridden and on a temperature hold at 76F. Each Toyo stove has its own thermostat and integral controls.

Domestic Hot Water System

DHW is provided to lavatory sinks by a 2.5 gallon electric on-demand hot water heater located in the shop. There does not appear to be a DHW re-circulation pump in use.

Lighting

The interior lighting consists mainly of 2-lamp, 48” fixtures utilizing 14w, T8 LED lamps. No lighting controls appear to be in use. Surface mount fixtures in the vestibule and utility room utilize A-type CFL bulbs. Exterior lighting consists of what appear to be 17w LED wall packs controlled by 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: Kwig Power Company - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.6700/kWh
#1 Oil	$ 4.50/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 Kwigillingok pays approximately $9,198 annually for electricity and other fuel costs for the Fisheries 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

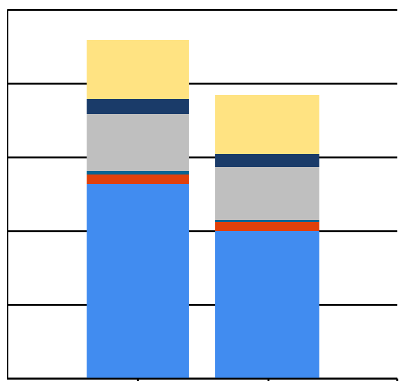


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

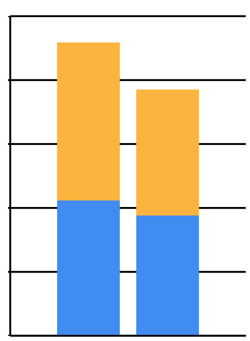
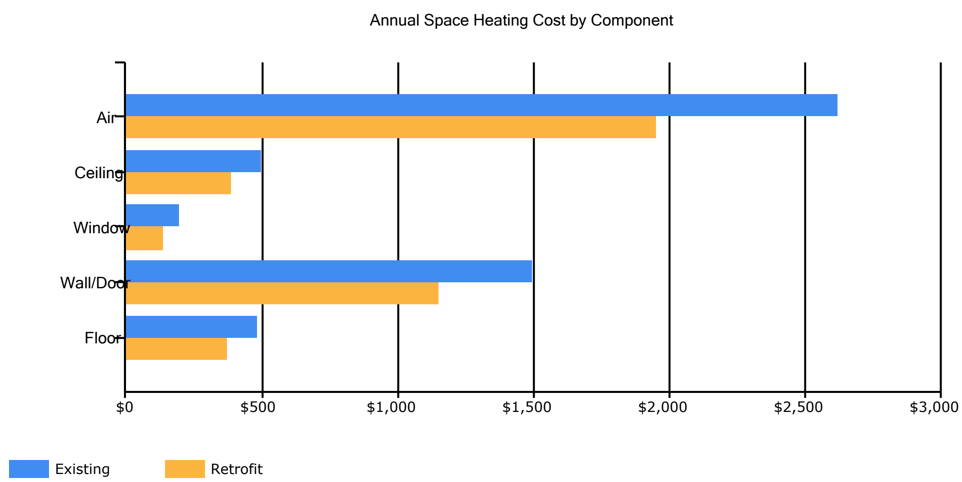


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	70	62	60	44	29	17	12	13	21	41	56	67
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	36	33	36	35	36	35	36	36	35	36	35	36
Ventilation_Fans	11	10	11	10	11	10	11	11	10	11	10	11
Lighting	198	180	198	191	198	191	198	198	191	198	191	198
Refrigeration	47	43	47	45	47	45	47	47	45	47	45	47
Other_Electrical	203	185	203	197	203	197	203	203	197	203	197	203

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	156	139	134	101	65	37	27	29	49	92	125	149
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):

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
Fisheries 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	6,322 kWh	21,577	3.340	72,069
#1 Oil	1,103 gallons	145,546	1.010	147,002
Total		**167,124**		**219,070**
BUILDING AREA		1,292	Square Feet	
BUILDING SITE EUI		129	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		170	**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	**129.4**	**11.15**	**$7.12**
With Proposed Retrofits	**104.3**	**8.99**	**$5.98**
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
Fisheries Building, Kwigillingok, 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: Fisheries Building - Office	Implement a Heating Temperature Unoccupied Setback to 64.0 deg F for the Fisheries Building - Office space.	$600 / 16.7 MMBTU	$1	8076.30	0.0	2,838.6
2	Ventilation	Add occupancy sensor to bathroom exhaust fan for $150 materials and $250 labor cost.	$124 / 2.5 MMBTU	$400	3.99	3.2	607.3
3	Lighting - Controls Retrofit: Office 1 T8-2 LED	Remove Manual Switching and Add new Occupancy Sensor and Improve Daylight Sensor	$48 / -0.1 MMBTU	$250	1.59	5.2	260.4
4	HVAC And DHW	At end of life of existing furnace, replace with higher efficiency model at an incremental cost of $2,000; total cost of replacement estimated to be $12,000. Add insulation blanket to hot water heater, estimated cost $200 installed.	$641 + $500 Maint. Savings / 13.4 MMBTU	$12,000	1.50	10.5	3,125.8
5	Lighting - Combined Retrofit: Hall CFL-2-A type 23W	Replace with LED 9W and Remove Manual Switching and Add new Occupancy Sensor	$39 / 0.0 MMBTU	$260	1.22	6.7	207.1
	TOTAL, cost-effective measures		**$1,452 + $500 Maint. Savings / 32.4 MMBTU**	**$12,911**	**2.20**	**6.6**	**7,039.3**
The following measures were *not* found to be cost-effective from a financial perspective, but are still recommended:							
6	Lighting - Controls Retrofit: Bathroom T8-2 LED	Remove Manual Switching and Add new Occupancy Sensor	$14 / 0.0 MMBTU	$250	0.62	18.3	73.1

Table 4.1 Fisheries Building, Kwigillingok, 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**
7	Lighting - Power Retrofit: Utility CFL-A type	Replace with LED 8W Module StdElectronic	$0 / 0.0 MMBTU	$5	0.03	445.2	0.1
	TOTAL, all measures		**$1,466 + $500 Maint. Savings / 32.4 MMBTU**	**$13,166**	**2.17**	**6.7**	**7,112.5**

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				
4	At end of life of existing furnace, replace with higher efficiency model at an incremental cost of $2,000; total cost of replacement estimated to be $12,000.				
Installation Cost	$12,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$641
Breakeven Cost	$17,974	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	13.4 MMBTU
		Savings-to-Investment Ratio	1.5	**Maintenance Savings ($/yr)**	$500
Auditors Notes:					

4.4.2 Ventilation System Measures

Rank	Description			Recommendation	
2				Add occupancy sensor to bathroom exhaust fan for $150 materials and $250 labor cost.	
Installation Cost	$400	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$124
Breakeven Cost	$1,597	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	2.5 MMBTU
		Savings-to-Investment Ratio	4.0		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Fisheries Building - Office			Implement a Heating Temperature Unoccupied Setback to 64.0 deg F for the Fisheries Building - Office space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$600
Breakeven Cost	$8,076	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	16.7 MMBTU
		Savings-to-Investment Ratio	8,076.3		
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	
5	Hall CFL-2-A type 23W	FLUOR CFL, 23 W with Manual Switching		Replace with LED 9W and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$260	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$39
Breakeven Cost	$318	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.2		
Auditors Notes: Replace (2) 23w A-type CFL bulbs with (7 or 9)w A-type LED bulbs @ $5 ea. No labor, owner to install. Add (1) switch mounted occupancy sensors @ $125 ea parts + 1 hr labor @ $125/hr.					

Rank	Location	Existing Condition		Recommendation	
7	Utility CFL-A type	FLUOR CFL, A Lamp 11W with Manual Switching		Replace with LED 8W Module StdElectronic	
Installation Cost	$5	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$
Breakeven Cost	$	**Simple Payback (yrs)**	445	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.0		
Auditors Notes: Replace (1) 11w A-type CFL bulbs with (7 or 9)w A-type LED bulbs @ $5 ea. No labor, owner to install.					

4.5.1b Lighting Measures – Lighting Controls

Rank	Location	Existing Condition		Recommendation	
3	Office 1 T8-2 LED	LED (2) 14W Module StdElectronic with Manual Switching		Remove Manual Switching and Add new Occupancy Sensor and Improve Daylight Sensor	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$48
Breakeven Cost	$396	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	1.6		
Auditors Notes: Add (1) switch mounted occupancy sensor @ $125 ea parts + 1 hr labor @ $125/hr.					

Rank	Location	Existing Condition		Recommendation	
6	Bathroom T8-2 LED	LED (2) 14W Module StdElectronic with Manual Switching		Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$14
Breakeven Cost	$155	**Simple Payback (yrs)**	18	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.6		
Auditors Notes: Add (1) switch mounted occupancy sensor @ $125 ea parts + 1 hr labor @ $125/hr.					

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
EF-2	unknown	e2000	e.33/115/1	Garage exhaust fan
VF-1	unknown	e2000	e.33/115/1	Garage ventilation fan

DHW SCHEDULE

SYMBOL	MFGR/MODEL	CAPACITY (gal.)	ELEMENT	REMARKS
HWH-1	In-Sink-Erato model W-152	2.5	12.5a/115/1	

HEAT PLANT SCHEDULE

SYMBOL	MFGR/MODEL	NOMINAL EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
F-1	American Standard Model No. AHV1M087A936SAA	82.4%	e.33/115/1	105 MBH input, Serial No. 6084523DX
Qty 2	Toyo Laser 73	87%	76w/120/1	40 MBH input

PLUMBING FIXTURES

SYMBOL	FIXTURE	GPF/GPM	QUANTITY	REMARKS
	W.C. Incinolet model TR Deluxe	n/a	1	Incinerating toilet
	Lavatory	1.75	1	

PLUG LOAD PARTIAL SUMMARY				
SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	5	200w	
	personal printer	1	85w	
	toaster oven	1	1250 w	
	Paper shredder	1	500w	
	microwave	1	1250w	
	personal coffee machine	1	500w	
	Full size residential refrigerator	1	550 kWh/yr	

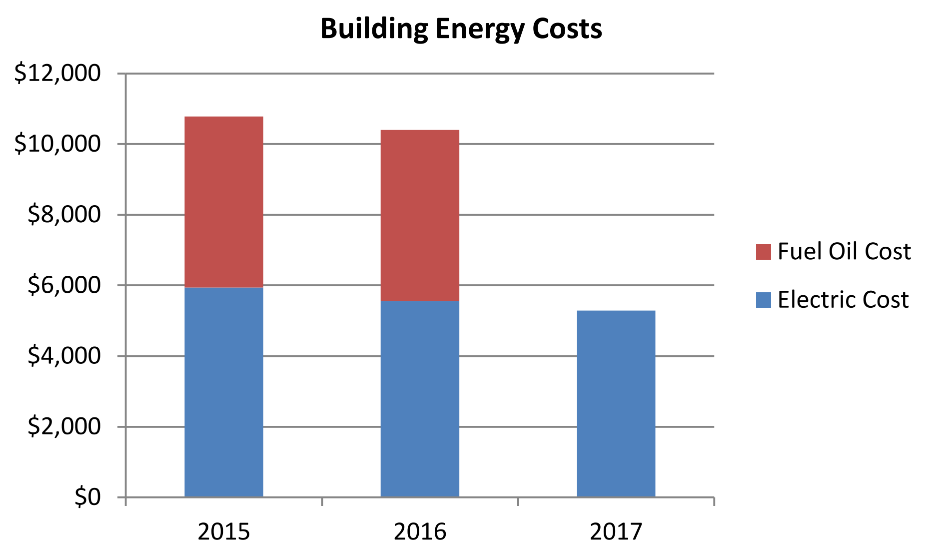
Appendix B – Benchmark Analysis and Utility Source Data

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, and fuel oil delivery data was provided for 2015 and 2016. Figures B.1 and B.2 show the 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 (prior to adjusted baseline)

FISHERIES BUILDING						
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use	Fuel oil Cost	Total kBTU's of Energy	Total Utility Cost
2015	8,999	$5,941	1,028	$4,842	166,410	$10,783
2016	8,304	$5,564	1,050	$4,841	166,942	$10,404
2017	7,947	$5,288				

Figure B.2 - Costs



Electricity: With the exception of an anomalous electric spike in November of 2015, Figure B.3 shows that the month to month consumption in this building is extremely consistent over the last 3 years. Figure B.2 shows an 8% decline in electric consumption from 2015 to 2016 and a 4% decline from 2016 to 2017.

Figure B.3 – 3 Years of monthly Electric Consumption

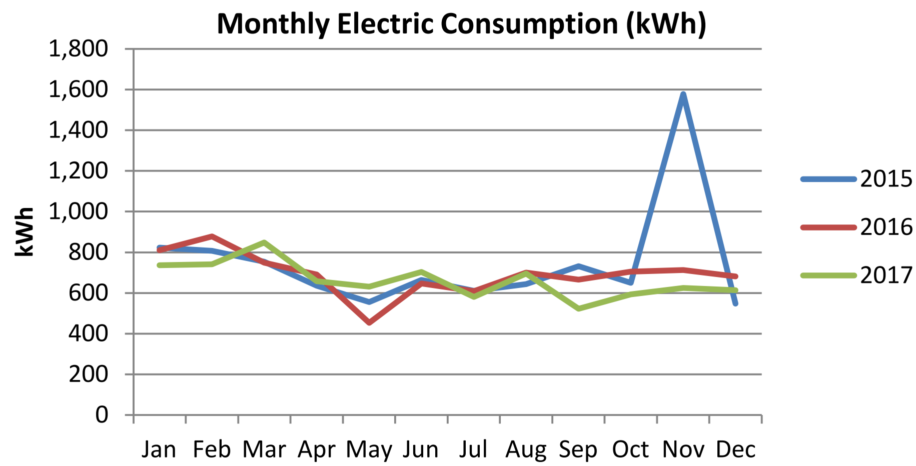
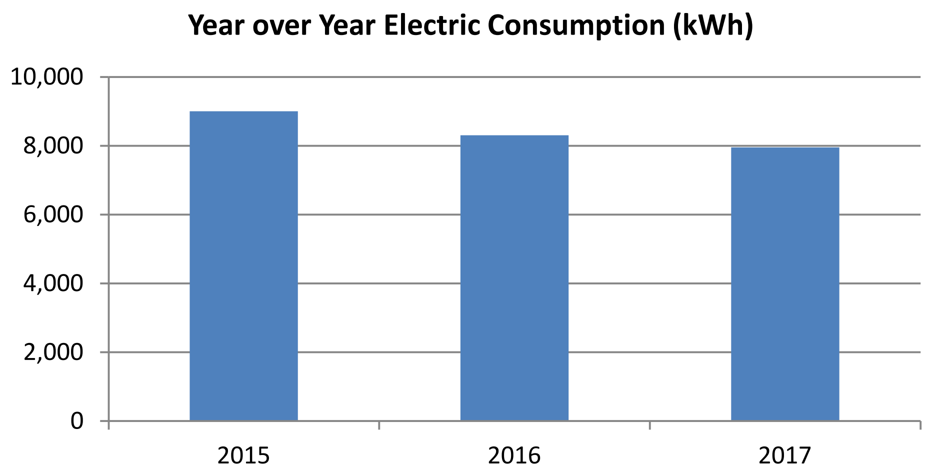
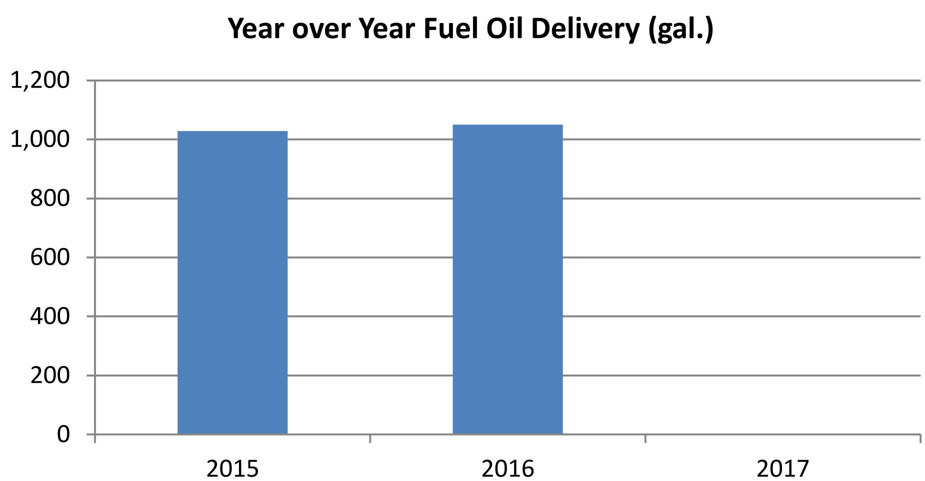


Figure B.4 – 3 years of Annual Electric Consumption



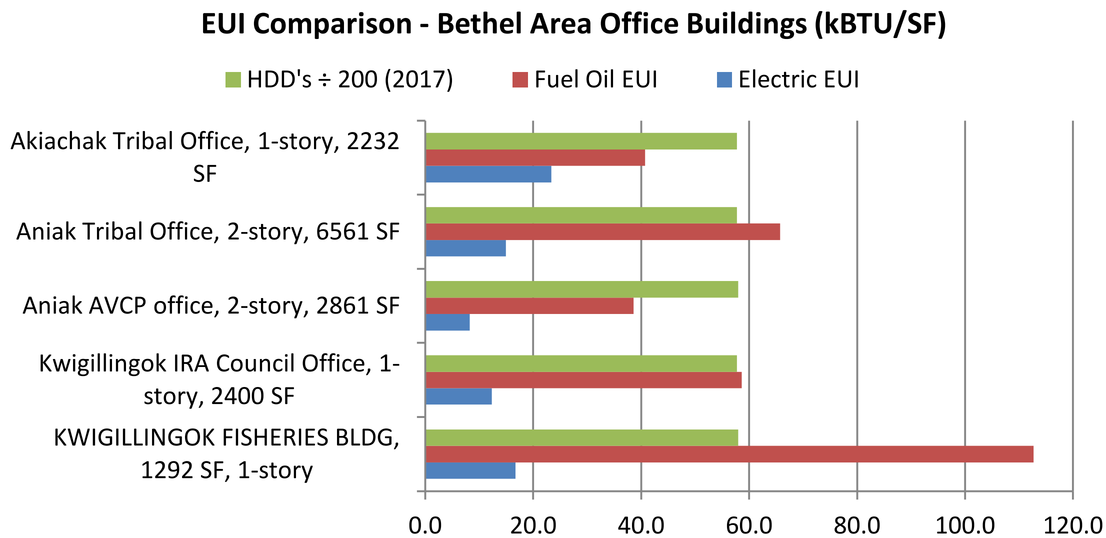
Fuel Oil: Figure B.5 shows a 3% increase in fuel oil deliveries between 2015 and 2016. No data for 2017 was provided.

Figure B.5 – 2 years of annual Fuel Oil Delivery



Comparing EUIs: Figure B.6 and the discussion in Section 1.5 above show that this building's heating system or envelope is very inefficient compared to other office buildings in the Bethel area. This is probably not attributed to the envelope, as it is in good condition. The high heating EUI is most likely attributed to two reasons: First, 60% of the building's floor space is used as a shop/garage with regular overhead door openings and a large exhaust fan. Secondly, the heating system uses forced air distribution, which is 5% to 10% less efficient than a hydronic boiler distribution system.

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, the periods for which data was available and the current use and occupancy of the building versus its historical use and occupancy. Prior to adjusting the baseline to account for the LED lighting upgrade, the benchmark baseline period selected for this building is 2016. The shaded figures below were used to calibrate the electric side of the AkWarm© model.

Figure B.6 – Benchmark Utility Data

ELECTRIC							FUEL OIL						
	2015		2016		2017			2015		2016		2017	
	kWh	Cost	kWh	Cost	kWh	Cost		gallons	Cost	gallons	Cost	gallons	Cost
Jan	823	$502	811	$543	737	$494	Jan	253	$1,192	200	$922	0	$0
Feb	807	$541	878	$588	741	$496	Feb	0	$0	0	$0	0	$0
Mar	754	$505	749	$502	848	$568	Mar	150	$707	250	$1,153	0	$0
Apr	636	$426	691	$463	657	$440	Apr	0	$0	0	$0	0	$0
May	555	$372	454	$304	631	$423	May	200	$942	150	$692	0	$0
Jun	664	$445	647	$433	703	$471	Jun	0	$0	0	$0	0	$0
Jul	611	$409	609	$408	581	$389	Jul	0	$0	0	$0	0	$0
Aug	643	$431	700	$469	695	$466	Aug	25	$118	0	$0	0	$0
Sep	731	$490	666	$446	522	$350	Sep	250	$1,178	0	$0	0	$0
Oct	650	$396	705	$472	594	$398	Oct	150	$707	0	$0	0	$0
Nov	1,578	$1,057	713	$478	624	$418	Nov	0	$0	200	$922	0	$0
Dec	547	$366	681	$456	614	$375	Dec	0	$0	250	$1,153	0	$0
Total	**8,999**	**$5,941**	**8,304**	**$5,564**	**7,947**	**$5,288**	**Total**	**1,028**	**$4,842**	**1,050**	**$4,841**	**0**	**$0**

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: Fisheries Building	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Richard John	
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350 **Auditor FAX:**
Client Phone: (907) 588-8114	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,292 square feet	**Design Space Heating Load:** Design Loss at Space: 169,292 Btu/hour with Distribution Losses: 184,229 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 280,837 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 7 people	**Design Indoor Temperature:** 72.5 deg F (building average)
Actual City: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days
Utility Information	
Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.670/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

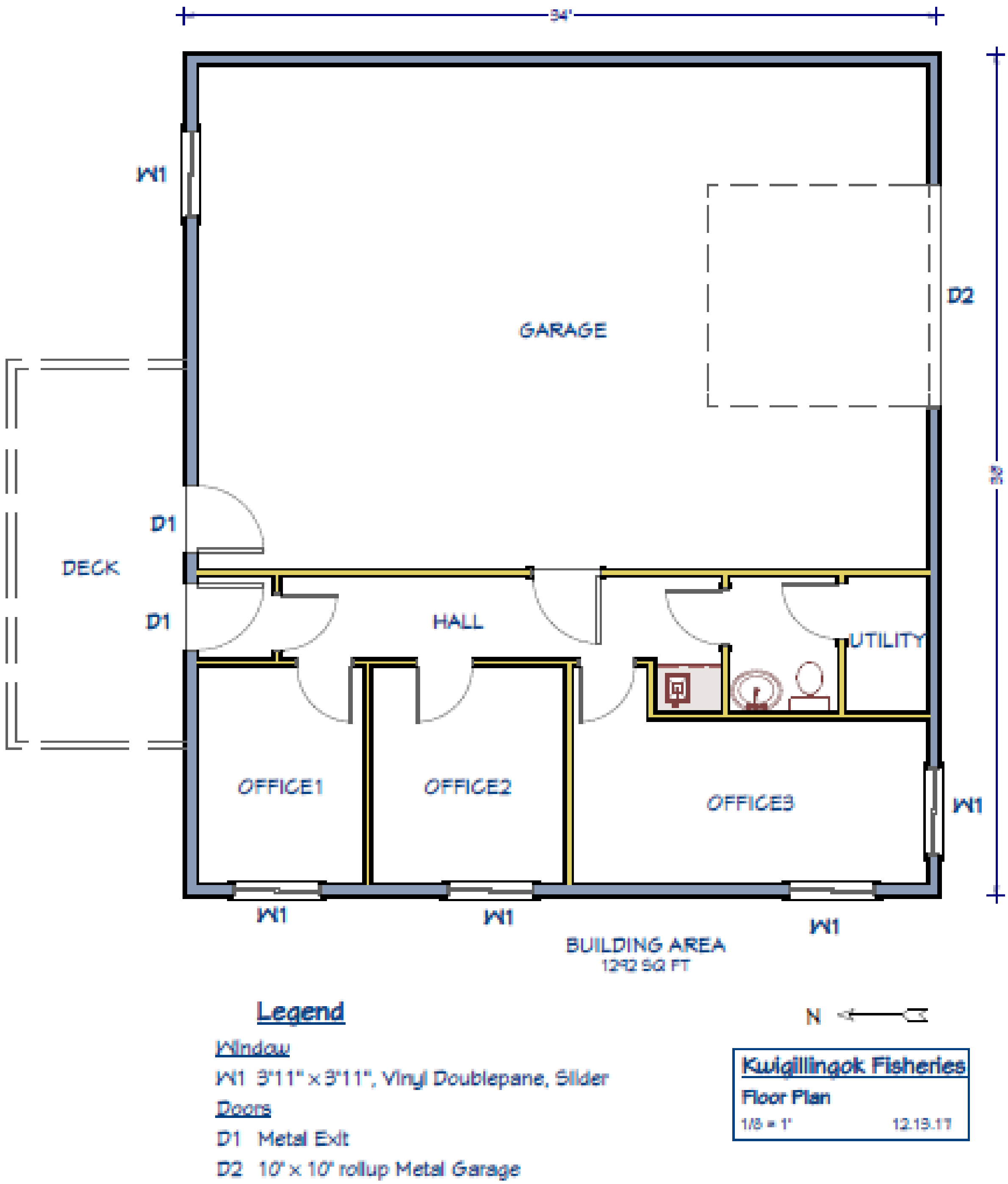
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$5,291	$0	$286	$85	$1,561	$369	$1,606	$0	**$9,198**
With Proposed Retrofits	$3,994	$0	$286	$43	$1,433	$369	$1,606	$0	**$7,731**
Savings	$1,296	$0	$0	$42	$128	$0	$0	$0	**$1,466**

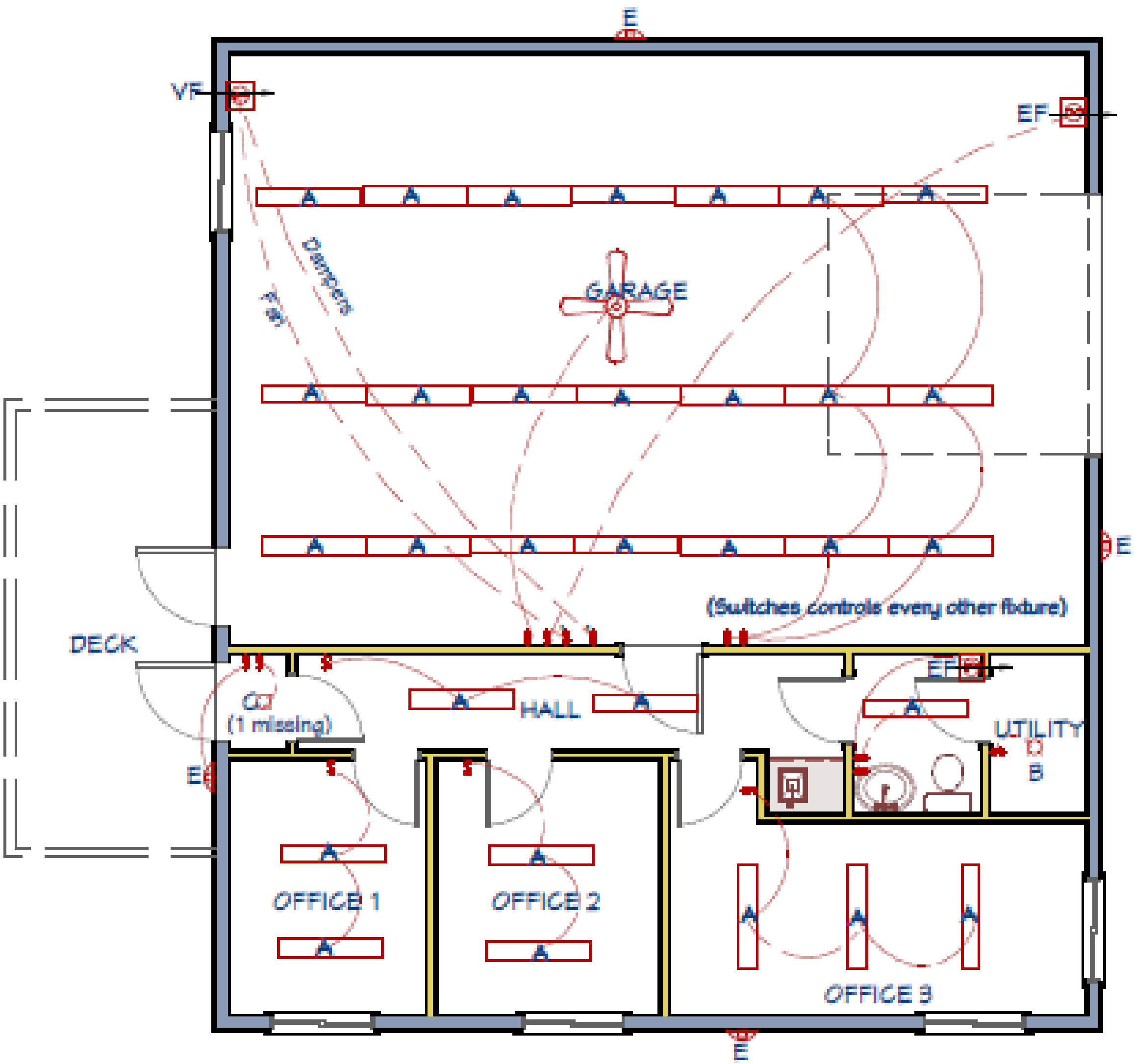
Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	129.4	11.15	$7.12
With Proposed Retrofits	104.3	8.99	$5.98

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



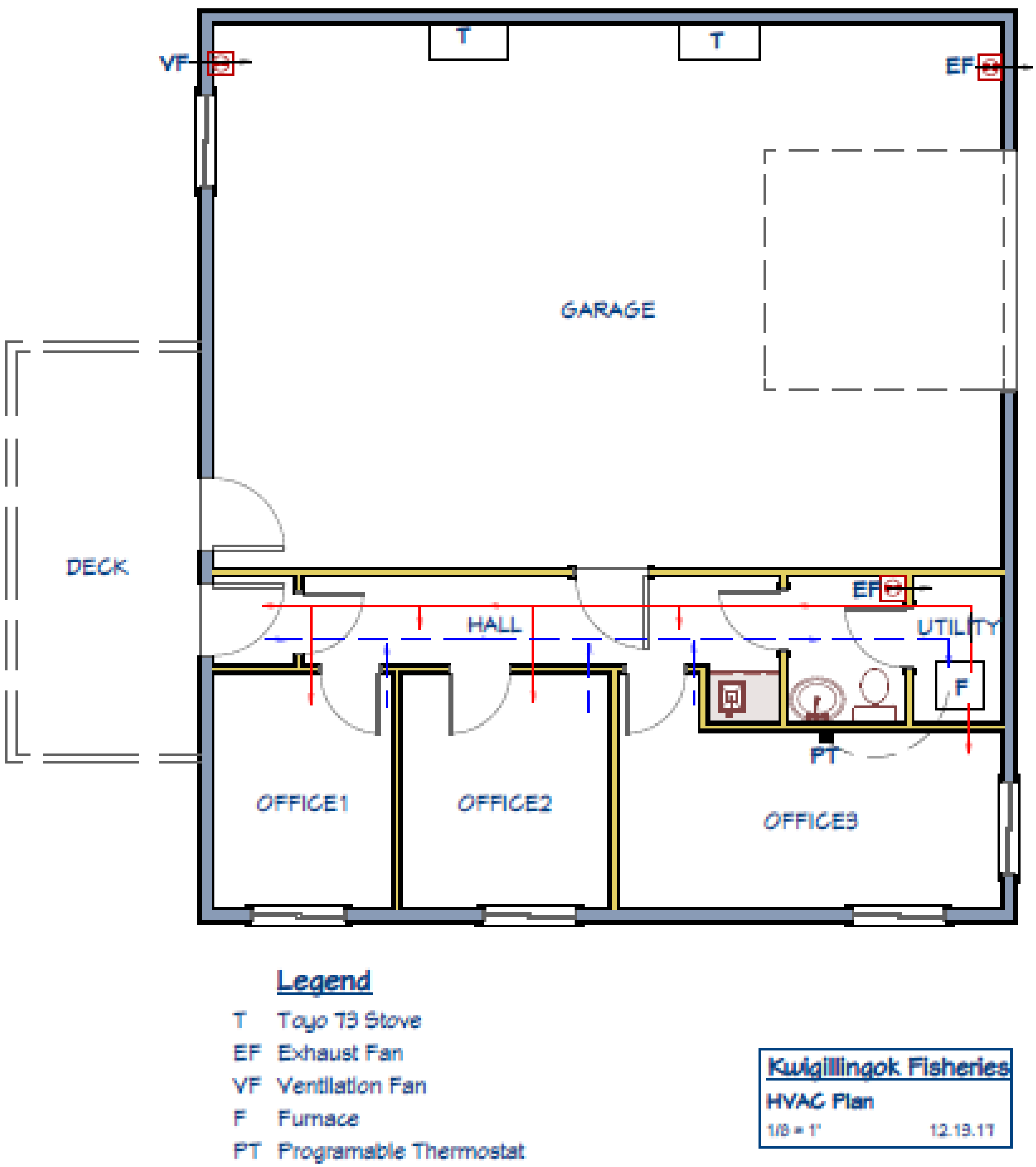


Legend

- A T8-2 lamps, LED, 14w ea. surface mount
- B CFL- A type, 11w
- C CFL- 2-A type bulbs, 23w ea. (one bulb missing)
- E Sm Wall Pack, LED est. 17w
- EF Exhaust Fan (to exterior)
- VT Ventilation Fan

N

Kuigillingok Fisheries
Lighting Plan
1/8 = 1' 12.13.17


VF
T
T
EF
GARAGE
DECK
EF
HALL
UTILITY
F
PT
OFFICE1
OFFICE2
OFFICE3
Legend
T Toyo T3 Stove
EF Exhaust Fan
VF Ventilation Fan
F Furnace
PT Programable Thermostat
Kwigillingok Fisheries
HVAC Plan
1/8 = 1'
12.13.11

Appendix E – Photographs & IR Images

Triodetic foundation shown. The lack of snow on roof indicates that insulation is not in the best condition. The IR images below support this conclusion.

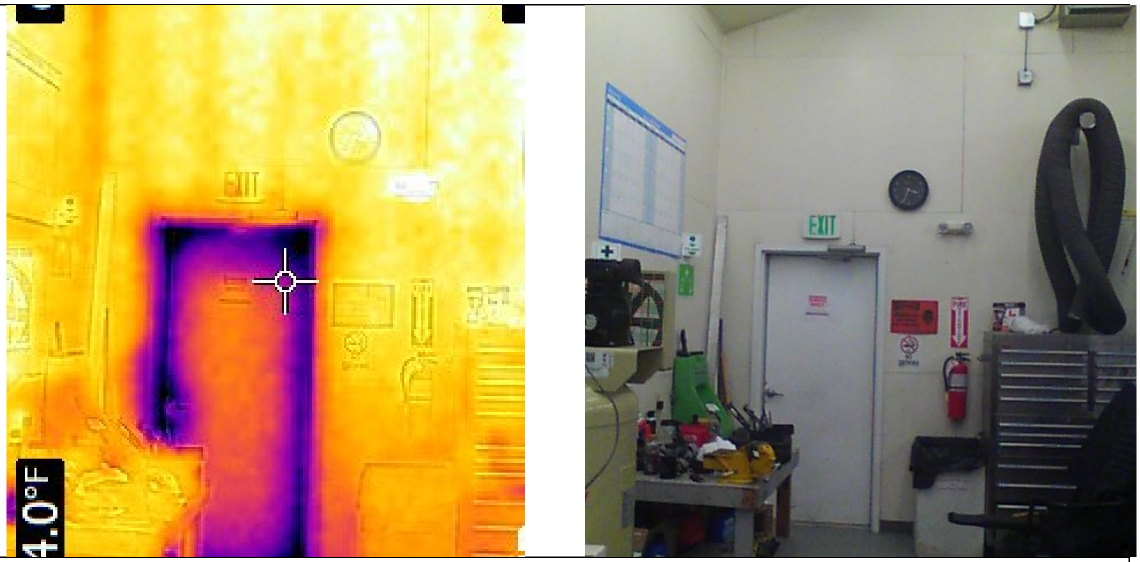
Shop, ventilation fan at top of image

On-demand electric hot water heater

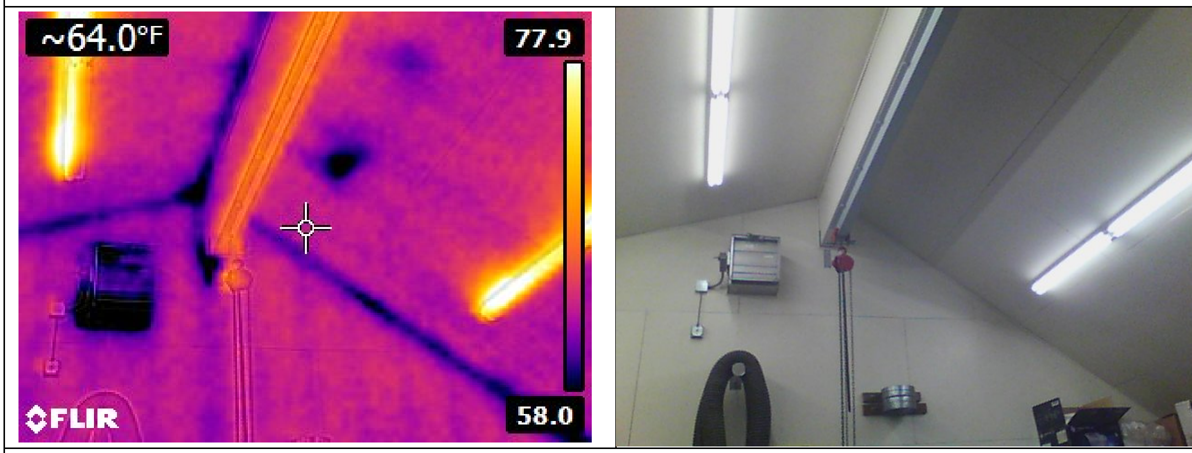
Electric incinerating toilet

Furnace; cover should be replaced

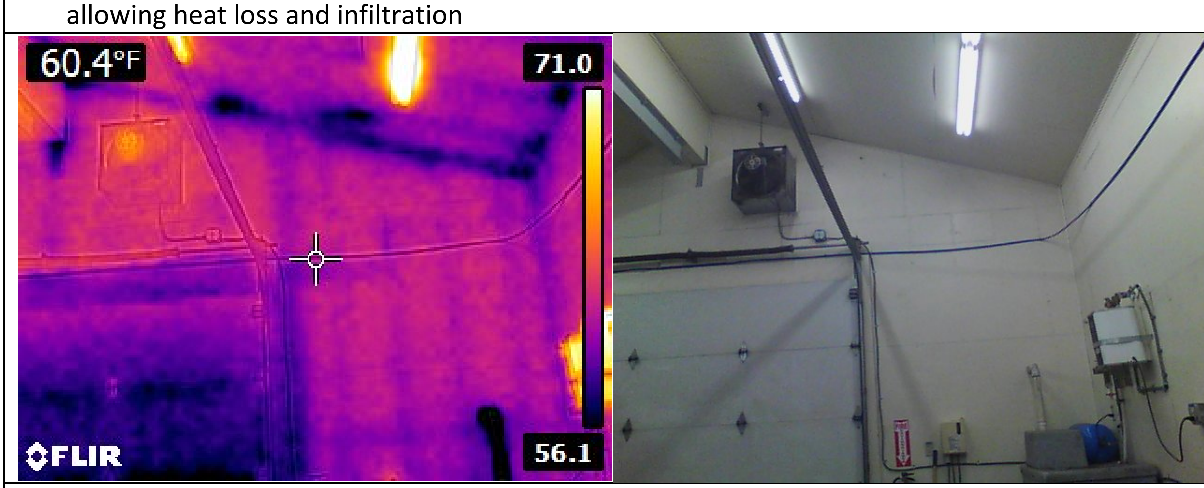
Typical office



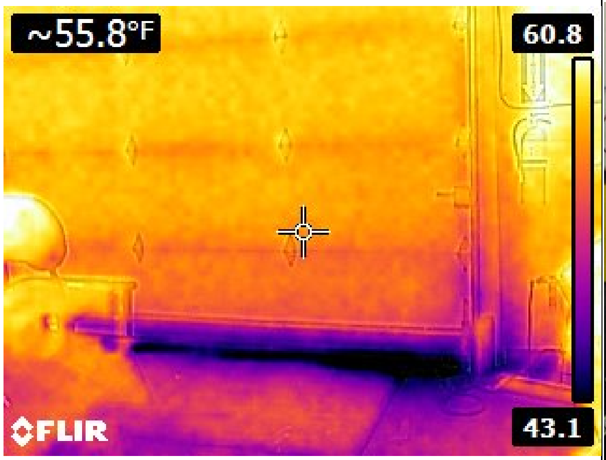
1. High heat loss around door periphery; new weather stripping and sweep would help



2. There are spots of damaged insulation in ceiling and the ventilation fan dampers are also allowing heat loss and infiltration



3. Studs, overhead door and ceiling are allowing heat loss

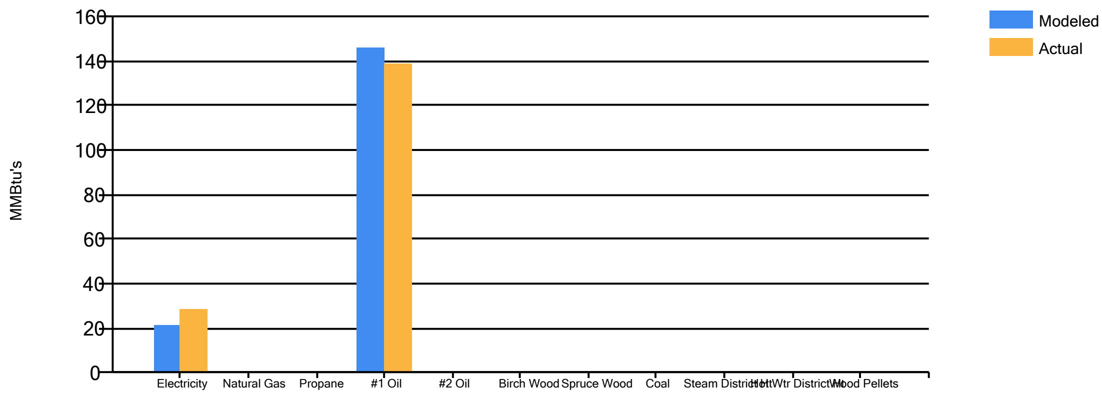


4. Overhead door could use a new sweep/bumper

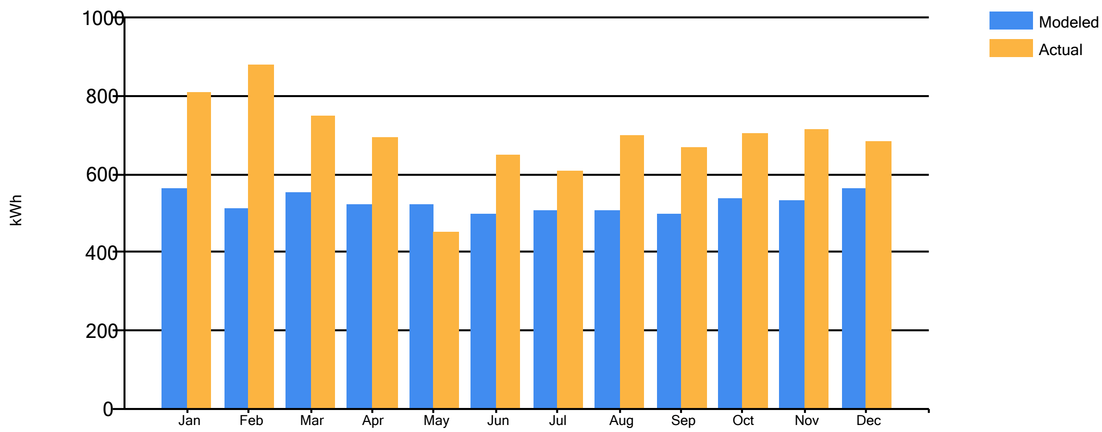
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

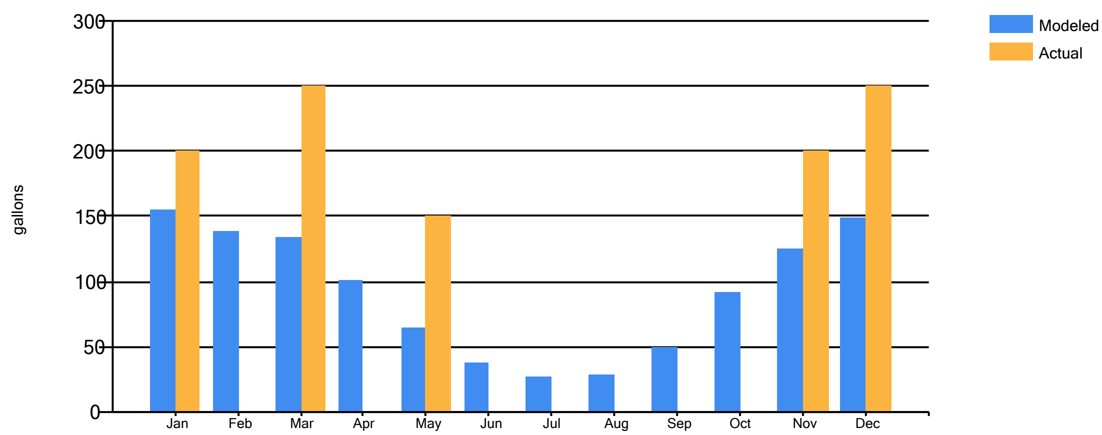
Annual Fuel Use – adjusted baseline



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 IRA Council Office

Prepared For
Native Village of Kwigillingok
Darrel T. John, Tribal Administrator
P.O. Box 90
Kwigillingok, AK 99622
kwigtribe@gmail.com
907-588-8114

Site Survey Date:
December 12, 2017

Prepared By:
James Fowler, PE, CEM
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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

New Release – October 1, 2018

Revision A – May 17, 2019

> Updated AkWarm model, recommended EEMs and this report to incorporate LED lighting upgrade performed by the building owner in October 2018.

Copy-edited version – May 24, 2019

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: Darrel John and Richard John, the tribal administrator and finance officer, Victoria Amik in the Post Office, Sherie the tribal police officer, 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. Thanks to Megan the school principal, who provided lodging.

Project Location

Post office
Clinic
IRA Council Office
Jail
Fisheries Building

NORTH

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1. SUMMARY

Revision A of this report updated the entire report to reflect that all florescent T8 lighting in the buiding was replaced by Native Village of Kwigillingok (NVK) staff in October 2018, with 14w T8, direct wire LED lamps and several occupancy sensors were installed. Current electric and oil costs were also used in this updated analysis and report.

This report was prepared for the NVK, owner of the IRA Council 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.

The site survey took place on December 12th and 13th, 2017. The outside temperature varied between 28F and 35F 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

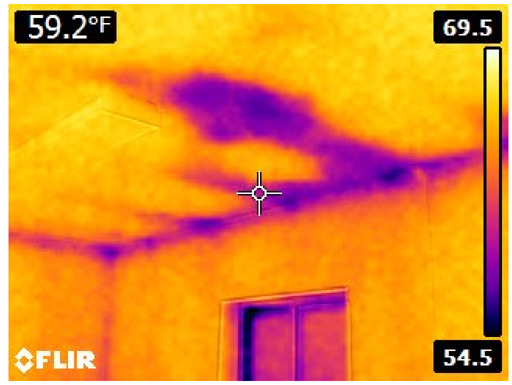
The 9 page summary is designed to contain all the information the building owner/operator should need to determine which energy improvements should be implemented, approximately how much they will cost and their estimated annual savings and simple payback. The summary discusses the subject building and 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 implemented as soon as possible:
   - Make sure the heat trace on the waste water line is off during the warmer months
   - Assure the setback feature on each of the Toyo Stoves is programmed and is re-programmed after each power outage
   - One of the Toyo Stoves is showing an error EE6, which indicates a fuel obstruction, this should be rectified for full performance.
   - The attic insulation is in very poor condition (see IR image at right). All of the storage items in the attic should be removed and stored elsewhere and new R-42 (minimum) should be installed (see EEM #10 in Table 1.1).
   - Switch mounted occupancy sensors should be added to each of the offices that is intermittently occupied.



b. <u>If all the recommended EEMs are incorporated in this building, there will be a 32.9% reduction in energy costs, totaling $3,682, with a simple payback of 5.9 years on the $21,785 implementation cost</u>.

c. Fuel oil delivery data for this building was estimated by the building owner to be 829 gallons in 2017. Given the condition and use of the building, this figure appears to be too low, so the AkWarm-C model was not calibrated to this figure. The model results in an annual oil consumption of 1027 gallons; this is the figure used to predict energy savings in this analysis.

d. It was assumed in this analysis, that electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by qualified electricians. <u>It should be noted that regulatory listings on certain light fixtures may be invalidated if re-wiring is not performed by a qualified electrician</u>.

e. Install a cumulative fuel oil meter on the oil line serving the furnace and hot water heater and record consumption monthly.

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 AkWarm-C© energy model calibrated to electric consumption but uncalibrated to actual fuel oil consumption[1], the total predicted energy costs are $11,155 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$4,997 for Electricity
$6,159 for #1 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	7,458 kWh	6,698 kWh
#1 Oil	1,082 gallons	527 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	$0.67	$196.30
Fuel Oil	$5.69	$43.11

Figure 1.1

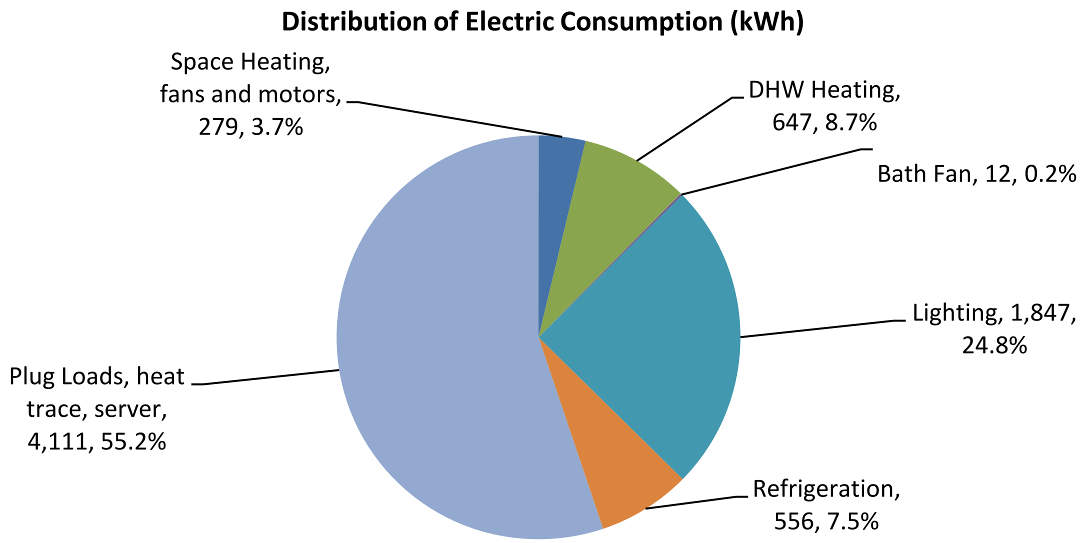
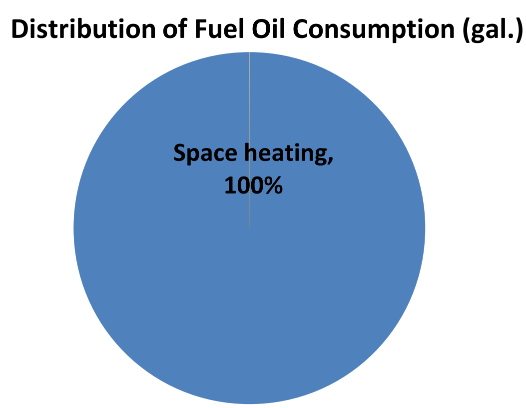


Figure 1.2



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

Based on this breakdown, it is clear that efficiency efforts should be focused primarily on space heating, lighting and controlling the heat trace on the waste water line.

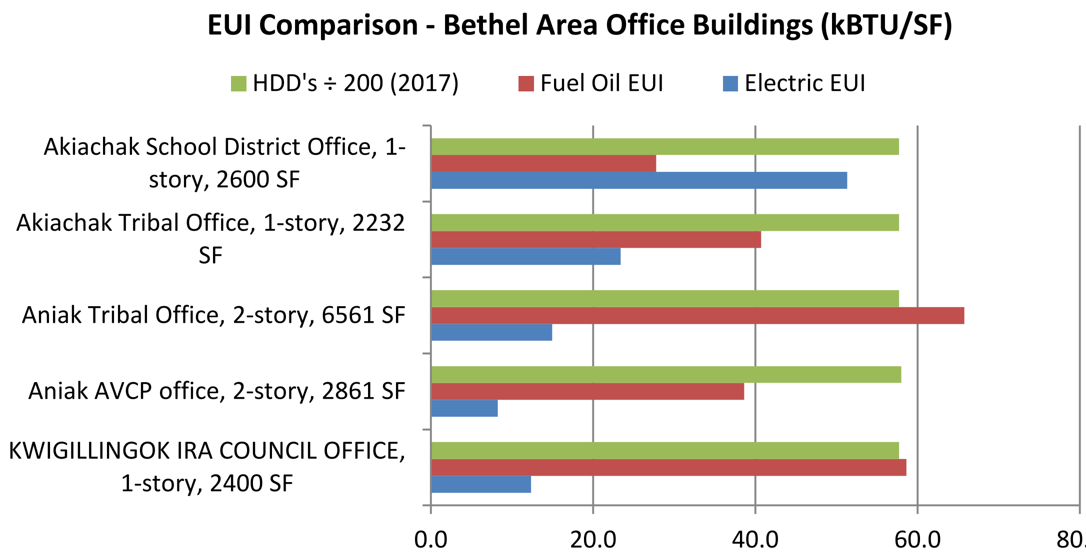
1.4 Benchmark Summary

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	70.1	6.05	$4.65
With Proposed Retrofits	38.5	3.32	$3.12
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 below, the subject building's heating EUI is second only to the Aniak Tribal office and is 26% higher than the average of all the office buildings. The subject building's electric EUI, on the other hand, is lower than all but one of the comparison buildings, and 45% lower than the average of all the office buildings. Additional discussion is provided in Appendix B.



[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.

1.6 Energy Efficiency Measures

A summary of the recommended EEMs and their associated costs are shown in Figure 1.3. The existing fuel oil consumption in Figure 1.3 is the figure predicted by the AkWarm-C model, as the actual 829 gallon figure obtained from the owner's Quickbooks report is suspected to be too low. Figure 1.4 shows the reduction in cost, consumption and BTU's of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in Figure 1.3 but not in Figure 1.4.

Figure 1.3

	Installed Cost	Energy & Maint. Savings	Simple Payback (yrs.)
HVAC related	$498	$1,126	0.4
Envelope	$19,779	$2,165	9.1
Heat Trace controls	$1,000	$37	27.0
Lighting	$508	$354	1.4
Totals	**$21,785**	**$3,682**	**5.9**

Figure 1.4

	Existing conditions (uncalibrated AkWarm-C model for oil)		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	7,458	25,454	6,698	22,860	10.2%
Gallons Oil	1,082	142,824	527	69,564	51.3%
Energy Cost	$11,155		$7,484		34.2%

Tables 1.1 below and Table 4.1 in section 4 summarize the energy efficiency measures analyzed for the IRA Council Office. Estimates of annual energy and maintenance savings, installed costs, SIR, CO2 savings, and simple paybacks are shown for each EEM. The $1 cost indicates that there is no appreciable cost to implement the EEM, but 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	Setback Thermostat: Office	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Office space.	$809 / 18.3 MMBTU	$1	10933.92	0.0	3,040.2

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**
2	Setback Thermostat: Seldom used offices #3, 4, 6, 7 & 8	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Seldom used offices #3, 4, 6, 7 & 8 space.	$232 / 5.2 MMBTU	$1	3129.99	0.0	870.3
3	Lighting - Combined Retrofit: Outdoor HID 100w	Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	$204 + $5 Maint. Savings / 1.0 MMBTU	$251	7.02	1.2	1,066.5
4	Lighting - Combined Retrofit: Outdoor INCAN 75w	Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	$148 + $5 Maint. Savings / 0.8 MMBTU	$251	5.15	1.6	774.7
5	HVAC And DHW	Add an R-9 insulating blanket to hot water heater, estimated cost $50 parts + 1 hr labor @ $45/hr	$17 / 0.0 MMBTU	$95	2.49	5.5	98.3
6	Ventilation	Replace bath fan with model with integral occupancy and humidity sensor for $150 materials and $250 labor cost.	$68 / 1.4 MMBTU	$400	2.25	5.9	265.4
7	Ceiling w/ Attic: Ceiling	Add R-42 blown cellulose insulation to attic with Standard Truss.	$1,500 / 34.0 MMBTU	$16,041	2.20	10.7	5,636.7
8	Air Tightening	Perform air sealing to reduce air leakage by 50%.	$607 / 13.7 MMBTU	$3,000	1.87	4.9	2,279.2
9	Window/Skylight: W1 Boarded	Replace existing window with U-0.22 vinyl window.	$58 / 1.3 MMBTU	$738	1.36	12.7	217.8
	TOTAL, cost-effective measures		**$3,643 + $10 Maint. Savings / 75.8 MMBTU**	**$20,779**	**2.90**	**5.7**	**14,249.1**
The following measures (if any are listed) were *not* found to be cost-effective but are still recommended:							
10	Other Electrical - Controls Retrofit: Heat Trace	Remove Manual Switching and Add new Clock Timer or Other Scheduling Control	$37 / 0.2 MMBTU	$1,000	0.31	27.1	193.0
11	Lighting - Combined Retrofit: Artic Entry - No Bulb 60W	Replace with LED 7W Module StdElectronic and Improve Manual Switching	-$8 / 0.0 MMBTU	$6	-8.22	999.9	-44.7
	TOTAL, all measures		**$3,672 + $10 Maint. Savings / 76.0 MMBTU**	**$21,785**	**2.78**	**5.9**	**14,397.4**

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 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	$6,347	$0	$435	$10	$1,238	$373	$2,753	$0	**$11,155**
With Proposed Retrofits	$3,086	$0	$412	$3	$895	$373	$2,716	$0	**$7,484**
Savings	$3,261	$0	$23	$8	$343	$0	$37	$0	**$3,672**

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

    d. Keep refrigeration coils clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the IRA Council 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 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 IRA Council 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.

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

1) Office: 1,890 square feet
2) Seldom used offices #3, 4, 6, 7 & 8: 510 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. Costs are considered to be accurate within +/-30% in this level of audit; 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:

- 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. IRA COUNCIL OFFICE EXISTING CONDITIONS

3.1. Building Description

The single story 2,400 square foot IRA Council Office was constructed in 1982. Based on its configuration, it appears that the east portion of the building may have been original and the west half, under the shed roof, may have been added at a later date. The building is used as offices from 8:00am until 6:00pm Monday through Friday and has a normal occupancy of 14 people including visitors. Offices 3, 6, 7 and 8 (see floorplan in Appendix D) are only occupied from 10:00am until 4:00pm.

Description of Building Shell

No plans or drawings were available for this building, so the details below are either assumed or based on observation. The building is constructed on wood pilings which support 4” x 8” beams which support 2” x 8” floor joists. The floor joist cavities are presumed to be filled with R-25 fiberglass batt.

The walls are constructed with 2” x 6” wood studs, 16” OC whose cavities are presumed to be filled with R-19 batt. Exterior walls are finished with T1-11 plywood siding and interior walls are finished with plywood. The windows utilize double glazing in either vinyl or wood frames. The wood-framed windows are in very poor condition (photo above right).

The vented attic is used for storage and the fiberglass batt, formerly with an insulation value of R-19 to R-25, has been disturbed and compressed and is now estimated to have an insulation value of R-14. The roof is supported by wood trusses and is covered with painted metal. As seen in the photo above left, the snow is nearly melted (in contrast to the arctic entry roof), further indicating that the attic insulation is in poor condition.

Description of Heating and Cooling Plants

Toyo-72

Nameplate Information:	Toyo Laser 72
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new is 87%; de-rated to 82% for age

Toyo-73

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Reading Error EE6. This is due to a fuel obstruction, fix for full performance. Nominal thermal efficiency when new is 87%; de-rated to 82% for age

HWH

Nameplate Information:	American Water Heater Company Model: E61-12U-015SV Serial: 03117135626
Fuel Type:	Electricity
Input Rating:	0 BTU/hr
Steady State Efficiency:	100 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

Space Heating and Cooling Distribution Systems

All building heat is provided by (2) Toyo Stoves, so there is no distribution system. The original building appears to have had a forced air furnace with distribution through ceiling ductwork.

Building Ventilation System

There is no mechanical ventilation in this building, fresh air is provided by operable windows.

HVAC Controls

Each Toyo Stove has its own thermostat and integral controls.

Domestic Hot Water System

DHW is provided by 12 gallon storage, electric water heater located in the bathroom. There does not appear to be a DHW re-circulation pump in use.

Lighting

At the time of the site survey, the interior lighting consists of 2-lamp, 48" fixtures utilizing T8 florescent lamps and electronic ballasts and no lighting controls appear to be in use. As previously mentioned, all of the interior lighting was upgraded by NVK staff to line voltage (direct wire) T8 LED lamps in October 2018 and several occupancy sensors were installed in offices. Exterior lighting consists of a mixture of fixtures utilizing A-type incandescent bulbs and HID wall packs.

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: Kwig Power Company - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.6700/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

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

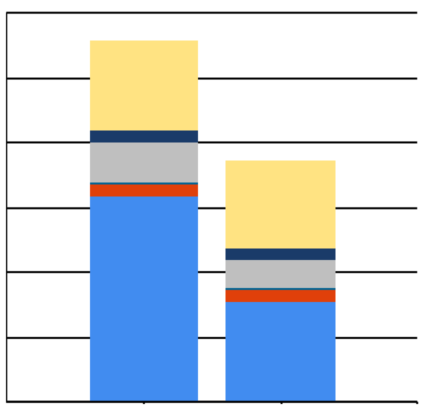


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

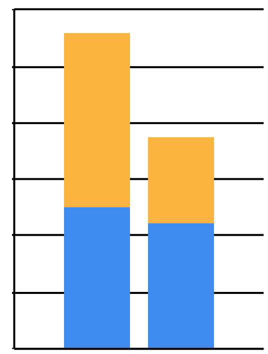
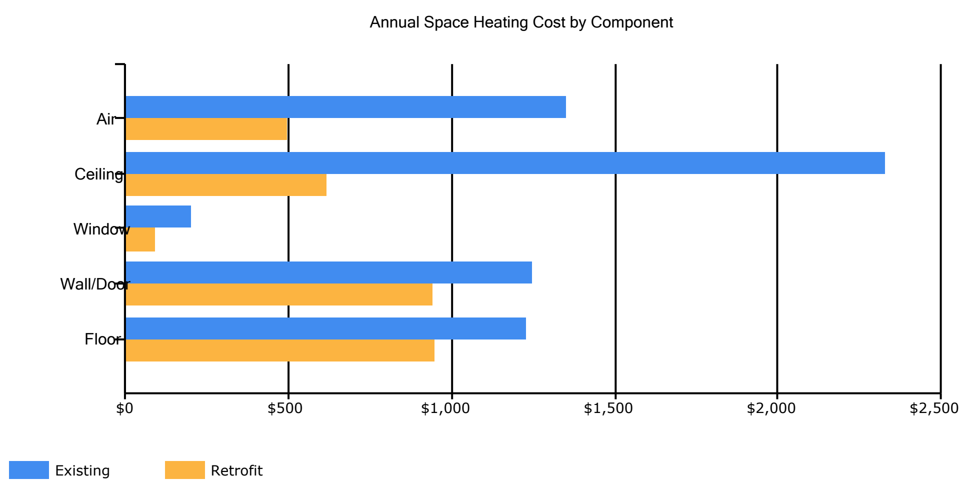


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	39	35	34	26	17	10	7	8	12	23	31	37
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	55	50	55	53	55	53	55	55	53	55	53	55
Ventilation_Fans	1	1	1	1	1	1	1	1	1	1	1	1
Lighting	157	143	157	152	157	152	157	157	152	157	152	154
Refrigeration	47	43	47	46	47	46	47	47	46	47	46	47
Other_Electrical	382	348	382	306	316	306	316	316	306	382	369	382

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	150	134	132	99	66	40	29	31	48	90	121	143
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):

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
IRA Council 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	7,458 kWh	25,453	3.340	85,011
#1 Oil	1,082 gallons	142,872	1.010	144,301
Total		**168,324**		**229,312**
BUILDING AREA		2,400	Square Feet	
BUILDING SITE EUI		70	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		96	**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	**70.1**	**6.05**	**$4.65**
With Proposed Retrofits	**38.5**	**3.32**	**$3.12**
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
IRA Council Office, Kwigillingok, 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	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Office space.	$809 / 18.3 MMBTU	$1	10933.92	0.0	3,040.2
2	Setback Thermostat: Seldom used offices #3, 4, 6, 7 & 8	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Seldom used offices #3, 4, 6, 7 & 8 space.	$232 / 5.2 MMBTU	$1	3129.99	0.0	870.3
3	Lighting - Combined Retrofit: Outdoor HID 100w	Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	$204 + $5 Maint. Savings / 1.0 MMBTU	$251	7.02	1.2	1,066.5
4	Lighting - Combined Retrofit: Outdoor INCAN 75w	Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	$148 + $5 Maint. Savings / 0.8 MMBTU	$251	5.15	1.6	774.7
5	HVAC And DHW	Add an R-9 insulating blanket to hot water heater, estimated cost $50 parts + 1 hr labor @ $45/hr	$17 / 0.0 MMBTU	$95	2.49	5.5	98.3
6	Ventilation	Replace bath fan with model with integral occupancy and humidity sensor for $150 materials and $250 labor cost.	$68 / 1.4 MMBTU	$400	2.25	5.9	265.4
7	Ceiling w/ Attic: Ceiling	Add R-42 blown cellulose insulation to attic with Standard Truss.	$1,500 / 34.0 MMBTU	$16,041	2.20	10.7	5,636.7
8	Air Tightening	Perform air sealing to reduce air leakage by 50%.	$607 / 13.7 MMBTU	$3,000	1.87	4.9	2,279.2
9	Window/Skylight: W1 Boarded	Replace existing window with U-0.22 vinyl window.	$58 / 1.3 MMBTU	$738	1.36	12.7	217.8

Table 4.1 IRA Council Office, Kwigillingok, 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**
	TOTAL, cost-effective measures		**$3,643 + $10 Maint. Savings / 75.8 MMBTU**	**$20,779**	**2.90**	**5.7**	**14,249.1**
The following measures (if any are listed) were *not* found to be cost-effective:							
10	Other Electrical - Controls Retrofit: Heat Trace	Remove Manual Switching and Add new Clock Timer or Other Scheduling Control	$37 / 0.2 MMBTU	$1,000	0.31	27.1	193.0
11	Lighting - Combined Retrofit: Artic Entry - No Bulb 60W	Replace with LED 7W Module StdElectronic and Improve Manual Switching	-$8 / 0.0 MMBTU	$6	-8.22	999.9	-44.7
	TOTAL, all measures		**$3,672 + $10 Maint. Savings / 76.0 MMBTU**	**$21,785**	**2.78**	**5.9**	**14,397.4**

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	
7	Ceiling w/ Attic: Ceiling	Framing Type: Standard Framing Spacing: 24 inches Insulated Sheathing: None Bottom Insulation Layer: R-19 Batt:FG or RW, 6 inches Top Insulation Layer: None Insulation Quality: Very Damaged Modeled R-Value: 14.6		Add R-42 blown cellulose insulation to attic with Standard Truss.	
Installation Cost	$16,041	**Estimated Life of Measure (yrs)**	30	**Energy Savings ($/yr)**	$1,500
Breakeven Cost	$35,364	**Simple Payback (yrs)**	11	**Energy Savings (MMBTU/yr)**	34.0 MMBTU
		Savings-to-Investment Ratio	2.2		
Auditors Notes: Remove stored items in attic and debris, do not store items in attic after insulation is blown in. Blow in R-42 cellulose or install R-38 batt. Add insulation to access hatch.					

4.3.2 Window Measures

Rank	Location	Size/Type, Condition		Recommendation	
9	Window/Skylight: W1 Boarded	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-0.22 vinyl window.	
Installation Cost	$738	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$58
Breakeven Cost	$1,005	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	1.3 MMBTU
		Savings-to-Investment Ratio	1.4		
Auditors Notes: Window boarded up consider replacing with newer double pane window.					

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)	
8			Air Tightness estimated as: 1250 cfm at 50 Pascals		Perform air sealing to reduce air leakage by 50%.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$607	
Breakeven Cost	$5,624	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	13.7 MMBTU	
		Savings-to-Investment Ratio	1.9			
Auditors Notes:						

4.4 Mechanical Equipment Measures

4.4.1 Heating/Cooling/Domestic Hot Water Measure

Rank	Recommendation				
5	Add an R-9 insulating blanket to hot water heater, estaimted cost $50 parts + 1 hr labor @ $45/hr				
Installation Cost	$95	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$17
Breakeven Cost	$236	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	2.5		
Auditors Notes:					

4.4.2 Ventilation System Measures

Rank	Description			Recommendation	
6				Replace bath fan with model with integral occupancy and humidity sensor for $150 materials and $250 labor cost.	
Installation Cost	$400	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$68
Breakeven Cost	$901	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	1.4 MMBTU
		Savings-to-Investment Ratio	2.3		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Office			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Office space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$809
Breakeven Cost	$10,934	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	18.3 MMBTU
		Savings-to-Investment Ratio	10,933.9		
Auditors Notes:					

Rank	Building Space			Recommendation	
2	Seldom used offices #3, 4, 6, 7 & 8			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Seldom used offices #3, 4, 6, 7 & 8 space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$232
Breakeven Cost	$3,130	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	5.2 MMBTU
		Savings-to-Investment Ratio	3,130.0		
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	
3	Outdoor HID 100w	HPS 100 Watt StdElectronic with Manual Switching		Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	
Installation Cost	$251	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$204
Breakeven Cost	$1,762	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	1.0 MMBTU
		Savings-to-Investment Ratio	7.0	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Replace (1) 100w HPS fixtures with new 17w LED fixture(s) with integral photocell sensor @ parts cost of $125 ea + 1 hr labor ea. @ $125/hr. Maintenance savings $5/fixture					

Rank	Location	Existing Condition		Recommendation	
4	Outdoor INCAN 75w	INCAN A Lamp, Halogen 75W with Manual Switching		Replace with LED 17W Module StdElectronic and Remove Manual Switching and Add new Daylight Sensor	
Installation Cost	$251	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$148
Breakeven Cost	$1,291	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	0.8 MMBTU
		Savings-to-Investment Ratio	5.1	**Maintenance Savings ($/yr)**	$5
Auditors Notes: Replace (1) 75w HPS fixtures with new 17w LED fixture(s) with integral photocell sensor @ parts cost of $125 ea + 1 hr labor ea. @ $125/hr. Maintenance savings $5/fixture					

Rank	Location		Existing Condition		Recommendation	
11	Artic Entry - No Bulb 60W		INCAN A Lamp, Halogen 60W with Manual Switching		Replace with LED 7W Module StdElectronic and Improve Manual Switching	
Installation Cost		$6	**Estimated Life of Measure (yrs)**	7	**Energy Savings ($/yr)**	-$8
Breakeven Cost		-$49	**Simple Payback (yrs)**	1000	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	-8.2		
Auditors Notes: Replace (1) A-type incandescent bulbs with (7 or 9)w 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

Rank	Location		Description of Existing		Efficiency Recommendation	
10	Heat Trace		Heat Trace with Manual Switching		Remove Manual Switching and Add new Clock Timer or Other Scheduling Control	
Installation Cost		$1,000	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$37
Breakeven Cost		$311	**Simple Payback (yrs)**	27	**Energy Savings (MMBTU/yr)**	0.2 MMBTU
			Savings-to-Investment Ratio	0.3		
Auditors Notes: Install remote bulb thermostat, to only enable heat trace when outside temperatures are below 35F; this is estimated to reduce "on" time by 12%. Estimated cost $1000 installed. 12% of winter temperatures are below 35F.						

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	e85	e15/120/1	bathroom fan

PUMP SCHEDULE

SYMBOL	MFGR/MODEL	GPM @ HD	MOTOR DATA HP/VOLTS/PH	REMARKS
Well Pump	Shurflow model 2088-94-144	3 @ 3	172.6w/115/1	

HEAT PLANT SCHEDULE

SYMBOL	MFGR/MODEL	EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
T-1	Toyo Laser 72	87%	76w/115/1%	de-rated to 82% thermal efficiency based on age
T-2	Toyo Laser 73	87%	76w/115/1%	de-rated to 82% thermal efficiency based on age

HOT WATER HEATER SCHEDULE

SYMBOL	MFGR/MODEL	GALLONS	NUMBER OF ELEMENTS	ELEMENT SIZE
HWH-1	American Water Heater Company Model: E61-12U-015SV	12	(1) 1500w	Serial: 03117135626

PLUMBING FIXTURES

SYMBOL	FIXTURE	GPF	QUANTITY	REMARKS
	W.C.	n/a	1	RV type WC

PLUG LOAD PARTIAL SUMMARY				
SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	14	200w	
	Personal printers	9	85w	
	Medium printer	1	125w	
	large copy/scan/fax machines	1	1250 w	
	Paper shredder	3	500w	
	Personal coffee machine	1	1200w	
	Microwaves	1	1000w	
	White Westinghouse refrigerator, model ATG173NLW1	1	556 kWh/yr	manufactured 1991
	Server, UPS, Hubs, ethernet switches	1	est 120 w	

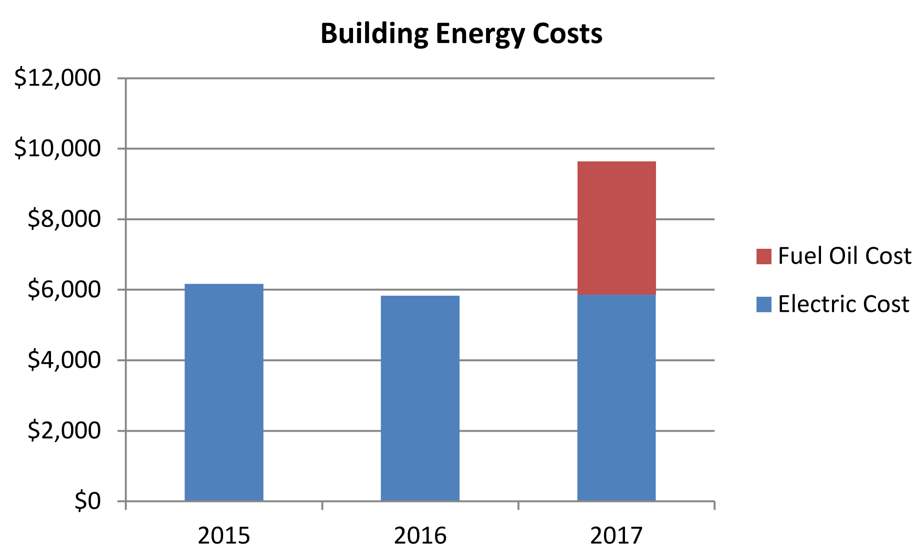
Appendix B – Benchmark Analysis and Utility Source Data

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 only one year of fuel oil delivery data was available, and that data was obtained from the accounting system, and appears to be suspect. Therefore, the fuel oil use predicted by the AkWarm-C model was used. Figures B.1 and B.2 show the 3-year summary (for electricity) of consumption and costs for this facility. The shaded cells represent the data used in the AkWarm-C model. This benchmark analysis was not updated for Revision A of this analysis.

Figure B.1 – Total Building Energy Consumption and Costs

IRA COUNCIL 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	9,279	$6,165				
2016	8,698	$5,828	1,050	$4,725	134,686	$10,553
2017	8,597	$5,860				

Figure B.2 - Costs



Electricity: The zero meter reading in August 2017 appears to be a meter reading error. Figure B.4 shows a 6% decline in electric consumption from 2015 to 2016 and a 1% decline from 2016 to 2017. Figure B.3 shows a fairly consistent monthly consumption throughout the year as expected in an office building.

Figure B.3 – 3 Years of monthly Electric Consumption

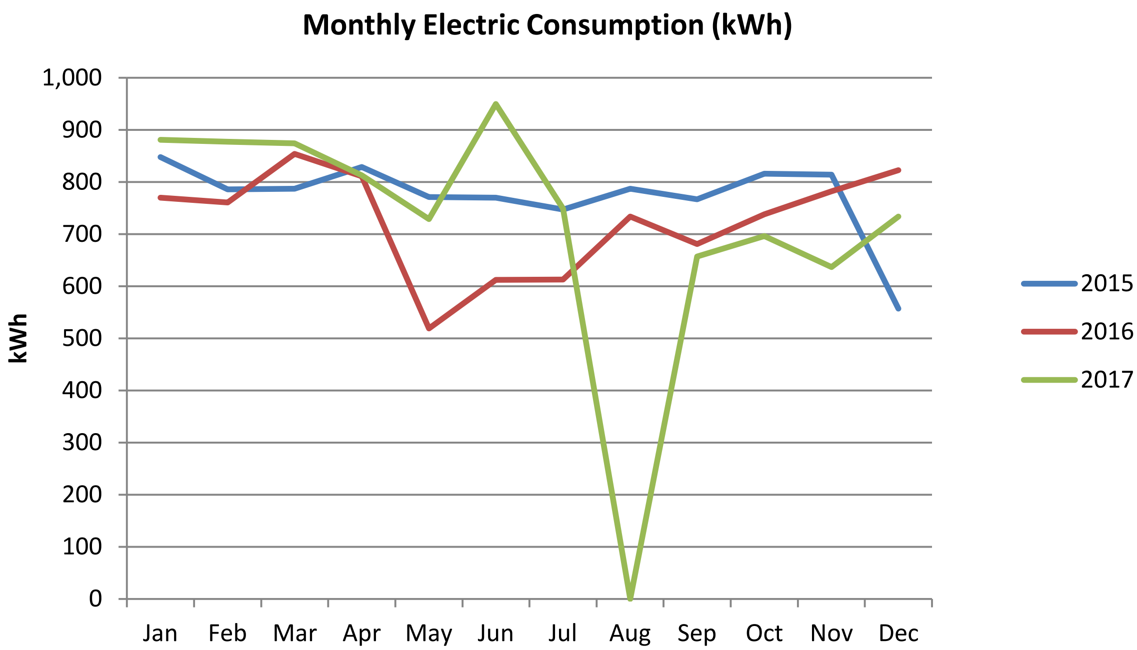
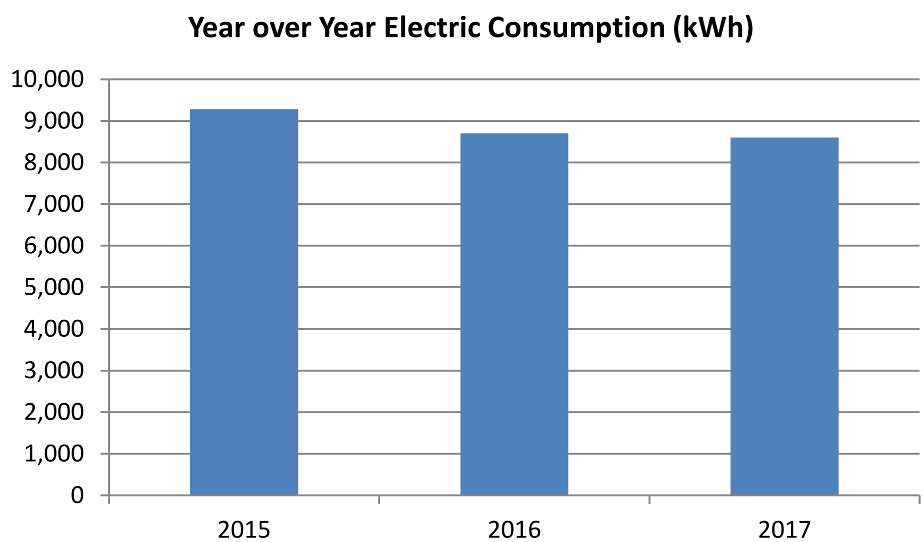


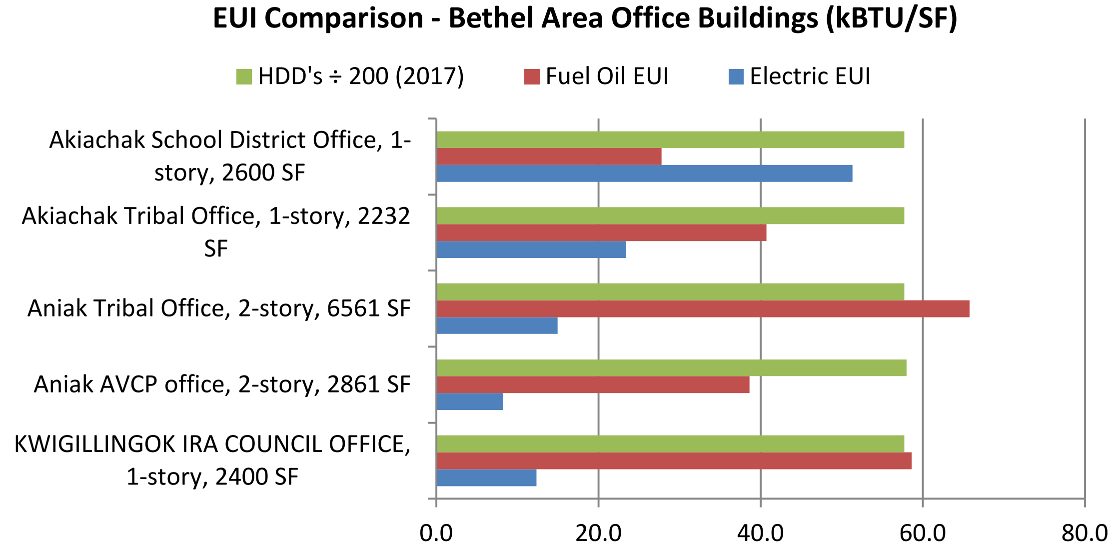
Figure B.4 – 3 years of Annual Electric Consumption



Fuel Oil: Because no oil delivery data was provided, no benchmarking can be performed on this building. As previously mentioned, the single year of data was obtained from the accounting software and is suspect because the records were inconsistent.

Comparing EUIs: Figure B.5 and the discussion in Section 1.5 above show that either this building's heating system or envelope is very inefficient. Based on observations, it is likely that the poor condition of the building envelop is causing the high heating EUI.

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. The benchmark baseline periods selected for this building are 2016 for electricity and the predicted AkWarm-C consumption for fuel oil. The shaded 2016 electric consumption figures below were used to calibrate the electric side of the AkWarm© model. 2016 was selected because there is a missing data point in August of 2017.

Figure B.6 – Benchmark Utility Data

ELECTRIC						
	2015		2016		2017	
	kWh	Cost	kWh	Cost	kWh	Cost
Jan	848	$517.28	770	$516	881	$590
Feb	786	$526.62	761	$510	877	$588
Mar	787	$527.28	854	$572	874	$586
Apr	829	$555.43	811	$543	813	$545
May	771	$516.57	519	$348	729	$588
Jun	770	$515.90	612	$410	950	$637
Jul	747	$500.49	613	$411	749	$502
Aug	787	$527.29	734	$492	0	$0
Sep	767	$513.89	681	$456	657	$440
Oct	816	$544.71	738	$494	696	$466
Nov	814	$546.38	782	$524	637	$427
Dec	557	$373.19	823	$551	734	$492
Total	**9,279**	**$6,165**	**8,698**	**$5,828**	**8,597**	**$5,860**

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: IRA Council Office	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Name: Richard John	
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350
	Auditor FAX:
Client Phone: (907) 588-8114	**Auditor Comment:**
Client FAX:	

Design Data

Building Area: 2,400 square feet	**Design Space Heating Load:** Design Loss at Space: 36,656 Btu/hour with Distribution Losses: 36,656 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 55,877 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: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days

Utility Information

Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.670/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

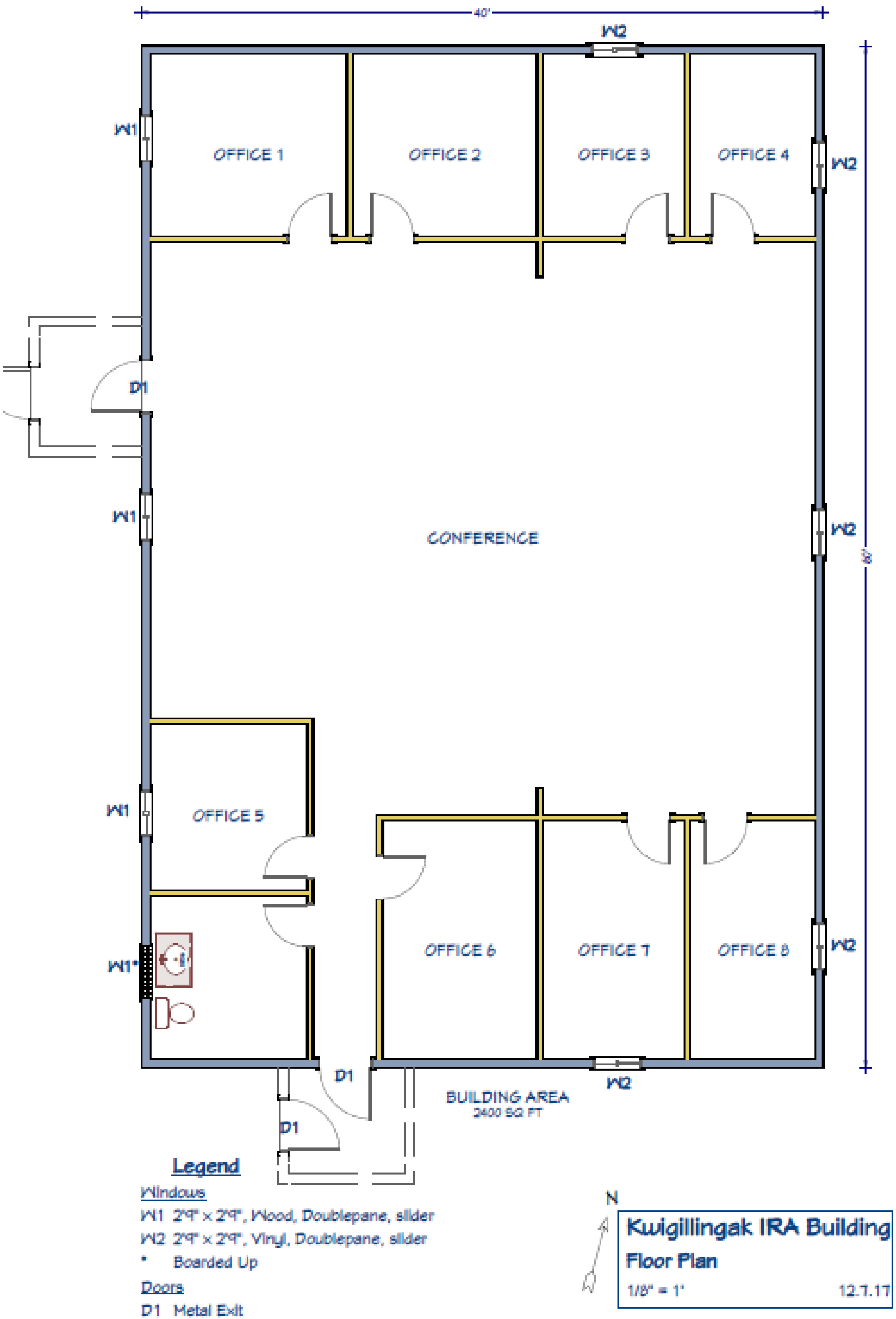
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Refrigeration	Other Electrical	Service Fees	Total Cost
Existing Building	$6,347	$0	$435	$10	$1,238	$373	$2,753	$0	**$11,155**
With Proposed Retrofits	$3,086	$0	$412	$3	$895	$373	$2,716	$0	**$7,484**
Savings	$3,261	$0	$23	$8	$343	$0	$37	$0	**$3,672**

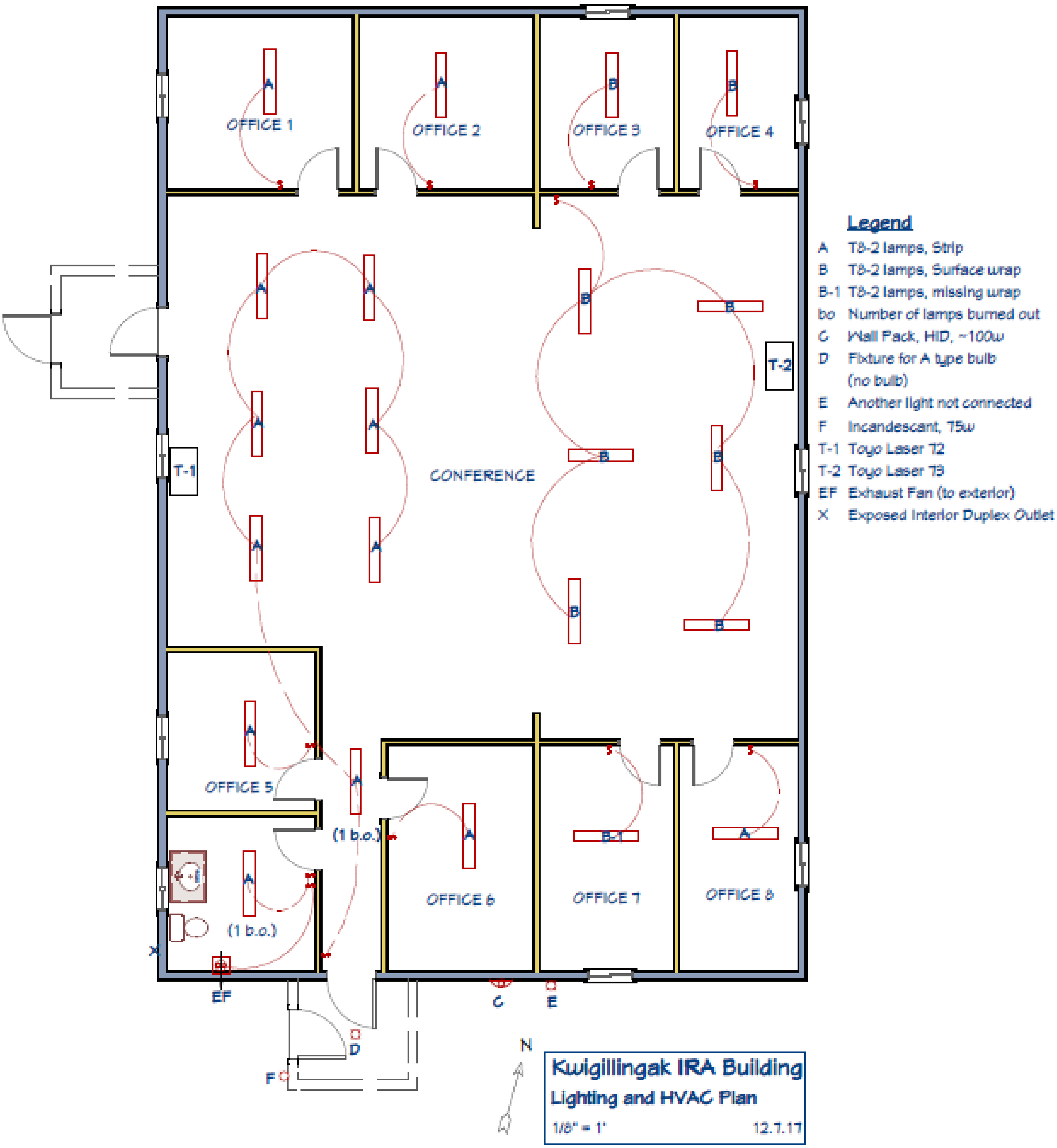
Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	70.1	6.05	$4.65
With Proposed Retrofits	38.5	3.32	$3.12

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




OFFICE 1
OFFICE 2
OFFICE 3
OFFICE 4
CONFERENCE
T-1
T-2
OFFICE 5
(1 b.o.)
(1 b.o.)
OFFICE 6
OFFICE 7
OFFICE 8
EF
C
E
D
F
N
Legend
A T8-2 lamps, Strip
B T8-2 lamps, Surface wrap
B-1 T8-2 lamps, missing wrap
bo Number of lamps burned out
C Wall Pack, HID, ~100w
D Fixture for A type bulb (no bulb)
E Another light not connected
F Incandescent, 75w
T-1 Toyo Laser 72
T-2 Toyo Laser 73
EF Exhaust Fan (to exterior)
X Exposed Interior Duplex Outlet
Kwigillingak IRA Building
Lighting and HVAC Plan
1/8" = 1'
12.7.17

Appendix E – Photographs & IR Images

Remaining wood frame windows are in very poor condition.

Typical condition of siding, needs paint; electrical outlet should be in weather proof junction box.

RV type pump toilet.

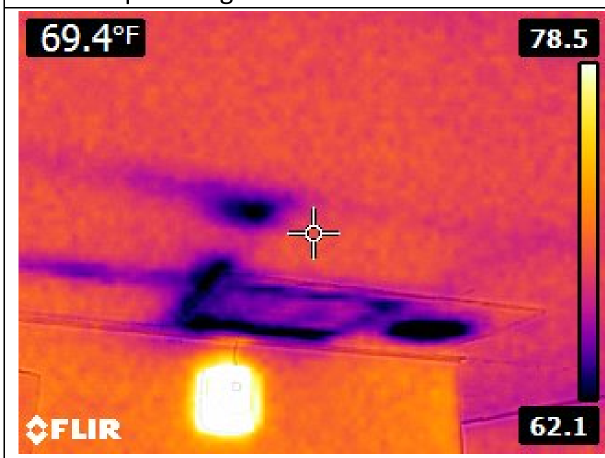
Large community room, looking toward entry door.

Large community room looking north.

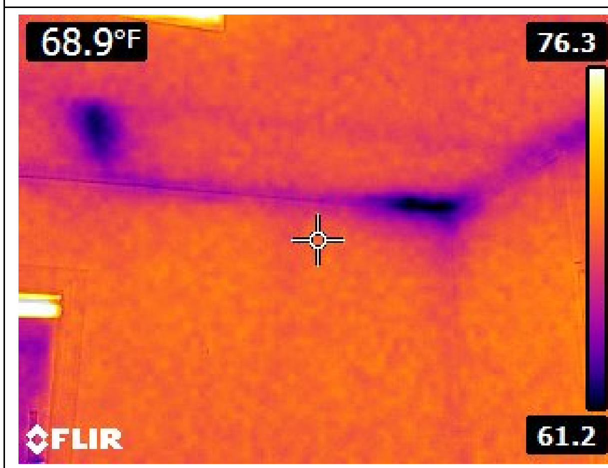
Attic is used as storage; insulation is severely compromised.

Attic insulation is also missing in a number of locations due to attic use as storage room.

1. Main entry door should have new weather stripping and sweep installed; or be replaced with new pre-hung unit.

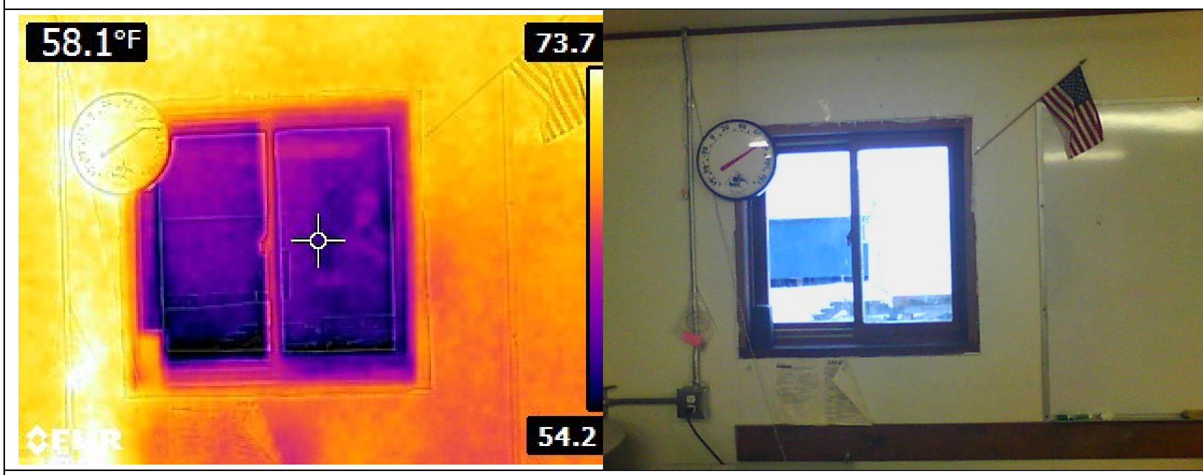


2. Many areas of damaged or missing attic insulation.



3. More damaged or missing attic insulation.

4. Vinyl frame window in average condition.

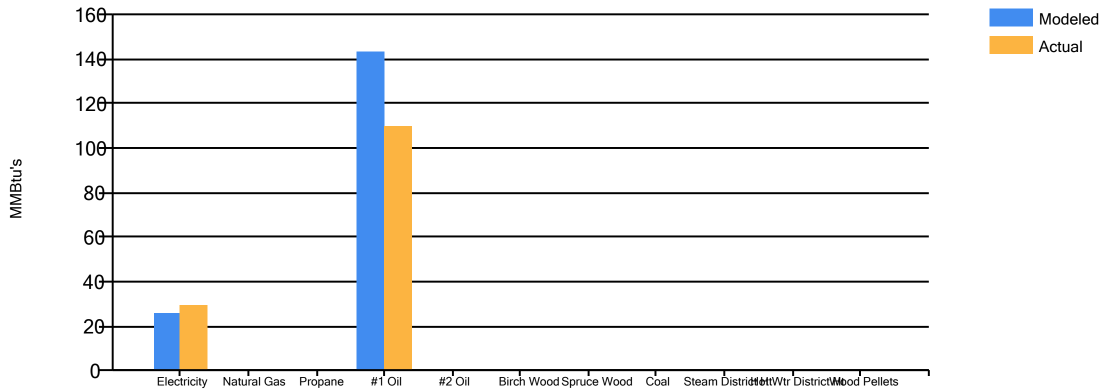


5. Wood frame window in very poor condition – compare to the vinyl frame window above.

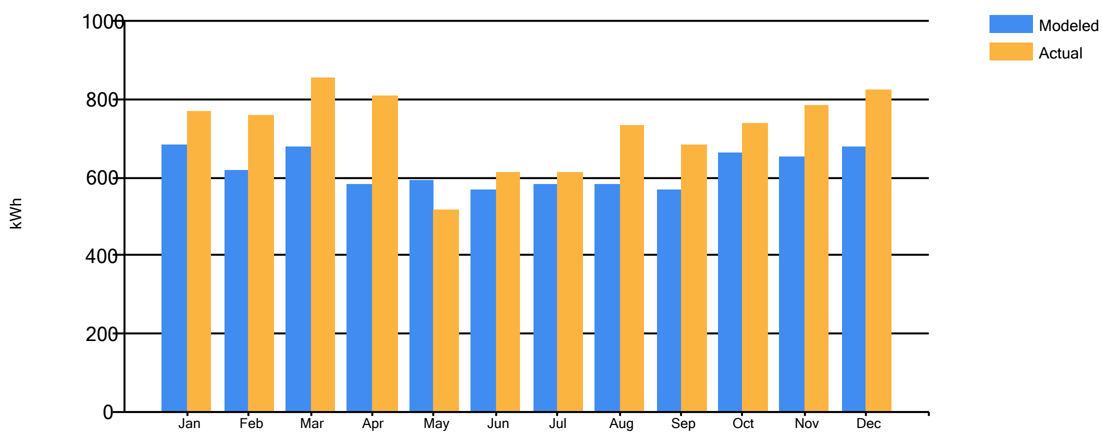
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

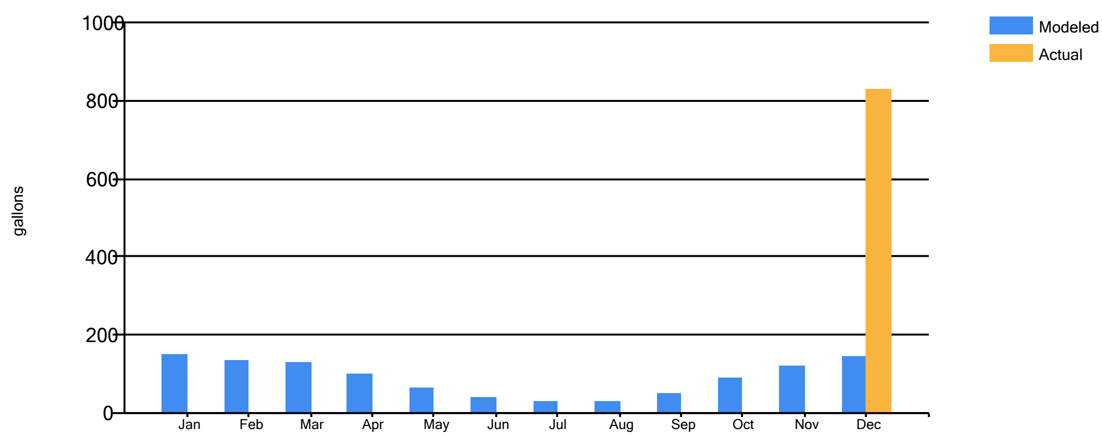
Annual Fuel Use



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 of the Post Office

Prepared For
Native Village of Kwigillingok
Darrel T. John, Tribal Administrator
P.O. Box 90
Kwigillingok, AK 99622
kwigtribe@gmail.com
907-588-8114

Site Survey Date:
December 12, 2017

Prepared By:
James Fowler, PE, CEM
Energy Audits of Alaska
200 W 34th Ave, Suite 1018
Anchorage, AK 99503
jim@jim-fowler.com

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 – October 4, 2018
New Release –October 2, 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.

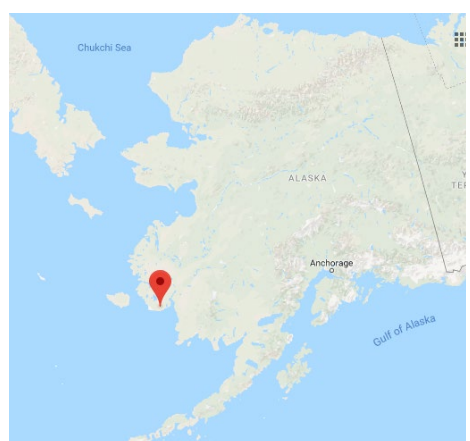
AkWarm-C© © is a building energy modeling software developed under contract by the Alaska Housing Finance Corporation (AHFC).

Acknowledgements

Thank you to the following people and organizations who contributed to this project: Darrel John, the Tribal Administrator; Richard John, the Finance Director; Victoria Amik in the Post Office; Sherie, the tribal police officer, who provided access to the buildings as well as their history, use, occupancy, and electric usage; and the US Department of Energy Office of Indian Energy who provided funding. Thanks to Megan the school principal, who provided lodging.

Project Location

Post office
Clinic
IRA Council Office
Jail
Fisheries Building
NORTH



Building contact:
Richard John
Finance Director
907-588-8114
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1. SUMMARY

This report was prepared for the Native Village of Kwigillingok, owner of the Post Office 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 December 12th and 13th, 2017. The outside temperature varied between 28F and 35F. 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 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, 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 are recommended:
    - Utilize the programmable temperature setback feature on the Toyo stoves; program the time and setback temperatures and re-program the settings after every power outage.

b. If all of the recommended EEMs are incorporated in this building there will be a 33.5% reduction in energy costs, totaling $1,995, with a simple payback of 2.9 years on the $5,858 implementation cost.
c. It was assumed in this analysis that electrical work, such as bypassing light fixture ballasts and installing occupancy sensors, would be performed by qualified electricians. 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. Install a cumulative fuel oil meter on the oil line serving the Toyo stoves and record consumption monthly.

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 calibrated AkWarm-C© © energy model the total predicted energy costs are $5,552 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$3,239 for Electricity
$2,313 for #1 Oil

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	4,835 kWh	2,454 kWh
#1 Oil	514 gallons	455 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	$0.67	$196.30
Fuel Oil	$4.50	$34.09

Figure 1.1

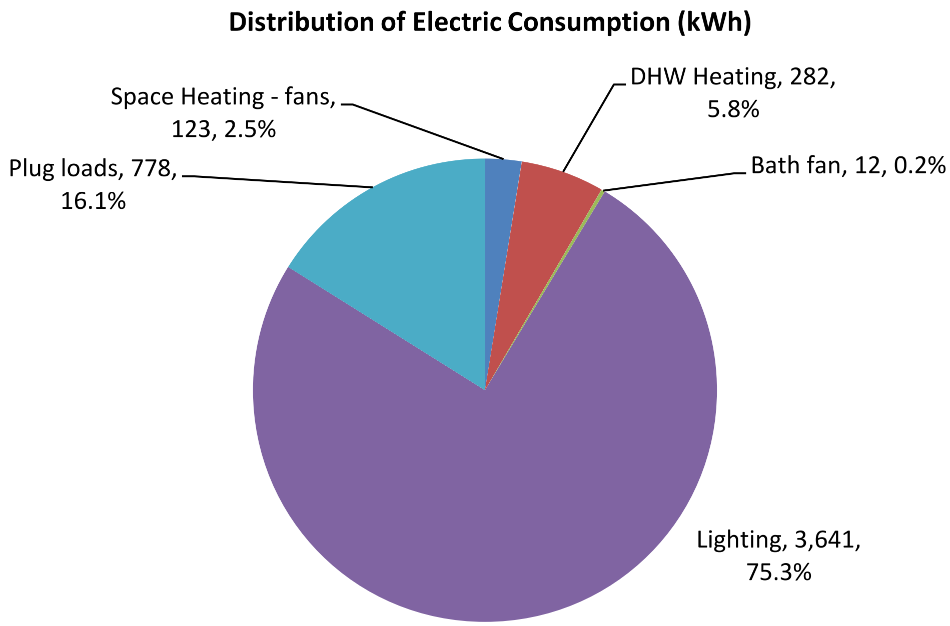
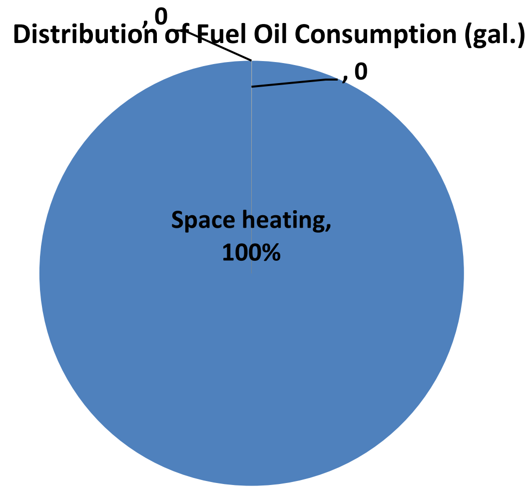


Figure 1.2



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

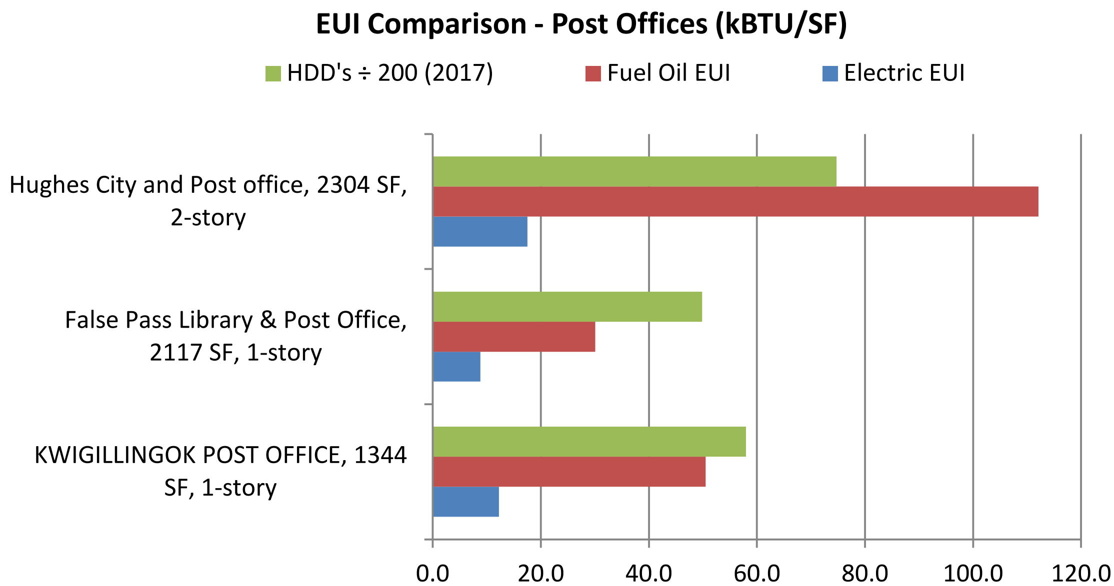
1.4 Benchmark Summary

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	62.7	5.41	$4.13
With Proposed Retrofits	50.9	4.39	$2.75
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[1] (HDDs) bars are intended to normalize the effect of weather differences. As seen in the chart, the subject building's heating EUI is slightly higher than the False Pass building's heating EUI, but this is somewhat expected as there are slightly more HDD's in Kwigillingok. The Hughes building, on the other hand, has a disproportionately high heating EUI despite having considerably more HDD's. The subject building and the False Pass building's electric EUI's are very similar, and again, the Hughes electric EUI is disproportionately high. 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. Figure 1.4 shows the reduction in cost, consumption, and BTU's of electricity and fuel oil if all of the recommended EEMs are incorporated. Maintenance savings are included in the cost savings figures of Figure 1.3 and are not included in the cost savings in Figure 1.4.

[1] 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	$252	$422	0.6
Lighting & Lighting controls	$5,606	$1,573	3.6
Totals	**$5,858**	**$1,995**	**2.9**

Figure 1.4

	Existing conditions		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	4,835	16,502	2,454	8,376	49.2%
Gallons Oil	514	67,848	455	60,060	11.5%
Energy Cost	$5,552		$3,692		33.5%

Tables 1.1 below and Table 4.1 in section 4 summarize the energy efficiency measures analyzed for the Post Office. Estimates of annual energy and maintenance savings, installed costs, SIR, CO2 savings, and simple paybacks are shown for each EEM. The $1 cost indicates that there is no appreciable cost to implement the EEM, but 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	Setback Thermostat: Rear office	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Rear office space.	$325 / 9.3 MMBTU	$1	4394.58	0.0	1,533.7
2	Setback Thermostat: Public area	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Public area space.	$52 / 1.5 MMBTU	$1	697.80	0.0	243.5
3	Lighting - Power Retrofit: Outdoor Lights HPS 70W	Replace with 7 LED 17W Module StdElectronic	$849 + $35 Maint. Savings / 4.3 MMBTU	$1,400	5.32	1.6	4,432.7
4	Ventilation	Add (1) switch mounted occupancy sensor controlling bathroom fan and light @ $125 ea parts + 1 hr labor @ $125/hr.	$45 / 1.2 MMBTU	$250	2.41	5.5	215.2

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 - Combined Retrofit: Lobby T8-2	Replace with 4 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$228 + $20 Maint. Savings / -0.1 MMBTU	$855	2.39	3.4	1,219.0
6	Lighting - Controls Retrofit: Workspace 2 T8-2	Remove Manual Switching and Add new Occupancy Sensor	$62 / 0.0 MMBTU	$320	1.86	5.1	333.8
7	Lighting - Combined Retrofit: Customer Service T8-2	Replace with 2 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$92 + $10 Maint. Savings / -0.1 MMBTU	$588	1.44	5.7	493.8
8	Lighting - Power Retrofit: Workspace 1 T8-2	Replace with 8 LED (2) 15W Module StdElectronic	$99 + $30 Maint. Savings / -0.1 MMBTU	$803	1.33	6.2	527.6
9	Lighting - Controls Retrofit: Workspace 3 T8-2	Remove Manual Switching and Add new Occupancy Sensor	$48 / 0.0 MMBTU	$320	1.23	6.7	257.5
	TOTAL, cost-effective measures		**$1,800 + $95 Maint. Savings / 16.0 MMBTU**	**$4,538**	**3.98**	**2.4**	**9,256.8**
The following measureswere *not* found to be cost-effective from a financial perspective but are still recommended:							
10	Lighting - Power Retrofit: Workspace 2 T8-2	Replace with 4 LED (2) 15W Module StdElectronic	$34 + $20 Maint. Savings / 0.0 MMBTU	$535	0.98	9.9	182.6
11	Lighting - Combined Retrofit: Bathroom T8-2	Replace with LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$17 + $5 Maint. Savings / 0.0 MMBTU	$384	0.81	17.4	91.3
12	Lighting - Power Retrofit: Workspace 3 T8-2	Replace with 3 LED (2) 15W Module StdElectronic	$9 + $15 Maint. Savings / 0.0 MMBTU	$401	0.57	17.1	45.6
	TOTAL, all measures		**$1,860 + $135 Maint. Savings / 15.9 MMBTU**	**$5,858**	**3.27**	**2.9**	**9,576.3**

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**	**Other Electrical**	**Service Fees**	**Total Cost**
Existing Building	$2,396	$0	$188	$6	$2,443	$519	$0	**$5,552**
With Proposed Retrofits	$2,120	$0	$188	$2	$863	$519	$0	**$3,692**
Savings	$275	$0	$0	$5	$1,580	$0	$0	**$1,860**

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. The 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 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, such as 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 so 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 and fans in Toyo stoves clean.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the Post Office. The scope of this project included evaluating the building shell, lighting and other electrical systems, 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 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 Post 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.

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

1) Public area: 188 square feet
2) Rear office: 1,156 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. Costs are considered to be accurate within +/-30% in this level of audit; 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 then 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 #1 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.POST OFFICE EXISTING CONDITIONS

3.1. Building Description

The single story, 1,344 square foot Post Office was constructed in 2001. It has a normal occupancy of 1 person with 20-50 visitors checking their mail boxes and utilizing mailing services during the day.The staff person occupies the building from 10:00 am until 1:00 pm and from 1:30 pm until 5:00 pm Monday through Friday, and from 11:00 am until 3:00 pm on Saturdays.

Description of Building Shell

There were no drawings or building plans available, so the details below are either assumed or based on observation. Furthermore, no access to the rear of the building (behind the customer service counter) was allowed. This area included a storage area, office, and the bathroom.

This building is constructed on a triodetic foundation which supports 6" x 12" beams which in turn support 2" x 12" floor joists, whose cavities are presumed to be filled with R-38 fiberglass batts. The walls are presumed to be constructed with 2" x 6" wood studs at 16" OC, whose cavities are assumed to be filled with R-21 batts. Exterior walls are finished with horizontal vinyl siding and interior walls are finished with hardboard (Masonite). Windows utilize double glazing in vinyl frames and are in good condition. The painted metal roof deck is presumably supported by wood trusses, and has either an unvented attic or a hot roof. The roof appears to have 2" x 8" joists so presumably 7-1/2" of either rigid foam or fiberglass batt insulation is installed in the cavities or under the roof deck. Overall the building shell is in good condition.

Description of Heating and Cooling Plants

Toyo-73

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil
Input Rating:	40,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 87%, de-rated to 82% due to age and condition

Toyo-73

Nameplate Information:	Toyo Laser 73
Fuel Type:	#1 Oil

Input Rating:	40,000 BTU/hr
Steady State Efficiency:	82 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new 87%, de-rated to 82% due to age and condition

Electric HWH - assumed, no access to rear

Nameplate Information:	No HWH observed, since no access to bathroom in rear office and bathroom area
Fuel Type:	Electricity
Input Rating:	1.5 kW
Steady State Efficiency:	100 %
Idle Loss:	0.5 %
Heat Distribution Type:	Water
Boiler Operation:	All Year

Space Heating and Cooling Distribution Systems

All building heat is provided by (2) Toyo Stoves, so there is no distribution system.

Building Ventilation System

There is no mechanical ventilation in this building, therefore fresh air is provided by operable windows. There is a small, manually operated transfer fan in the wall between the public customer area and the rear office/storage. There is a second transfer fan in the wall between the two storage areas in the rear of the building, also manually operated. These are assumed to assist with the distribution of the heat from the Toyo stoves.

HVAC Controls

Each Toyo Stove has its own thermostat and integral controls.

Domestic Hot Water System

The bathroom was not accessible, but it is assumed that there is a small, electric water heater providing hot water for the lavatory sink.

Lighting

The interior lighting consists mainly of 2-lamp, 48" fixtures utilizing T8 florescent lamps and electronic ballasts. No lighting controls appear to be in use. Exterior lighting consists of 70W HPS wall packs controlled by a 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) represents the predicted electrical usage for the building. If actual electricity usage records were available then 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: Kwig Power Company - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.6700/kWh
#1 Oil	$ 4.50/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 Kwigillingok pays approximately $5,552 annually for electricity and other fuel costs for the Post 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

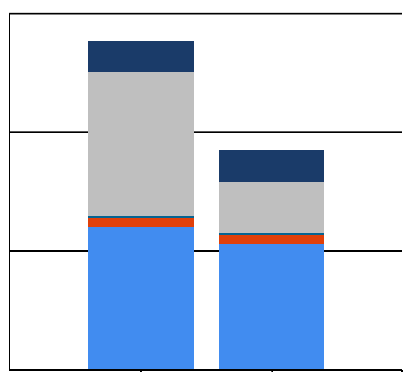


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

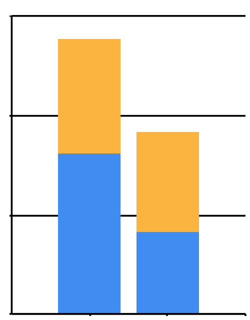
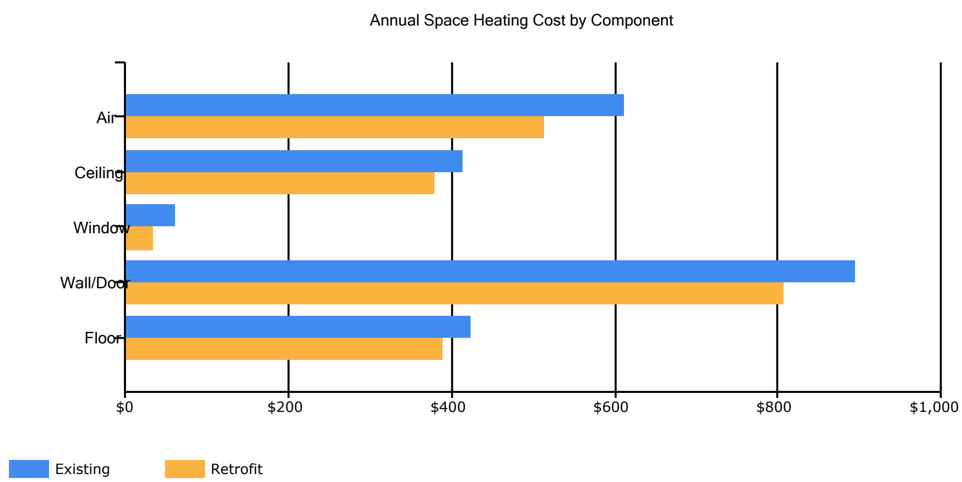


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	18	16	15	11	7	4	3	3	5	10	14	17
Space_Cooling	0	0	0	0	0	0	0	0	0	0	0	0
DHW	24	22	24	23	24	23	24	24	23	24	23	24
Ventilation_Fans	1	1	1	1	1	1	1	1	1	1	1	1
Lighting	309	282	309	299	309	299	309	309	299	309	299	309
Other_Electrical	66	60	66	64	66	64	66	66	64	66	64	66

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	74	65	62	46	30	17	12	13	23	43	59	71
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
Post Office EUI Calculations

Energy Type	Building FuelUse per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	4,835 kWh	16,500	3.340	55,111
#1 Oil	514 gallons	67,834	1.010	68,512
Total		**84,334**		**123,623**
BUILDING AREA		1,344	Square Feet	
BUILDING SITE EUI		63	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		92	**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	**62.7**	**5.41**	**$4.13**
With Proposed Retrofits	**50.9**	**4.39**	**$2.75**

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
Post Office, Kwigillingok, 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: Rear office	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Rear office space.	$325 / 9.3 MMBTU	$1	4394.58	0.0	1,533.7
2	Setback Thermostat: Public area	Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Public area space.	$52 / 1.5 MMBTU	$1	697.80	0.0	243.5
3	Lighting - Power Retrofit: Outdoor Lights HPS 70W	Replace with 7 LED 17W Module StdElectronic	$849 + $35 Maint. Savings / 4.3 MMBTU	$1,400	5.32	1.6	4,432.7
4	Ventilation	Add (1) switch mounted occupancy sensor controlling bathroom fan and light @ $125 ea parts + 1 hr labor @ $125/hr.	$45 / 1.2 MMBTU	$250	2.41	5.5	215.2
5	Lighting - Combined Retrofit: Lobby T8-2	Replace with 4 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$228 + $20 Maint. Savings / -0.1 MMBTU	$855	2.39	3.4	1,219.0
6	Lighting - Controls Retrofit: Workspace 2 T8-2	Remove Manual Switching and Add new Occupancy Sensor	$62 / 0.0 MMBTU	$320	1.86	5.1	333.8
7	Lighting - Combined Retrofit: Customer Service T8-2	Replace with 2 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	$92 + $10 Maint. Savings / -0.1 MMBTU	$588	1.44	5.7	493.8
8	Lighting - Power Retrofit: Workspace 1 T8-2	Replace with 8 LED (2) 15W Module StdElectronic	$99 + $30 Maint. Savings / -0.1 MMBTU	$803	1.33	6.2	527.6
9	Lighting - Controls Retrofit: Workspace 3 T8-2	Remove Manual Switching and Add new Occupancy Sensor	$48 / 0.0 MMBTU	$320	1.23	6.7	257.5

Table 4.1 Post Office, Kwigillingok, 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**
	TOTAL, cost-effective measures		**\$1,800 + \$95 Maint. Savings / 16.0 MMBTU**	**\$4,538**	**3.98**	**2.4**	**9,256.8**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
10	Lighting - Power Retrofit: Workspace 2 T8-2	Replace with 4 LED (2) 15W Module StdElectronic	\$34 + \$20 Maint. Savings / 0.0 MMBTU	\$535	0.98	9.9	182.6
11	Lighting - Combined Retrofit: Bathroom T8-2	Replace with LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	\$17 + \$5 Maint. Savings / 0.0 MMBTU	\$384	0.81	17.4	91.3
12	Lighting - Power Retrofit: Workspace 3 T8-2	Replace with 3 LED (2) 15W Module StdElectronic	\$9 + \$15 Maint. Savings / 0.0 MMBTU	\$401	0.57	17.1	45.6
	TOTAL, all measures		**\$1,860 + \$135 Maint. Savings / 15.9 MMBTU**	**\$5,858**	**3.27**	**2.9**	**9,576.3**

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 then 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

Rank	**Description**			**Recommendation**	
4				Add (1) switch mounted occupancy sensor controlling bathroom fan and light @ $125 ea parts + 1 hr labor @ $125/hr.	
Installation Cost	$250	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$45
Breakeven Cost	$602	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	1.2 MMBTU
		Savings-to-Investment Ratio	2.4		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	**Building Space**			**Recommendation**	
1	Rear office			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Rear office space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$325
Breakeven Cost	$4,395	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	9.3 MMBTU
		Savings-to-Investment Ratio	4,394.6		
Auditors Notes:					

Rank	**Building Space**			**Recommendation**	
2	Public area			Implement a Heating Temperature Unoccupied Setback to 63.0 deg F for the Public area space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$52
Breakeven Cost	$698	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.5 MMBTU
		Savings-to-Investment Ratio	697.8		
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**	
3	Outdoor Lights HPS 70W	7 HPS 70 Watt StdElectronic with Manual Switching		Replace with 7 LED 17W Module StdElectronic	
Installation Cost	$1,400	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$849
Breakeven Cost	$7,444	**Simple Payback (yrs)**	2	**Energy Savings (MMBTU/yr)**	4.3 MMBTU
		Savings-to-Investment Ratio	5.3	**Maintenance Savings ($/yr)**	$35
Auditors Notes: Replace (7) 50w HPS fixtures with new 17w LED fixtures with integral photocell sensor @ parts cost of $75 ea + 1 hr labor ea. @ $125/hr. Maintenance savings $5/fixture.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
5	Lobby T8-2	4 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 4 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$855	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$228
Breakeven Cost	$2,047	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	2.4	**Maintenance Savings ($/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 @ $XX/hr. Replace (8) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.: Add ceiling mounted occupancy sensors @ $195 ea parts + 1 hr labor @ $125/hr.					

Rank	**Location**	**Existing Condition**		**Recommendation**	
7	Customer Service T8-2	2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 2 LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$588	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$92
Breakeven Cost	$844	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	1.4	**Maintenance Savings ($/yr)**	$10
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (2) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Install ceiling mounted occupancy sensor controlling fixture on public side of service counter at an estimated cost of $320.					

Rank	Location	Existing Condition		Recommendation	
8	Workspace 1 T8-2	8 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 8 LED (2) 15W Module StdElectronic	
Installation Cost	$803	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$99
Breakeven Cost	$1,065	**Simple Payback (yrs)**	6	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
		Savings-to-Investment Ratio	1.3	**Maintenance Savings ($/yr)**	$30

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (6) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (12) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.

Rank	Location	Existing Condition		Recommendation	
10	Workspace 2 T8-2	4 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 4 LED (2) 15W Module StdElectronic	
Installation Cost	$535	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$34
Breakeven Cost	$523	**Simple Payback (yrs)**	10	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	1.0	**Maintenance Savings ($/yr)**	$20

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (4) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (8) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) ceiling mounted occupancy sensor @ $195 ea parts + 1 hr labor @ $125/hr.

Rank	Location	Existing Condition		Recommendation	
11	Bathroom T8-2	FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with LED (2) 15W Module StdElectronic and Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$384	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$17
Breakeven Cost	$312	**Simple Payback (yrs)**	17	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.8	**Maintenance Savings ($/yr)**	$5

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (1) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (2) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) switch mounted occupancy sensors @ $125 ea parts + 1 hr labor @ $125/hr.

Rank	Location	Existing Condition		Recommendation	
12	Workspace 3 T8-2	3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 3 LED (2) 15W Module StdElectronic	
Installation Cost	$401	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$9
Breakeven Cost	$230	**Simple Payback (yrs)**	17	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
		Savings-to-Investment Ratio	0.6	**Maintenance Savings ($/yr)**	$15

Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (3) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (6) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) ceiling mounted occupancy sensor @ $195 ea parts + 1 hr labor @ $125/hr.

4.5.1b Lighting Measures – Lighting Controls

Rank	Location		Existing Condition		Recommendation	
6	Workspace 2 T8-2		4 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$320	**Estimated Life of Measure (yrs)**	12	**Energy Savings ($/yr)**	$62	
Breakeven Cost	$594	**Simple Payback (yrs)**	5	**Energy Savings (MMBTU/yr)**	0.0 MMBTU	
		Savings-to-Investment Ratio	1.9			
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (4) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (8) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) ceiling mounted occupancy sensor @ $195 ea parts + 1 hr labor @ $125/hr.						

Rank	Location		Existing Condition		Recommendation	
9	Workspace 3 T8-2		3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Remove Manual Switching and Add new Occupancy Sensor	
Installation Cost	$320	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$48	
Breakeven Cost	$395	**Simple Payback (yrs)**	7	**Energy Savings (MMBTU/yr)**	0.0 MMBTU	
		Savings-to-Investment Ratio	1.2			
Auditors Notes: Remove or bypass ballast and re-wire end caps for line voltage (may need to replace end caps) in (3) fixtures @ 0.75 hrs/fixture @ $125/hr. Replace (6) 32w or 40w lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture. Add (1) ceiling mounted occupancy sensor @ $195 ea parts + 1 hr labor @ $125/hr.						

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	e85	e15w/120/1	bathroom fan
TR (qty 2)	Unknown	e100	E80w/115/1	transfer fans

HEAT PLANT SCHEDULE

SYMBOL	MFGR/MODEL	EFFICIENCY	MOTOR DATA HP/VOLTS/PH	REMARKS
T-1	Toyo Laser 72	87%	76w/115/1%	de-rated to 82% thermal efficiency based on age
T-2	Toyo Laser 73	87%	76w/115/1%	de-rated to 82% thermal efficiency based on age

HOT WATER HEATER SCHEDULE

SYMBOL	MFGR/MODEL	GALLONS	NUMBER OF ELEMENTS	ELEMENT SIZE
HWH-1	Unknown	10	(1) 1500w	

PLUMBING FIXTURES

SYMBOL	FIXTURE	GPF/GPM	QUANTITY	REMARKS
	W.C.	e1.6	1	
	Lavatory faucet	e2.0	1	

PLUG LOAD PARTIAL SUMMARY

SYMBOL	FIXTURE	QUANTITY	ESTIMATED CONSUMPTION	REMARKS
	Desktop computers with LCD monitor	2	200w	
	Personal printers	1	85w	
	Electric scale	1	e20w	
	Pitney Bowes postage meter	1	e50 w	

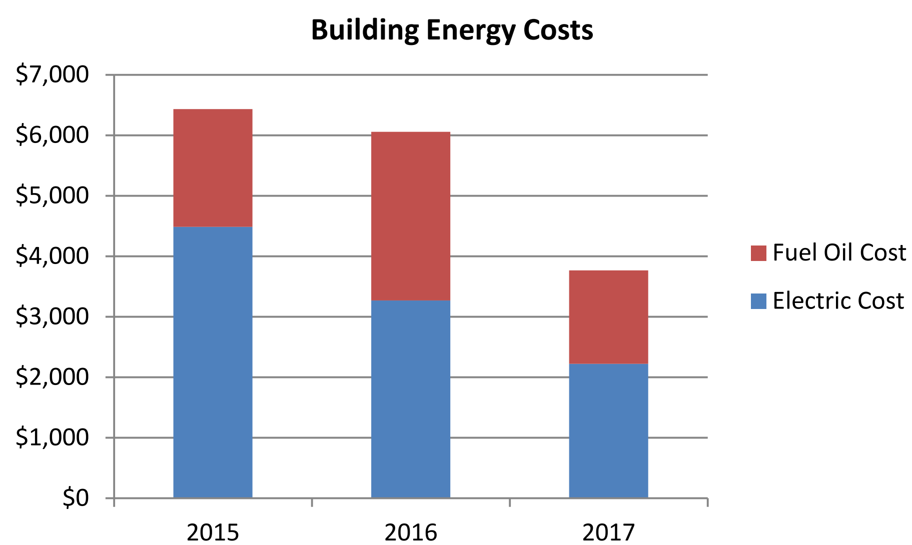
Appendix B – Benchmark Analysis and Utility Source Data

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 and fuel oil delivery data from 2015 through 2017 was available. 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

POST OFFICE						
	Elec. Consumption (kWh)	**Electric Cost**	**Fuel Oil use**	**Fuel oil Cost**	**Total kBTU's of Energy**	**Total Utility Cost**
2015	6,757	$4,488	442	$1,945	81,406	$6,432
2016	4,831	$3,267	700	$2,788	108,888	$6,055
2017	3,318	$2,223	400	$1,544	64,124	$3,767
	3-year average Fuel Oil		514	$2,092	84,336	$5,359

Figure B.2 - Costs



Electricity: There is a dramatic 25% to 30% reduction in electric use each year and a significant reduction in winter usage in 2017, when compared to 2015 and 2016. The reasons for this are unknown, but the on-site staff person indicated that she took over the position in 2015 and expressed an energy conservation mindset. It can be presumed that the reductions are a result of conservation efforts made by the staff person. The 2017 consumption is very consistent on a month to month basis.

Figure B.3 – 3 Years of monthly Electric Consumption

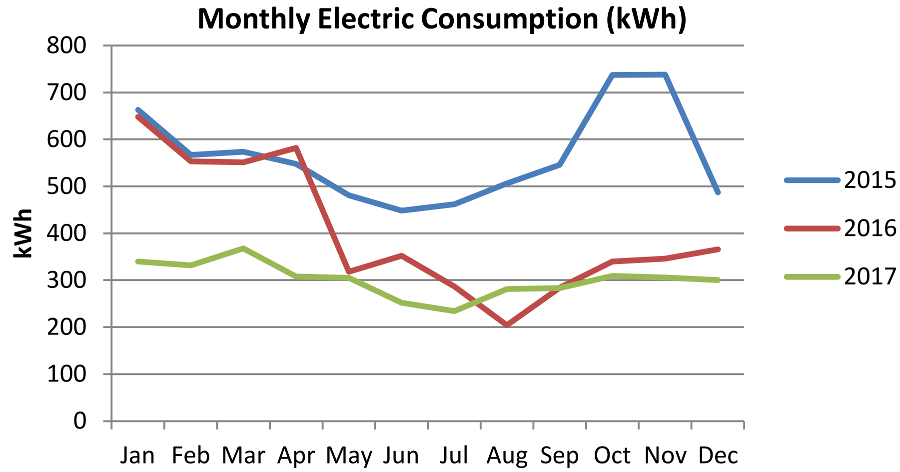
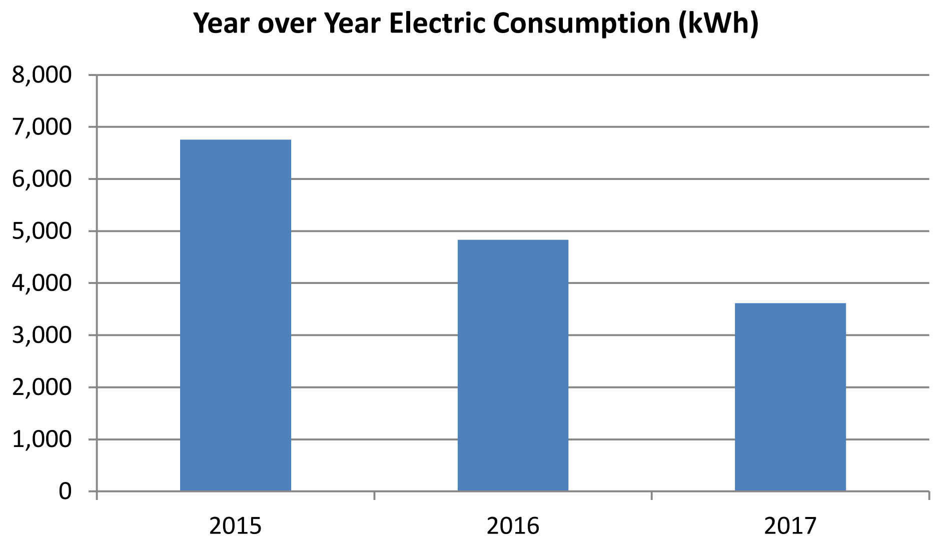
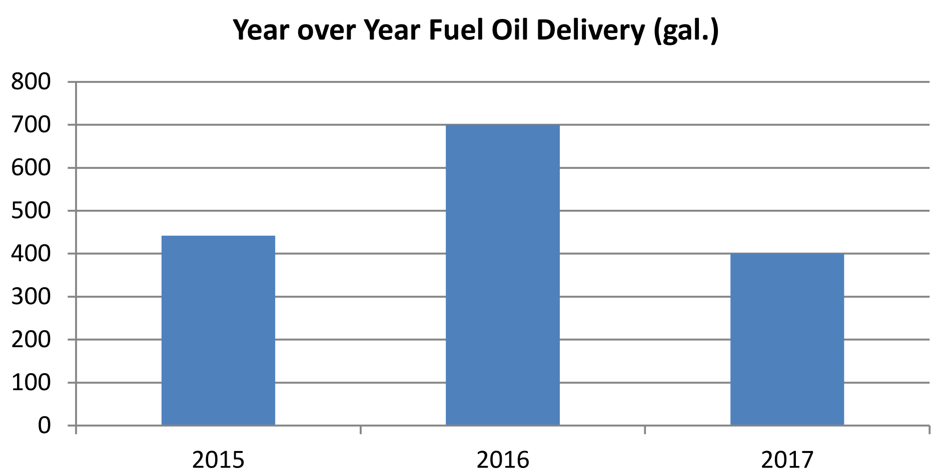


Figure B.4 – 3 years of Annual Electric Consumption

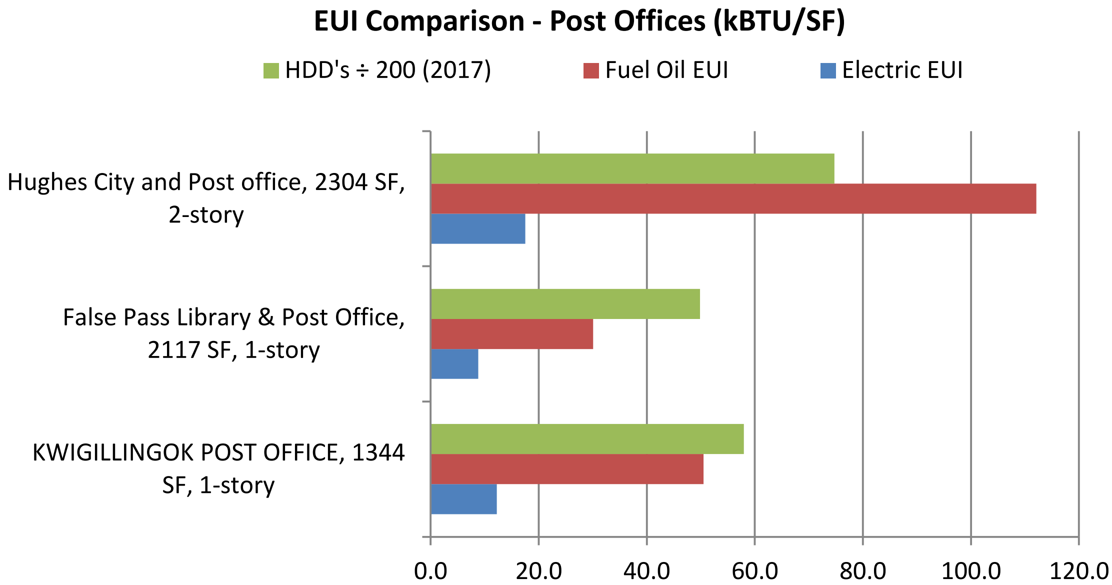


Fuel Oil: Oil delivery is erratic on a year to year basis, so the average of 3 years was used to calibrate the AkWarm© model.



Comparing EUIs: Figure B.5 and the discussion in Section 1.5 above show that this building's heating and electric EUI's fall close to the average of the three comparison buildings.

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. The benchmark baseline periods selected for this building are 2016 for electricity and the average of 2015 through 2017 for fuel oil 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

ELECTRIC							FUEL OIL								
	2015		2016		2017			2015		2016		2017		3-year average	
	kWh	Cost	kWh	Cost	kWh	Cost		gallons	Cost	gallons	Cost	gallons	Cost	gallons	Cost
Jan	663	$404	648	$464	340	$228	Jan	200	$880	300	$1,320	0	$0		
Feb	567	$380	553	$371	332	$222	Feb	0	$0	0	$0	400	$0		
Mar	574	$385	551	$369	368	$247	Mar	242	$1,065	0	$0	0	$1,544		
Apr	548	$367	582	$390	308	$206	Apr	0	$0	0	$0	0	$0		
May	481	$322	318	$213	305	$204	May	0	$0	0	$0	0	$0		
Jun	448	$300	352	$236	252	$169	Jun	0	$0	0	$0	0	$0		
Jul	462	$310	287	$192	234	$157	Jul	0	$0	0	$0	0	$0		
Aug	506	$339	204	$137	281	$188	Aug	0	$0	0	$0	0	$0		
Sep	546	$366	284	$190	283	$190	Sep	0	$0	0	$0	0	$0		
Oct	737	$494	340	$228	309	$207	Oct	0	$0	0	$1,468	0	$0		
Nov	738	$494	346	$232	306	$205	Nov	0	$0	400	$0	0	$0		
Dec	487	$326	366	$245	300	$0	Dec	0	$0	0	$0	0	$0		
Total	**6,757**	**$4,488**	**4,831**	**$3,267**	**3,618**	**$2,223**	**Total**	**442**	**$1,945**	**700**	**$2,788**	**400**	**$1,544**	**514**	**$2,092**

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, and 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, fluorescent 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: Post Office	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok **Client Name:** Richard John	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350 **Auditor FAX:**
Client Phone: (907) 588-8114 **Client FAX:**	**Auditor Comment:**

Design Data

Building Area: 1,344 square feet	**Design Space Heating Load:** Design Loss at Space: 20,998 Btu/hour with Distribution Losses: 20,998 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 32,009 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 2 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days

Utility Information

Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.670/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

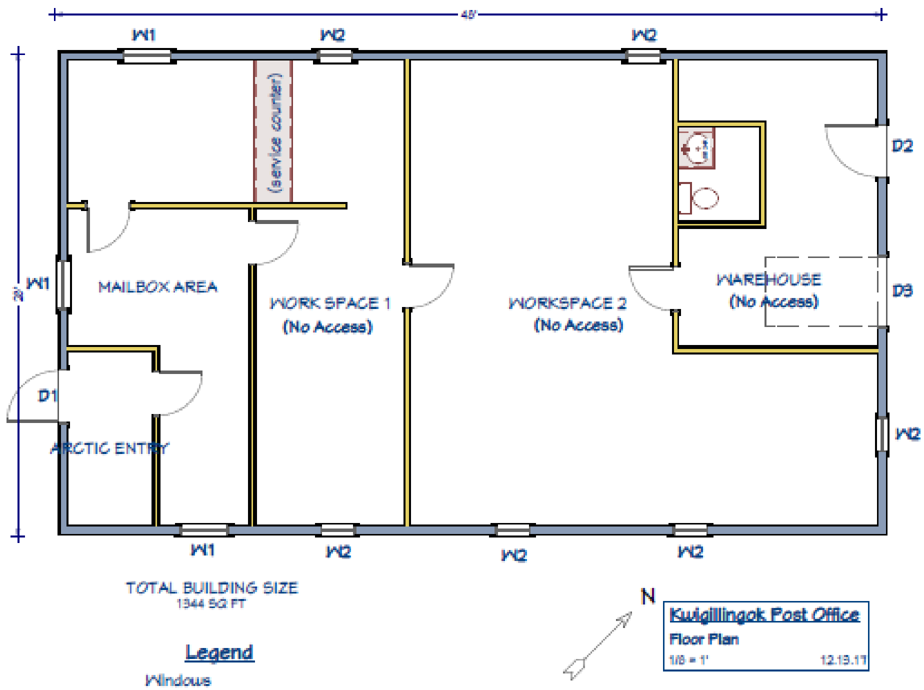
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Service Fees	Total Cost
Existing Building	$2,396	$0	$188	$6	$2,443	$519	$0	**$5,552**
With Proposed Retrofits	$2,120	$0	$188	$2	$863	$519	$0	**$3,692**
Savings	$275	$0	$0	$5	$1,580	$0	$0	**$1,860**

Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	62.7	5.41	$4.13
With Proposed Retrofits	50.9	4.39	$2.75

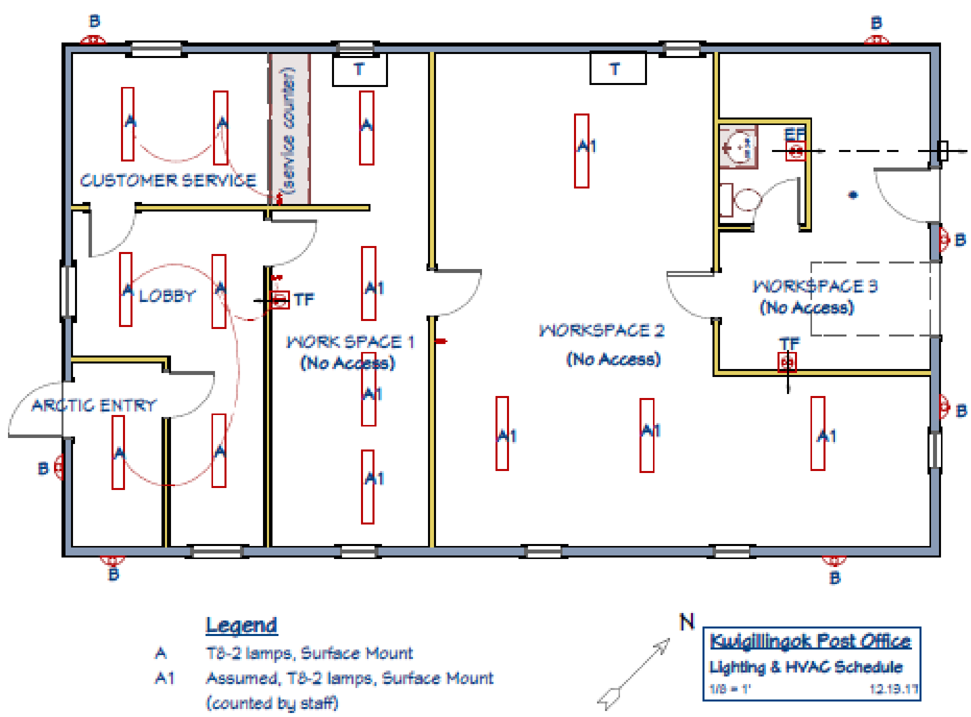
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure’s conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

BUILDING SCHEMATICS



Legend

Windows
W1 2'10" x 5'2", Vinyl, Double-pane, Single Hung
W2 1' x 2', Vinyl, Double-pane, Awning
Doors
D1 Metal Half light
D2 Metal Exit
D3 4' x 6'6" Rollup Metal Overhead



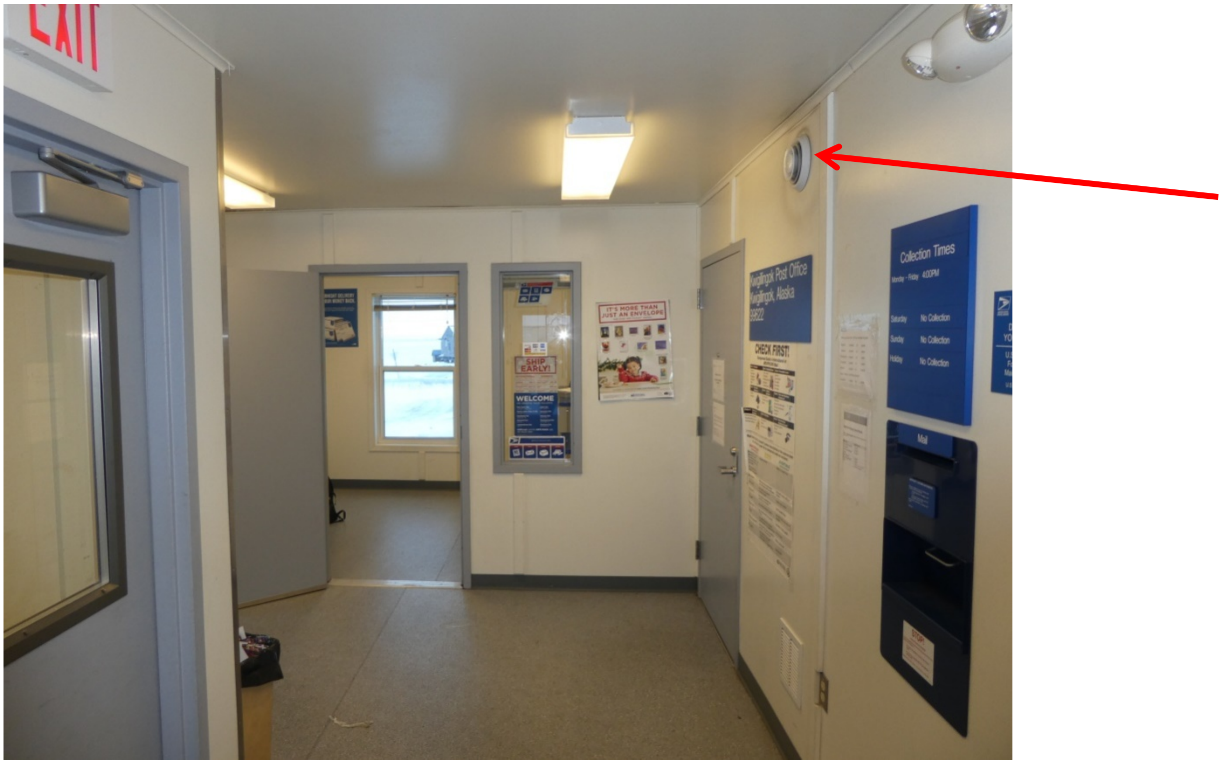
Legend

A T8-2 lamps, Surface Mount
A1 Assumed, T8-2 lamps, Surface Mount (counted by staff)
B HPS, Wall pack, 70w + small halogen
T Toyo Stove 73 series
EF Exhaust Fan
TF Transfer Fan, controlled manually
• Lighting Unknown

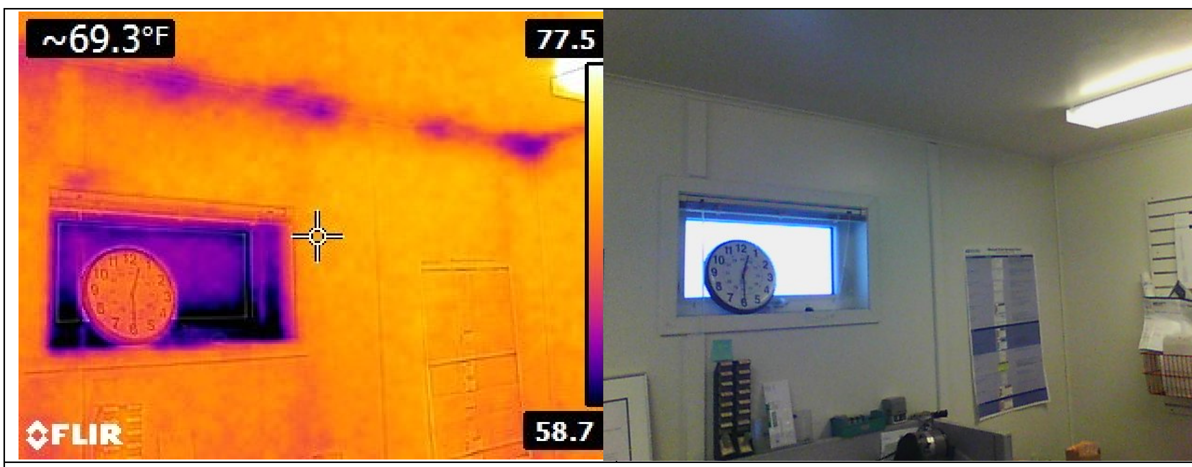
Appendix E – Photographs& IR Images

Public access area

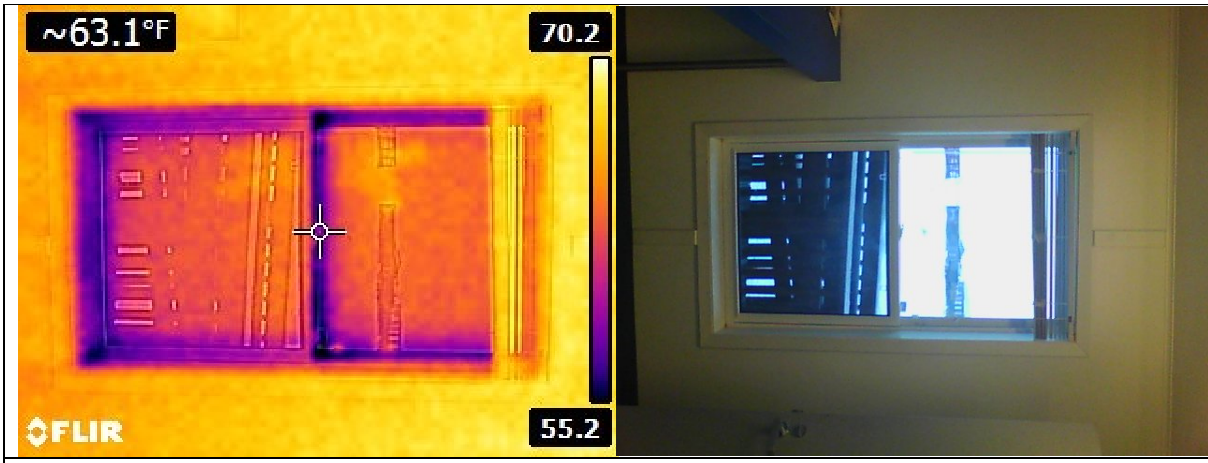
Looking over customer service desk, the only visible portion of building rear



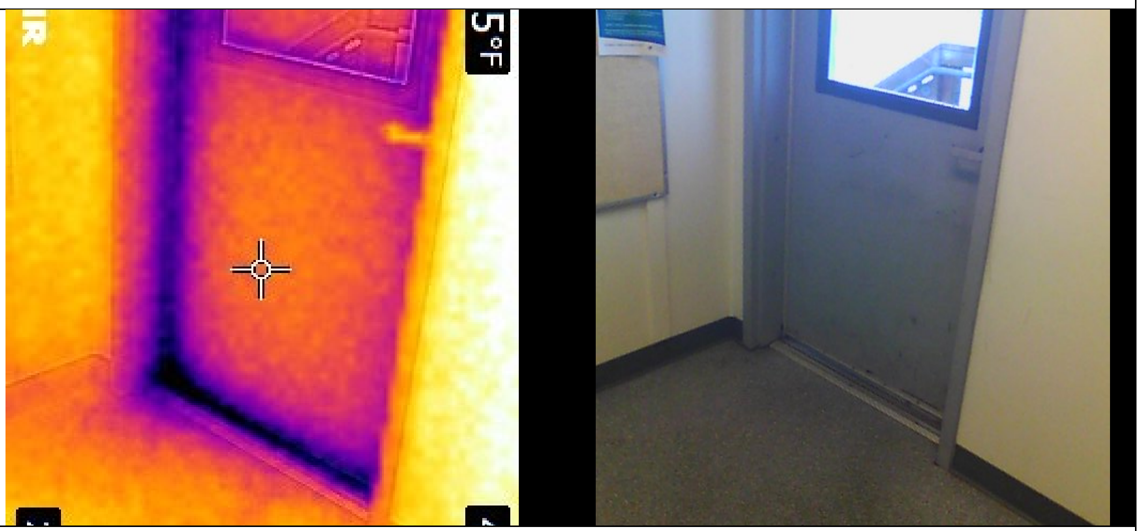
Public access area, doorway into customer service area; arrow shows transfer fan



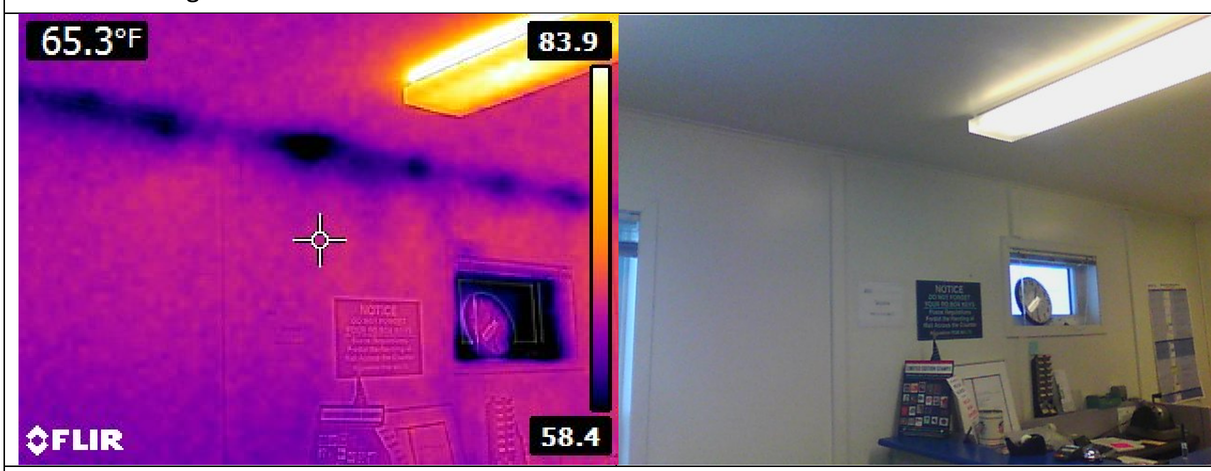
1. Window is open; poor insulation installation at wall/ceiling interface is evident



2. Windows are in good condition



3. Door is in good condition as well

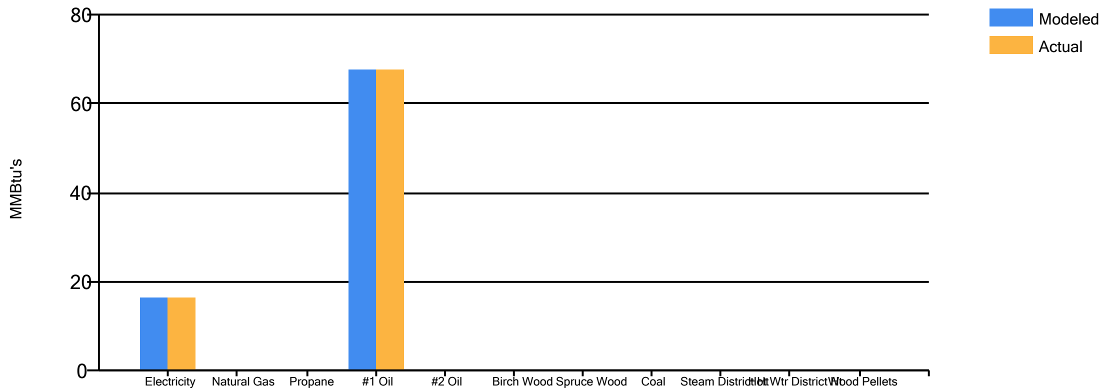


4. More indication of poorly installed insulation at wall/ceiling interface

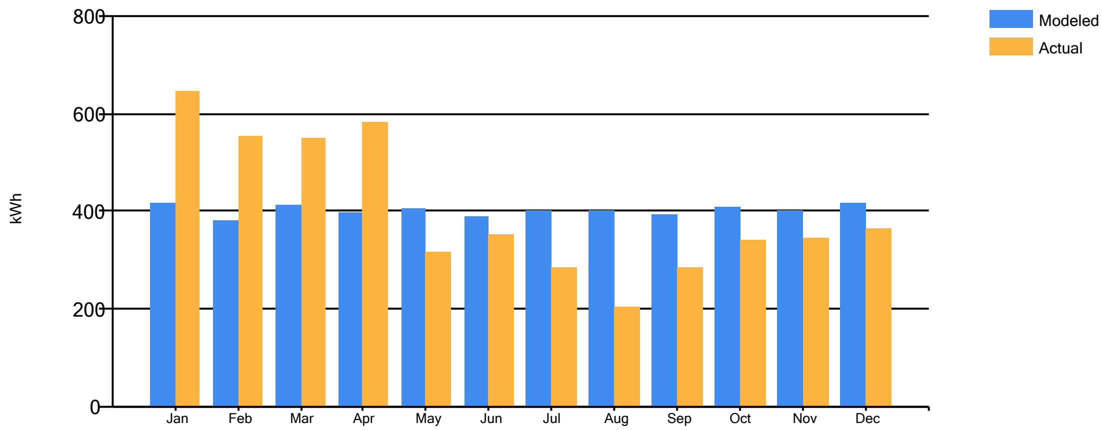
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

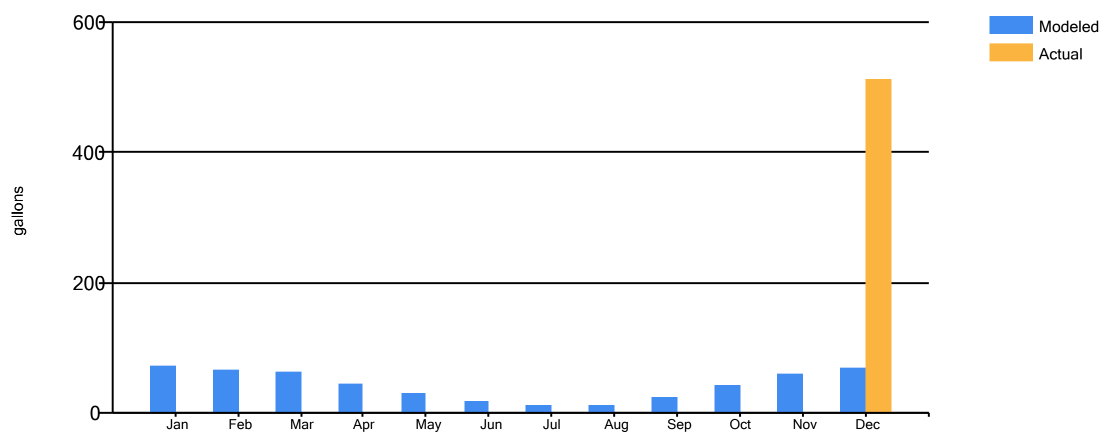
Annual Fuel Use



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 the VPSO Office & Jail

Prepared For

Native Village of Kwigillingok
Darrel T. John, Tribal Administrator
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Site Survey Date:

December 12, 2017

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Energy Audits of Alaska

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

Revision Tracking

Copy-edited version – October 3, 2018

New Release – October 2, 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: Darrel and Richard John, the Tribal Administrator and Finance officer, Victoria Amik in the Post Office, Sherie the tribal police officer, who provided access to the buildings as well as their history, use and occupancy and electric usage. Also thanks to the US Department of Energy Office of Indian Energy for providing funding. Thanks to Megan the school principal, for facilitating and providing lodging.

Project Location

Post office
Clinic
IRA Council Office
Jail
Fisheries Building
NORTH

Building contact:
Richard John
Finance Director
907-588-8114
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1. SUMMARY

This report was prepared for the Native Village of Kwigillingok, owner of the VPSO Office & Jail. 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 December 12th and 13th, 2017. The outside temperature varied between 28F and 35F 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

This 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, 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. ECMs are no cost or low cost energy conservation measures typically implemented by the building owner or the owner's staff. The following ECMs are recommended:

- Utilize the programmable temperature setback feature on the Toyo stove; program the time and setback temperatures and re-program the settings after every power outage.

b. If all the recommended EEMs are incorporated in this building, there will be a 25.7% reduction in energy costs, totaling $444, with a simple payback of 1.2 years on the $540 implementation cost.

c. An estimate of fuel oil delivery data for this building was provided by the building owner but the figure is suspected to be too low. Therefore the fuel oil consumption figures in this analysis were derived from the AkWarm-C energy simulation model. The modeled figures may not represent the actual consumption figures, which are unknown, and therefore the energy savings may lose accuracy.

d. For 6 of the 12 baseline months, this building consumed less than 60 kWh of electricity. If consumption is less than 60 kWh/month, it is not recorded by the Kwig Power Company and there is no charge. An estimated 50 kWh/month was used for the 6 months.

e. It was assumed in this analysis, that electrical work such as bypassing light fixture ballasts and installing occupancy sensors would be performed by qualified electricians. 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

As mentioned above, 6 of the 12 months of electric data are missing and the estimated oil consumption is thought to be too low. Based on electricity and fuel oil prices in effect at the time of the audit, the revised baseline electric consumption, and using the AkWarm-C© energy model[1] to predict fuel oil usage, the building's total predicted energy costs are $1,730 per year. The breakdown of the annual predicted energy costs and fuel use for the buildings analyzed are as follows:

$910 for Electricity
$820 for #1 Fuel Oil

Predicted Annual Fuel Use

Fuel Use	Existing Building	With Proposed Retrofits
Electricity	1,358 kWh	779 kWh
#1 Fuel Oil	182 gallons	172 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	$0.67	$196.30
Fuel Oil	$4.50	$34.09

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

Figure 1.1

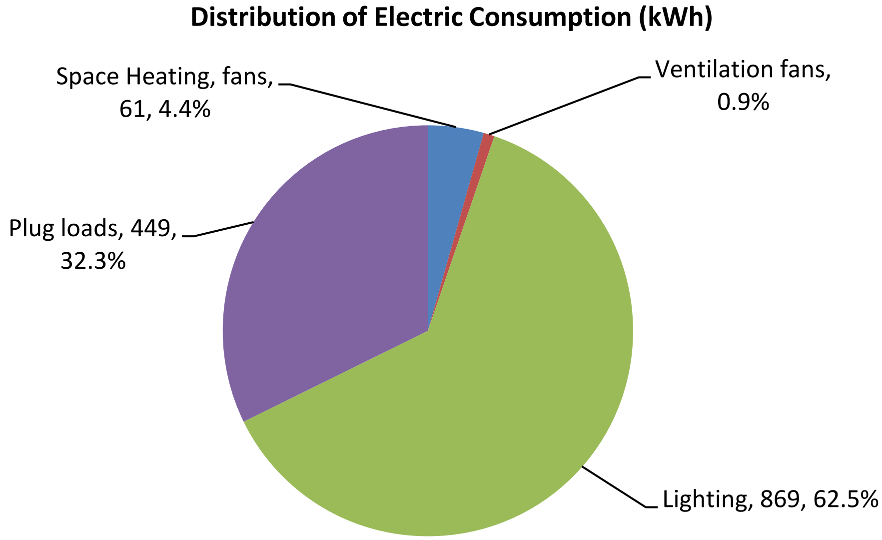
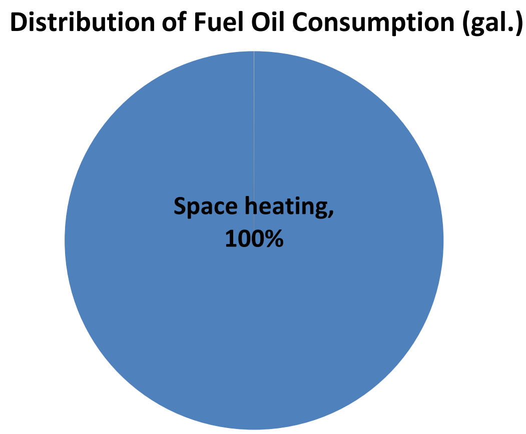


Figure 1.2



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

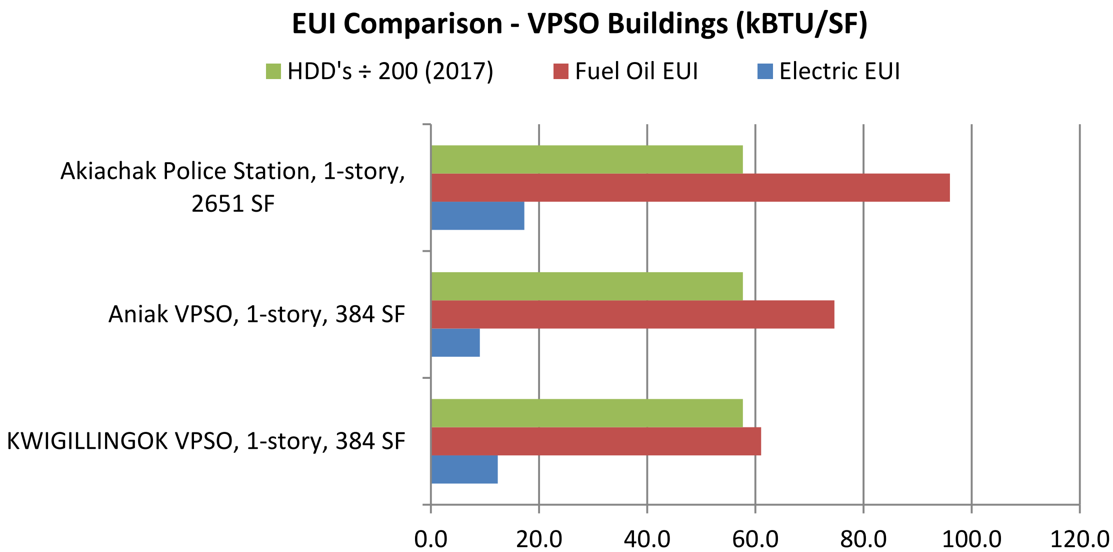
1.4 Benchmark Summary

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	74.7	6.44	$4.50
With Proposed Retrofits	66.0	5.69	$3.37
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 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. The Aniak VPSO building is an exact duplicate of the Kwig building, but it is essentially unoccupied so its electric and heating EUI's are predicted by the AkWarm-C models based on a theoretical occupancy scenario. Any differences in EUIs between these two buildings are due only to differences in occupancy and use. The subject building's heating EUI is nearly 30% better than the Akiachak police station. 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 BTU's 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. The annual electric consumption includes 6 months of an estimated 50 kWh/mo. consumption (representing the missing data) and the fuel oil consumption is based on the AkWarm-C model's predicted use.

[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.)
Set back programming of Toyo and occupancy sensor on bath fan	$2	$126	0.0
Lighting	$538	$318	1.7
Totals	**$540**	**$444**	**1.2**

Figure 1.4

	Existing conditions (oil use calculated by AkWarm)		Proposed Conditions		Effective reduction in building energy consumption and costs
		kBTU of consumption		kBTU of consumption	
kWh Electric	1,356	4,628	779	2,659	42.6%
Gallons Oil	182	24,024	172	22,704	5.5%
Energy Cost	$1,729		$1,285		25.7%

Tables 1.1 below and Table 4.1 in section 4 summarize the energy efficiency measures analyzed for the VPSO Office & Jail. Estimates of annual energy and maintenance savings, installed costs, SIR, CO2 savings, and simple paybacks are shown for each EEM. The $1 cost indicates that there is no appreciable cost to implement the EEM, but 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	Setback Thermostat: Police Station	Implement a Heating Temperature Unoccupied Setback to 65.0 deg F for the Police Station space.	$56 / 1.6 MMBTU	$1	758.79	0.0	265.8
2	Ventilation	Add Occupancy sensor to bathroom light switch. Cost is included in bathroom lighting retrofit, EEM #7.	$70 / 1.8 MMBTU	$1	645.30	0.0	334.2
3	Lighting - Power Retrofit: Hall	Replace with LED 9W Module StdElectronic	$95 / 0.0 MMBTU	$5	156.06	0.1	505.6

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
4	Lighting - Power Retrofit: Artic Entry	Replace with LED 9W Module StdElectronic	$94 / 0.0 MMBTU	$5	154.04	0.1	500.4
5	Lighting - Power Retrofit: Storage INCAN 60W	Replace with LED 9W Module StdElectronic	$6 / 0.0 MMBTU	$5	15.85	0.9	30.4
6	Lighting - Power Retrofit: Office T8-2	Replace with 2 LED (2) 15W Module StdElectronic	$93 + $10 Maint. Savings / -0.1 MMBTU	$268	3.17	2.6	497.8
	TOTAL, cost-effective measures		**$414 + $10 Maint. Savings / 3.3 MMBTU**	**$285**	**13.63**	**0.7**	**2,134.2**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
7	Lighting - Combined Retrofit: Bathroom INCAN	Replace with LED 9W Module StdElectronic and Controls retrofit	$20 / 0.0 MMBTU	$255	0.64	12.8	106.9
	TOTAL, all measures		**$434 + $10 Maint. Savings / 3.3 MMBTU**	**$540**	**7.50**	**1.2**	**2,241.2**

Table Notes:

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

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

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	$863	$0	$0	$7	$581	$278	$0	**$1,729**
With Proposed Retrofits	$814	$0	$0	$2	$201	$278	$0	**$1,296**
Savings	$48	$0	$0	$5	$380	$0	$0	**$434**

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	
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) **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.

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit identifies and evaluates energy efficiency measures at the VPSO Office & Jail. 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 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 VPSO Office & Jail 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 Office & Jail is classified as being made up of the following activity areas:

1) Police Station: 384 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. Costs are considered to be accurate within +/-30% in this level of audit; 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:

- 3413 BTU/kWh
- 60% load factor for all motors unless otherwise stated
- 132,000 BTU/gallon of #1 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 & Jail EXISTING CONDITIONS

3.1. Building Description

The 384 square foot, single story VPSO Office & Jail was constructed in 2015. It is used by the VPSO as an office and when needed, the cells are used to hold prisoners. It has a normal occupancy of 1 person, and an occasional additional occupancy of 1 inmate. The hours of operation for this building are from 8:00am until 5:00pm and from midnight until 4:00am. When the holding cell is in use, occupancy is 24/7.

Description of Building Shell

There were no drawings or building plans available, so the details below are either assumed or based on observation. 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 but R-19 was assumed.

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 with low-E coatings 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.

Description of Heating and Cooling Plants

Toyo Laser 56

Nameplate Information:	Toyo Laser 56
Fuel Type:	#1 Oil
Input Rating:	22,000 BTU/hr
Steady State Efficiency:	84 %
Idle Loss:	0.5 %
Heat Distribution Type:	Air
Notes:	Nominal thermal efficiency when new is 87%; de-rated to 84% for age

Space Heating and Cooling Distribution Systems

There is no heating distribution system in this building.

Building Ventilation System

There is no mechanical 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
It appears that there was functional plumbing in this building at one time, but it was non-functional during the site survey.

Lighting
The interior lighting consists of single 2-lamp, 48" fixtures utilizing T8 florescent lamps and electronic ballasts and surface mounted and recessed can fixtures utilizing incandescent and LED, A-type bulbs. No lighting controls appear to be in use. Exterior lighting consists of a 2-bulb, 65w BR30 incandescent fixture 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) 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: Kwig Power Company - Commercial - Sm

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

Table 3.1 – Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.6700/kWh
#1 Oil	$ 4.50/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 Kwigillingok pays approximately $1,730 annually for electricity and other fuel costs for the VPSO Office & Jail.

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

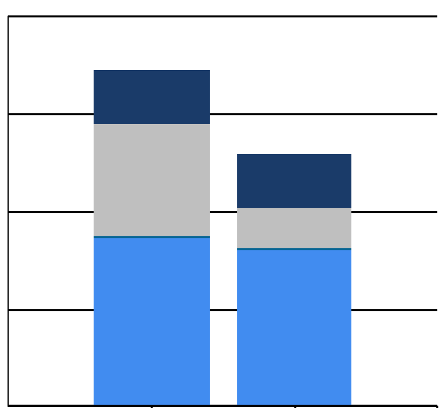


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

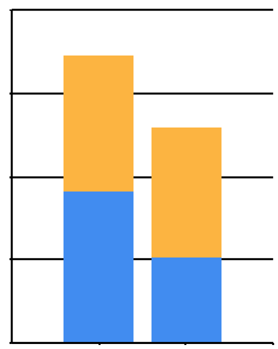
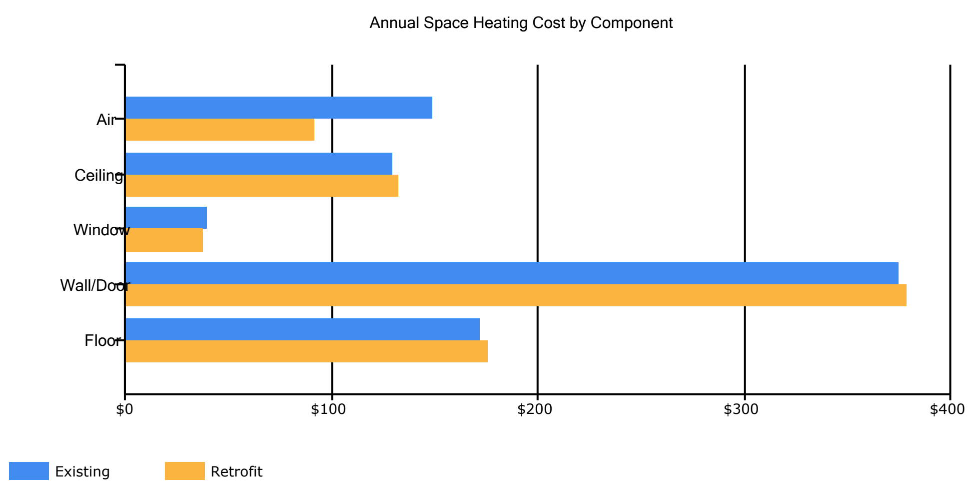


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing 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	10	8	8	6	3	2	1	1	2	5	8	9
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	74	67	74	71	74	71	74	74	71	74	71	74
Other_Electrical	35	32	35	34	35	34	35	35	34	35	34	35

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space_Heating	27	24	22	16	10	5	3	4	7	16	22	26
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 dividing 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 = <u>*(Electric Usage in kBtu + Gas Usage in kBtu + similar for other fuels)*</u>
Building Square Footage

Building Source EUI = <u>*(Electric Usage in kBtu X SS Ratio + Gas Usage in kBtu X SS Ratio + similar for other fuels)*</u>
Building Square Footage
where "SS Ratio" is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.4
VPSO Office & Jail 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	1,358 kWh	4,633	3.340	15,476
#1 Oil	182 gallons	24,044	1.010	24,285
Total		**28,678**		**39,760**
BUILDING AREA		384	Square Feet	
BUILDING SITE EUI		75	kBTU/Ft^2/Yr	
BUILDING SOURCE EUI		104	**kBTU/Ft^2/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	**74.7**	**6.44**	**$4.50**
With Proposed Retrofits	**66.0**	**5.69**	**$3.37**
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 Office & Jail, Kwigillingok, 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: Police Station	Implement a Heating Temperature Unoccupied Setback to 65.0 deg F for the Police Station space.	$56 / 1.6 MMBTU	$1	758.79	0.0	265.8
2	Ventilation	Add Occupancy sensor to bathroom light switch. Cost is included in bathroom lighting retrofit, EEM #7.	$70 / 1.8 MMBTU	$1	645.30	0.0	334.2
3	Lighting - Power Retrofit: Hall	Replace with LED 9W Module StdElectronic	$95 / 0.0 MMBTU	$5	156.06	0.1	505.6
4	Lighting - Power Retrofit: Artic Entry	Replace with LED 9W Module StdElectronic	$94 / 0.0 MMBTU	$5	154.04	0.1	500.4
5	Lighting - Power Retrofit: Storage INCAN 60W	Replace with LED 9W Module StdElectronic	$6 / 0.0 MMBTU	$5	15.85	0.9	30.4
6	Lighting - Power Retrofit: Office T8-2	Replace with 2 LED (2) 15W Module StdElectronic	$93 + $10 Maint. Savings / -0.1 MMBTU	$268	3.17	2.6	497.8
	TOTAL, cost-effective measures		**$414 + $10 Maint. Savings / 3.3 MMBTU**	**$285**	**13.63**	**0.7**	**2,134.2**
The following measures were *not* found to be cost-effective from a financial perspective but are still recommended:							
7	Lighting - Combined Retrofit: Bathroom INCAN	Replace with LED 9W Module StdElectronic and Controls retrofit	$20 / 0.0 MMBTU	$255	0.64	12.8	106.9

Table 4.1 VPSO Office & Jail, Kwigillingok, 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
	TOTAL, all measures		$434 + $10 Maint. Savings / 3.3 MMBTU	$540	7.50	1.2	2,241.2

4.2 Interactive Effects of Projects

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

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

Rank	Description			Recommendation	
2				Add Occupancy sensor to bathroom light switch. Cost is included in bathroom lighting retrofit, EEM #7.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$70
Breakeven Cost	$645	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.8 MMBTU
		Savings-to-Investment Ratio	645.3		
Auditors Notes:					

4.4.3 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
1	Police Station			Implement a Heating Temperature Unoccupied Setback to 65.0 deg F for the Police Station space.	
Installation Cost	$1	**Estimated Life of Measure (yrs)**	15	**Energy Savings ($/yr)**	$56
Breakeven Cost	$759	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	1.6 MMBTU
		Savings-to-Investment Ratio	758.8		
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**	
3	Hall		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)**	$95
Breakeven Cost		$780	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	156.1		
Auditors Notes: Replace (1) 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**	
4	Artic Entry		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)**	$94
Breakeven Cost		$770	**Simple Payback (yrs)**	0	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	154.0		
Auditors Notes:						

Rank	**Location**		**Existing Condition**		**Recommendation**	
5	Storage INCAN 60W		INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 9W Module StdElectronic	
Installation Cost		$5	**Estimated Life of Measure (yrs)**	20	**Energy Savings ($/yr)**	$6
Breakeven Cost		$79	**Simple Payback (yrs)**	1	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	15.8		
Auditors Notes: Replace (1) 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**	
6	Office T8-2		2 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with 2 LED (2) 15W Module StdElectronic	
Installation Cost		$268	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$93
Breakeven Cost		$850	**Simple Payback (yrs)**	3	**Energy Savings (MMBTU/yr)**	-0.1 MMBTU
			Savings-to-Investment Ratio	3.2	**Maintenance Savings ($/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 @ $125/hr. Replace (4) lamps with 15w T8 LED's @ $20 ea. Maintenance savings $5/fixture.						

Rank	**Location**		**Existing Condition**		**Recommendation**	
7	Bathroom INCAN		INCAN A Lamp, Std 60W with Manual Switching		Replace with LED 9W Module StdElectronic and Controls retrofit	
Installation Cost		$255	**Estimated Life of Measure (yrs)**	10	**Energy Savings ($/yr)**	$20
Breakeven Cost		$164	**Simple Payback (yrs)**	13	**Energy Savings (MMBTU/yr)**	0.0 MMBTU
			Savings-to-Investment Ratio	0.6		
Auditors Notes: Replace (1) A-type incandescent bulbs with (7 or 9)w A-type LED bulbs @ $5 ea. No labor, owner to install: Add (1) switch mounted occupancy sensors @ $125 ea parts + 1 hr labor @ $125/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

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**
Well Pump	Flojet model 2840-000	4.5 @ 3	1.5a/115/1	Potable water booster

HEAT PLANT SCHEDULE				
SYMBOL	**MFGR/MODEL**	**NOMINAL EFFICIENCY**	**MOTOR DATA HP/VOLTS/PH**	**REMARKS**
	Toyo Laser 56	88%	60w/120/1	22 MBH input

PLUMBING FIXTURES				
SYMBOL	**FIXTURE**	**GPF**	**QUANTITY**	**REMARKS**
	W.C.		1	Non-functional, honey bucket in use
	Lavatory		1	Non-functional

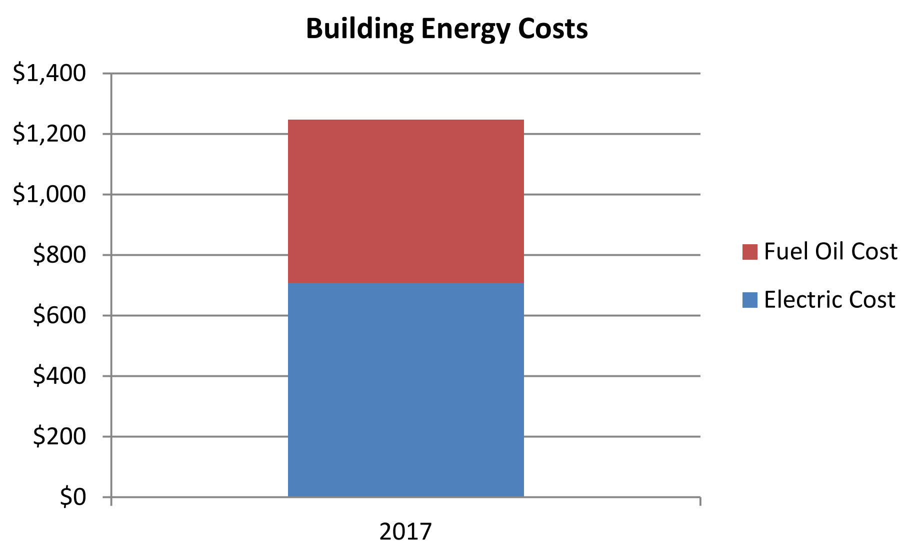
Appendix B – Benchmark Analysis and Utility Source Data

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. Twelve months of 2017 electric data was provided by the owner, but as previously mentioned, when the building consumes less than 60 kWh/month, there is no recording of consumption and no charge. So, 6 of the 12 months of 2017 data are blank. 50 kWh/mo was the assumed consumption during these months, and this is the data used to calibrate the AkWarm-C model. Fuel oil delivery was estimated by the owner to be 120 gallons/year but this figure is too low, so the oil consumption used in this analysis was that predicted by the AkWarm-C model. Figures B.1 and B.2 summarize the energy 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

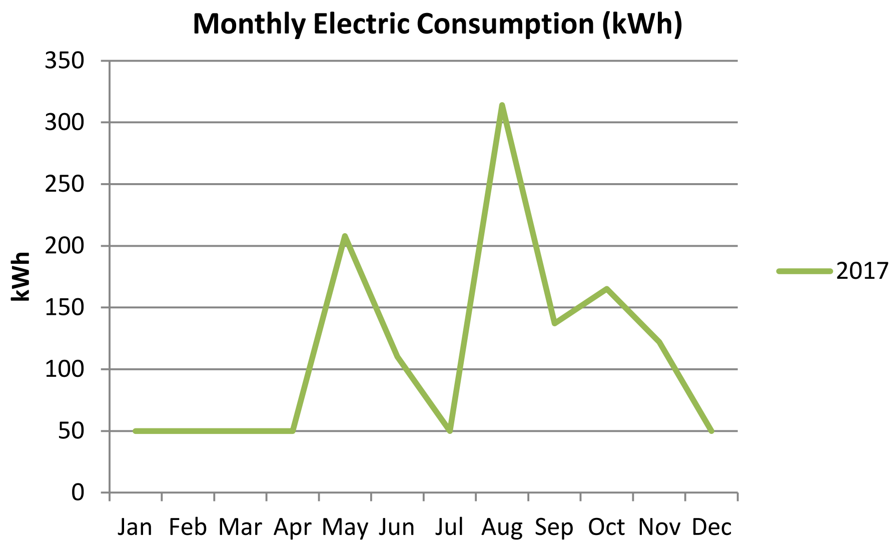
KWIG VPSO BUILDING						
	Elec. Consumption (kWh)	Electric Cost	Fuel Oil use	Fuel oil Cost	Total kBTU's of Energy	Total Utility Cost
2017 data provided by owner	1,056	$708	120	$540	20,468	$1,248
2017 used in AkWarm	1,356	$909	182	$819	24,024	$1,728

Figure B.2 - Costs



Electricity: The erratic monthly consumption shown in Figure B.3 renders any kind of benchmark analysis inconclusive.

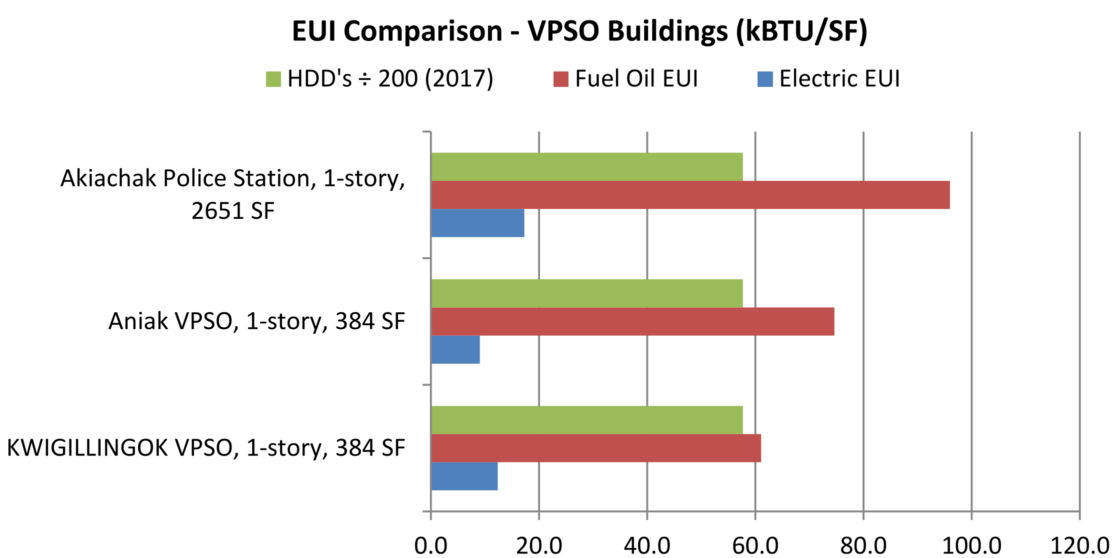
Figure B.3 – 3 Years of monthly Electric Consumption



Fuel Oil: Because fuel oil delivery was only estimated, no benchmarking can be performed on this building.

Comparing EUIs: Figure B.4 and the discussion in Section 1.5 above show that this building's heating system and/or envelope and its electric consumption are more efficient than the Akiachak police station. Since the Aniak and Kwig buildings are identical, the differences in their heating and electric EUI are due strictly to their use and occupancy.

Figure B.4 – EUIs



After performing the 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. Because the data is not representative of the building's actual consumption, the data in Figure B.5 below was used in and generated by the AkWarm-C model.

Figure B.5 – Benchmark Utility Data

ELECTRIC						
	2015		2016		2017	
	kWh	Cost	kWh	Cost	kWh	Cost
Jan	0	$0	0	$0	50	$0
Feb	0	$0	0	$0	50	$0
Mar	0	$0	0	$0	50	$0
Apr	0	$0	0	$0	50	$0
May	0	$0	0	$0	208	$139
Jun	0	$0	0	$0	110	$74
Jul	0	$0	0	$0	50	$0
Aug	0	$0	0	$0	314	$210
Sep	0	$0	0	$0	137	$92
Oct	0	$0	0	$0	165	$111
Nov	0	$0	0	$0	122	$82
Dec	0	$0	0	$0	50	$0
Total	**0**	**$0**	**0**	**$0**	**1,356**	**$708**
assume 50 kWh/mo when no charges						

FUEL OIL						
	2015		2016		2017	
	gallons	Cost	gallons	Cost	gallons	Cost
Jan	0	$0	0	$0	0	$0
Feb	0	$0	0	$0	0	$0
Mar	0	$0	0	$0	0	$0
Apr	0	$0	0	$0	0	$0
May	0	$0	0	$0	0	$0
Jun	0	$0	0	$0	0	$0
Jul	0	$0	0	$0	0	$0
Aug	0	$0	0	$0	0	$0
Sep	0	$0	0	$0	0	$0
Oct	0	$0	0	$0	0	$0
Nov	0	$0	0	$0	0	$0
Dec	0	$0	0	$0	0	$0
Total	**0**	**$0**	**0**	**$0**	**120**	**$540**
120 gallons/yr is not realistic, use AkWarm's 182 gal. prediction						

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 Office & Jail	**Auditor Company:** Energy Audits of Alaska
Address: Kwigillingok, AK	**Auditor Name:** Jim Fowler, PE, CEM
City: Kwigillingok **Client Name:** Richard John	**Auditor Address:** 200 W 34th Ave, Suite 1018 Anchorage, AK 99503
Client Address: P.O. Box 90 Kwigillingok, AK 99622	**Auditor Phone:** (907) 269-4350 **Auditor FAX:**
Client Phone: (907) 588-8114 **Client FAX:**	**Auditor Comment:**
Design Data	
Building Area: 384 square feet	**Design Space Heating Load:** Design Loss at Space: 13,410 Btu/hour with Distribution Losses: 13,410 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 20,443 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 people	**Design Indoor Temperature:** 68 deg F (building average)
Actual City: Kwigillingok	**Design Outdoor Temperature:** -19.1 deg F
Weather/Fuel City: Kwigillingok	**Heating Degree Days:** 11,596 deg F-days
Utility Information	
Electric Utility: Kwig Power Company - Commercial - Sm	**Natural Gas Provider:** None
Average Annual Cost/kWh: $0.670/kWh	**Average Annual Cost/ccf:** $0.000/ccf

Annual Energy Cost Estimate

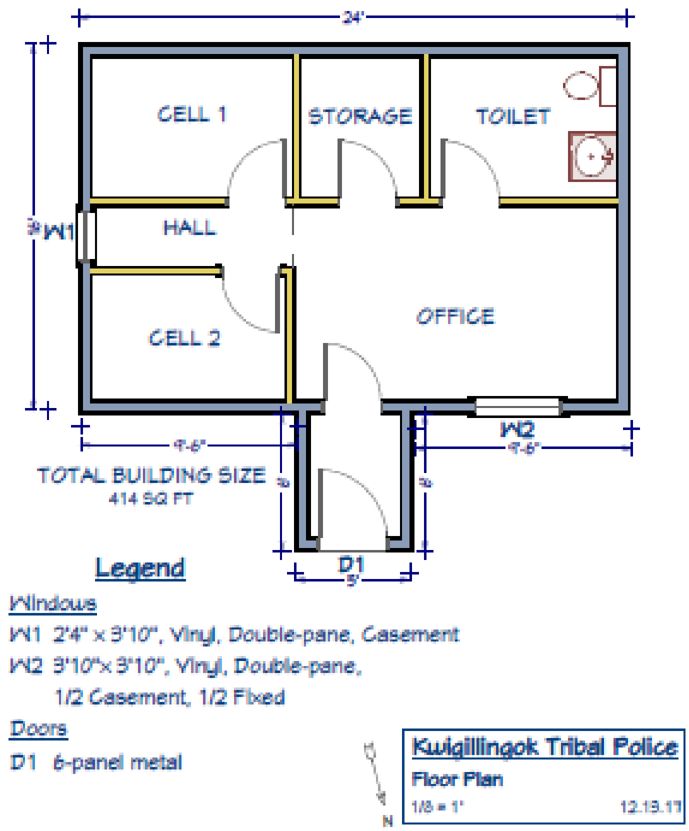
Description	Space Heating	Space Cooling	Water Heating	Ventilation Fans	Lighting	Other Electrical	Service Fees	Total Cost
Existing Building	$863	$0	$0	$7	$581	$278	$0	**$1,729**
With Proposed Retrofits	$814	$0	$0	$2	$201	$278	$0	**$1,296**
Savings	$48	$0	$0	$5	$380	$0	$0	**$434**

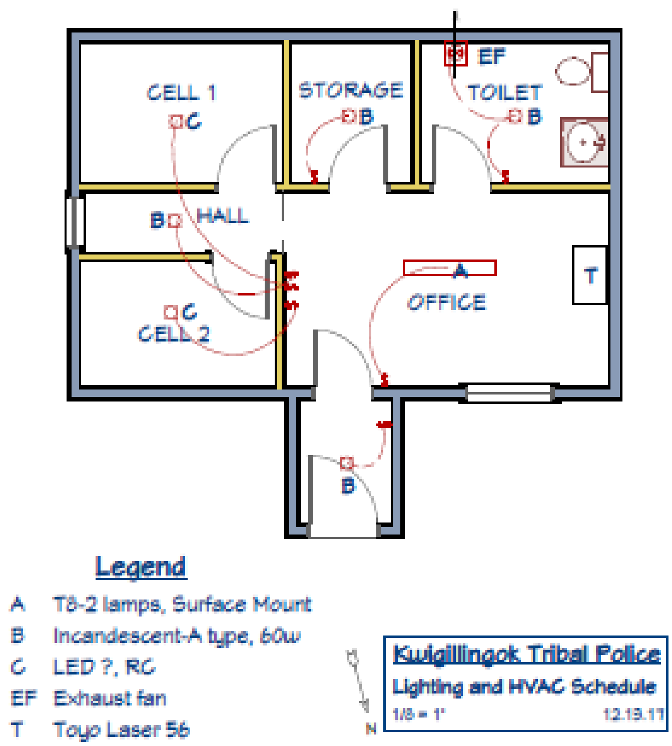
Building Benchmarks

Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	74.7	6.44	$4.50
With Proposed Retrofits	66.0	5.69	$3.37

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

Posts and pads

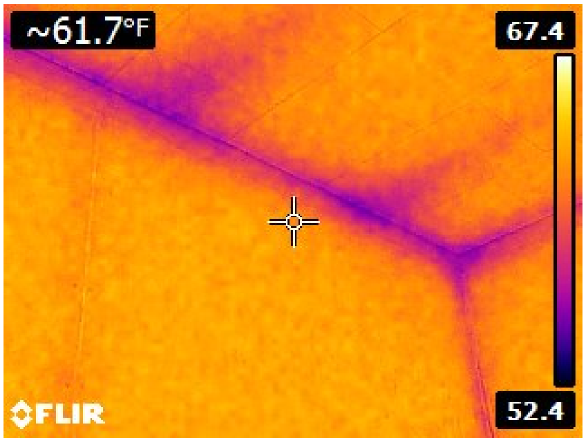
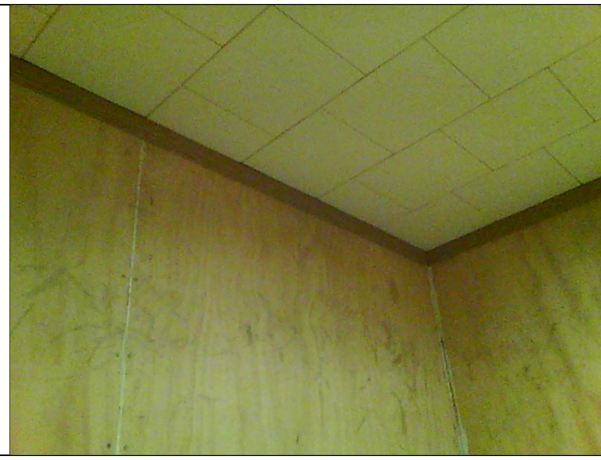
Floor support joists

Interior office

Potable water booster pump and pressure tank (presumed to be non-functional)

Non-functional WC and lavatory; honey bucket in use

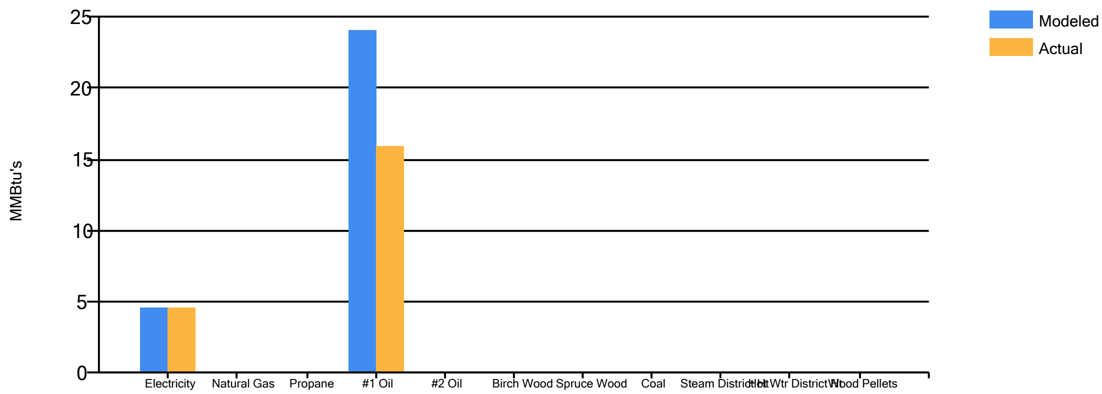
1. Main entry door, in average condition

	
2. Attic insulation in average condition	

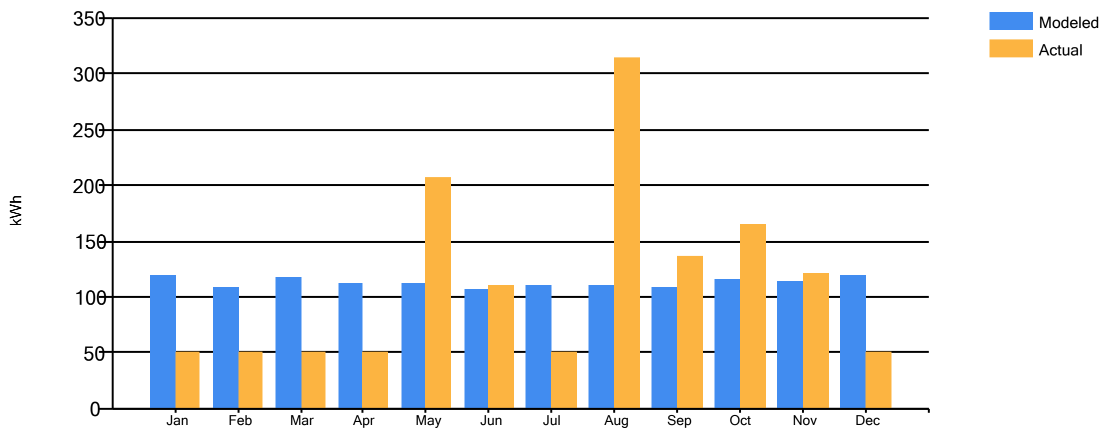
Appendix F – Actual Fuel Use versus Modeled Fuel Use

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

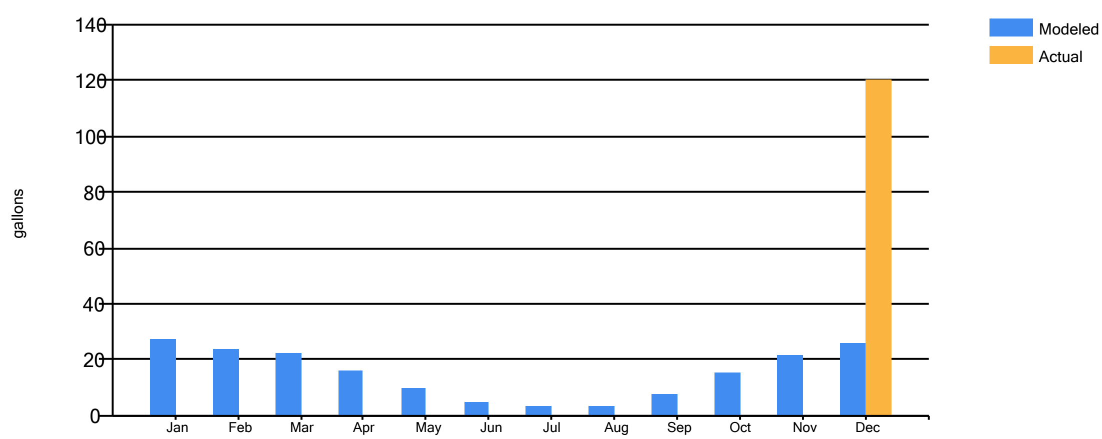
Annual Fuel Use – the yellow bar is the owner's estimate of annual consumption, the blue bar is AkWarm-C's prediction of fuel use



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

Appendices H, I & J
Accompanying Level 2+ Commercial Energy Audits on KWIGILLINGOK 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.

Heating, ventilation, and air-conditioning (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:

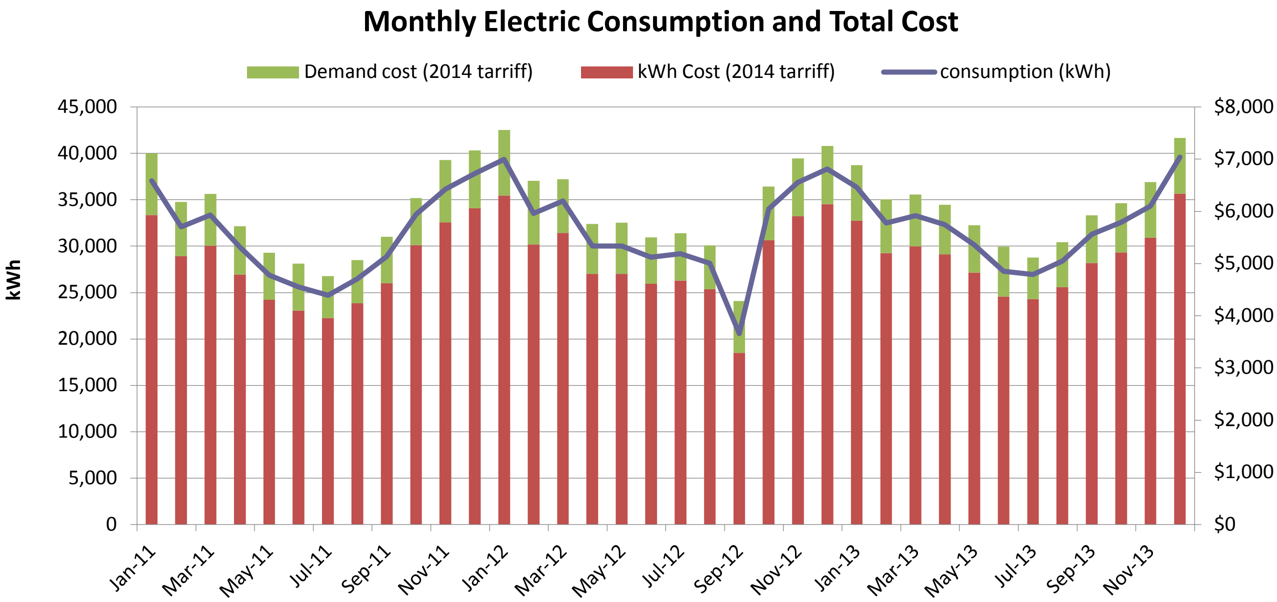
- Manually over-ridden automatic control settings including programmable thermostats, motor control switches, disabled variable frequency motor drives.
- Timer clocks not used or disabled
- Duct and/or valve leakage or dysfunction
- Pumps, fans or actuators not operating correctly
- Scheduling, resets 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 Direct Digital Control (DDC) control systems. Some systems do not have the capability to monitor natural gas 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. 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.

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 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	
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)

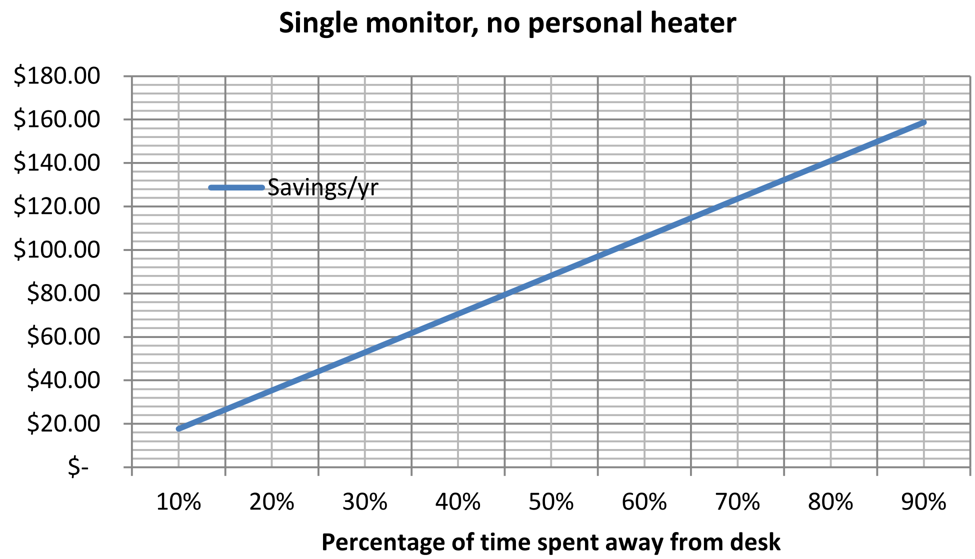
3) **Efficient Building Management:** Certain EEMs and ECMs are recommended to improve the efficiency of building management. As an example, all lights should be upgraded at the same time, all lamps should be replaced as a preventative maintenance activity (rather than as they fail, one at a time), lamp 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.

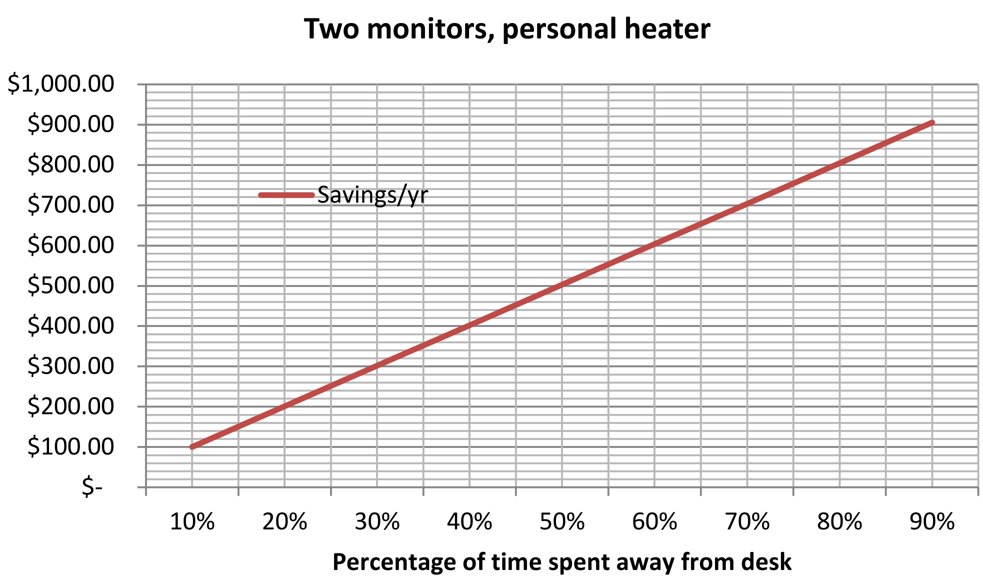
   Other examples of efficient building management include:
   - If a building is only partially occupied and has adequate zoning, group occupants together in the same heating zone and turn down the heat and turn off lighting in the unoccupied zones.
   - Conversion from an 8 hr. per day, 5-day work to 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 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 G can be purchased for as little as $15.

c. At their end of 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. 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 LED's.
- 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

[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.

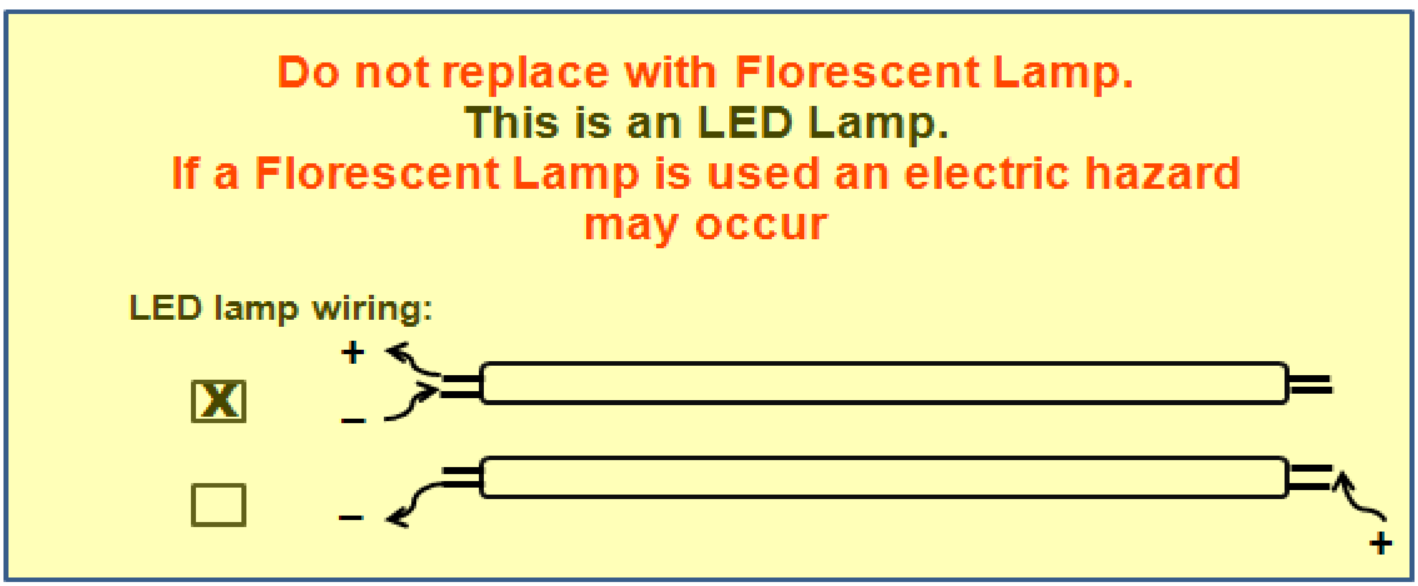
recommended for long corridors, large vehicle bays and large storage areas with multiple switches and lighting zones. Zoned controls are designed to activate and de-activate lighting by zone, by row, or even by fixture, based on the location of the occupant. **Step-Dim occupancy sensors** turn on a portion 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. In order to maintain a fixture's regulatory certifications (UL, for example), the re-wiring must be performed by a qualified electrician.

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



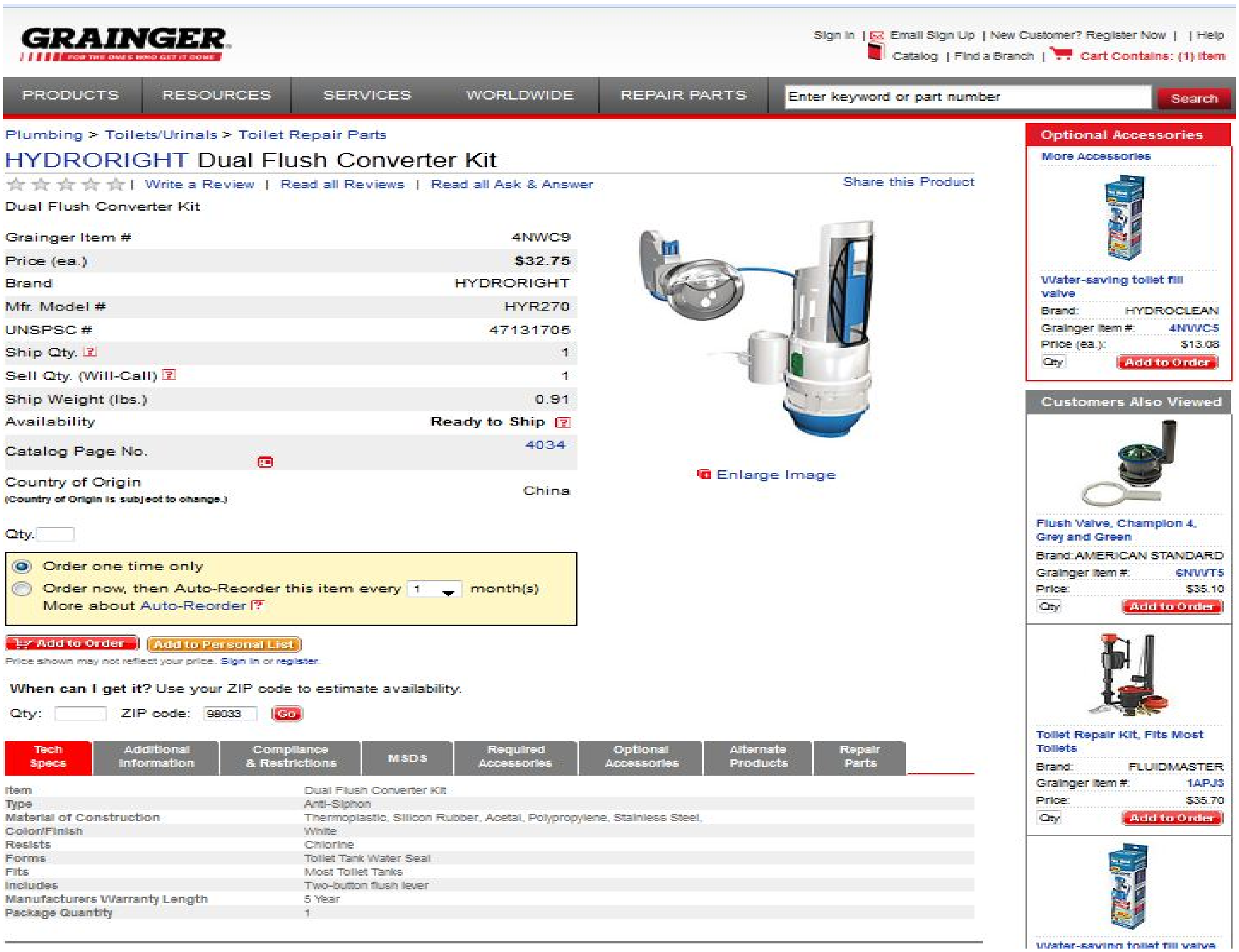
LED Screw-in bulbs (Type A)
A-type, screw-in bulbs, typically using 4.5 to 9.5 watts (40w to 75w equivalent), are now available at a cost of less than $5.00 each, and often for as little as $2.00 when subsidized. LED reflector bulbs, including PAR30 (3.75" diameter) and PAR36 (4.5" diameter) sizes, typically 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

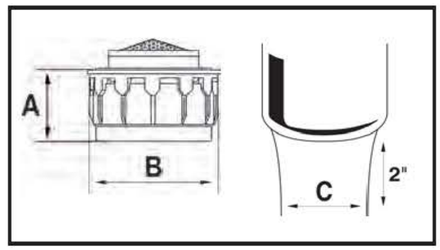
Low Flow Aerator – 1.5 gpm

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

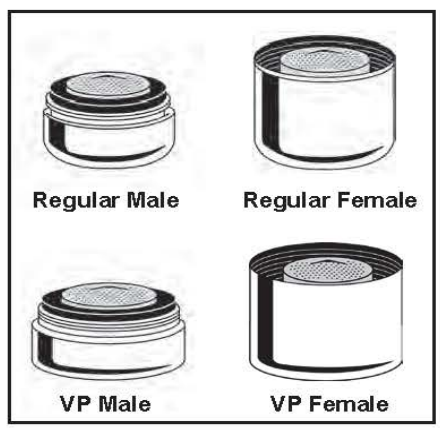
PART NUMBERS* & PACKING

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

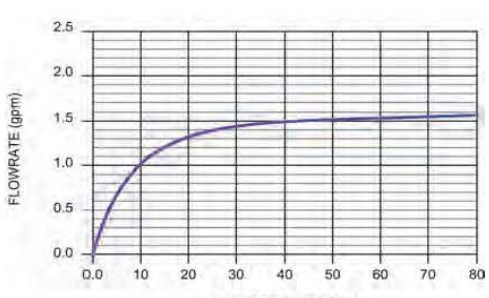
DIMENSIONS

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, TV's and anything with a "sleep" cycle – schedule to turn devices completely off during unoccupied hours

APC by Schneider Electric | United States [change]

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Product information | Search

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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

Add to Cart

Email Technical Specifications

Printer Friendly

RoHS Green Premium

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?

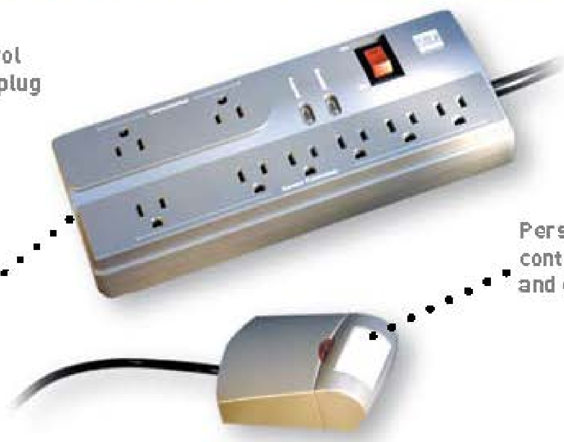
A single workspace can consume 1,500 kWh each year with an average cost of $175 (and growing)! Add up the cost of every workspace and the amount is staggering. Isolé can dramatically cut this cost with energy savings of up to 50%.

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

Specifications

Power Strip:

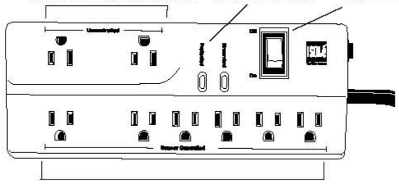
- Electrical rating: 120VAC, 12A, 50/60 Hz
- 12A dry contact relay
- Six-foot black cord
- Transformer provides power to sensor
- Mounts with screws or double-sided tape
- UL 1449 rating: 600V
- Circuit: High-energy, multistage hybrid
- Noise filtration: 0-25db (94.38%)
- Joule rating: 740 joules
- Maximum 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

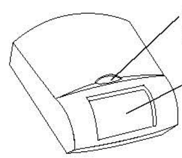
Personal Sensor:

- Nine-foot connector cable
- Supply voltage: 12 VDC
- UL and CUL listed; five-year warranty

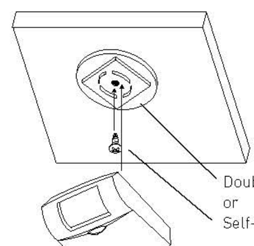
Controls & Mounting

Product Controls





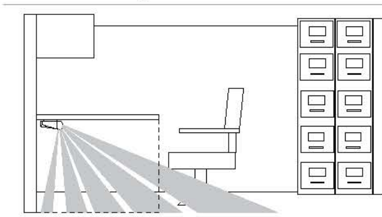
Personal Sensor Mounting



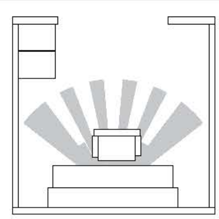
Sensor mounts under desk or binder bin with double-sided tape or self-taping screw

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)

amazon prime | All | wifi line voltage thermostat

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1-16 of 21 results for "wifi line voltage thermostat"

Honeywell TL8230A1003 Line Volt Thermostat 240/208 VAC 7 Day Programmble
by Honeywell
$46.68 prime
In stock on June 19, 2017
397
More Buying Choices
$46.68 (20 new offers)

Honeywell RLV4305A1000/E 5-2 Day Programmable Thermostat for Electric Baseboard Heaters
by Honeywell
$44.20 ~~$49.99~~ prime
Get it by **Monday, Jun 19**
149
More Buying Choices
$24.95 (56 used & new offers)

With Wi-Fi capability

King Electric ATMOZ1-240-WIFI Wi-Fi Programmable Line Voltage Thermostat, White
by King Electric
$106.95 prime
Only 7 left in stock - order soon.
3
More Buying Choices
$85.56 (8 used & new offers)

Product Description
... The atmos *WiFi* enabled *thermostat* & smart phone app! king's atmoz WiFi ...

Programmable, 7-day set-back, low voltage thermostat (with Wi-Fi capability)

Home: Heating & Cooling: Thermostats: Programmable Thermostats:
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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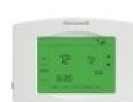
Description | **Specifications** | Reviews | Community Q&A

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

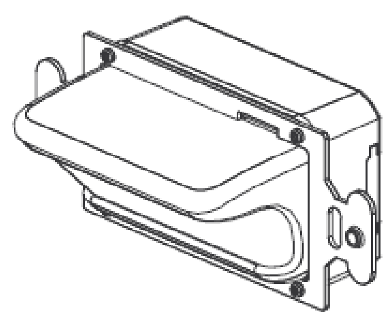
Product Overview

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

GREENTEK ENERGY SYSTEMS

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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)

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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

Add to Wishlist | Add to Compare

Availability: In stock

Retail Price: $15.00

Special Price: $10.75

Qty 0

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Compare Products

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 – used with line voltage (after bypassing or removal of ballast)

LED Linear Lighting

L4T8B/8XX/14F/DE-39
Rev. 01

Job Name/Title:______________________________ Catalog Number__________________
Contractor:__________________________________ Notes:__________________________

LED Linear Lighting

14W 4 Ft Double-Ended LED Retrofit Frosted T8 with Internal Driver Ballast By-Pass

Features

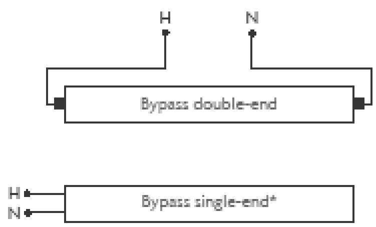
- Bypass double-end connection minimizes labor and eliminates need for additional non-shunted sockets
- Extremely long life and energy efficient
- Alternate to install as single-end bypass*
- Easy and safe replacement for fluorescent T8 systems

Specs

- 14W
- 120-277V
- 82 CRI
- 50,000 Average Rated Life
- 210° Beam angle
- -20°C to 40°C Ambient temperature

Applications

- Office, retail, hospitality, warehouse



G13 Bi-pin Base

Catalog Number	Product Code	UPC Code	Color Temp	Watts	Lumens	LPW	Case Qty	DLC
L4T8B/835/14F/DE-39	78565	751338016170	3500K	14	1,700	121	1/10	Y
L4T8B/840/14F/DE-39	78566	751338016187	4000K	14	1,800	129	1/10	Y
L4T8B/850/14F/DE-39	78567	751338016200	5000K	14	1,800	129	1/10	Y
L4T8B/865/14F/DE-39	78568	751338016217	6500K	14	1,800	129	1/10	-

Specifications are subject to change without prior notice.
*Requires non-shunted lampholder for single end operation

TOPAZ New York | California | Florida | www.topaz-usa.com | 800.666.2852 | Fax: 631.654.1261

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

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

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This product can be found in LED Bulbs › LED Linear

Printer friendly

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

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

LM79
LM80

"BIAX to LED"

LEDBIAX®

Replaces the following:

17in or 21in 2G11 BIAX fluorescent lamps

High LPW OSRAM LED:

OSRAM

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

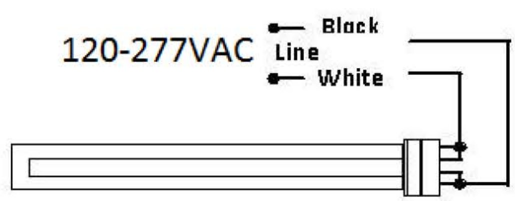
Finish: White bottom, Diffused lens

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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- Dimmable LED Light Bulbs
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- G16 G25 G40 Globe LEDs
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- LED Security Lights
- LED Under Cabinet
- LED Vintage Filament Bulbs
- PAR16/20/30/38 LED Bulbs
- Patio/Party Lights
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- 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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- Product Documentation
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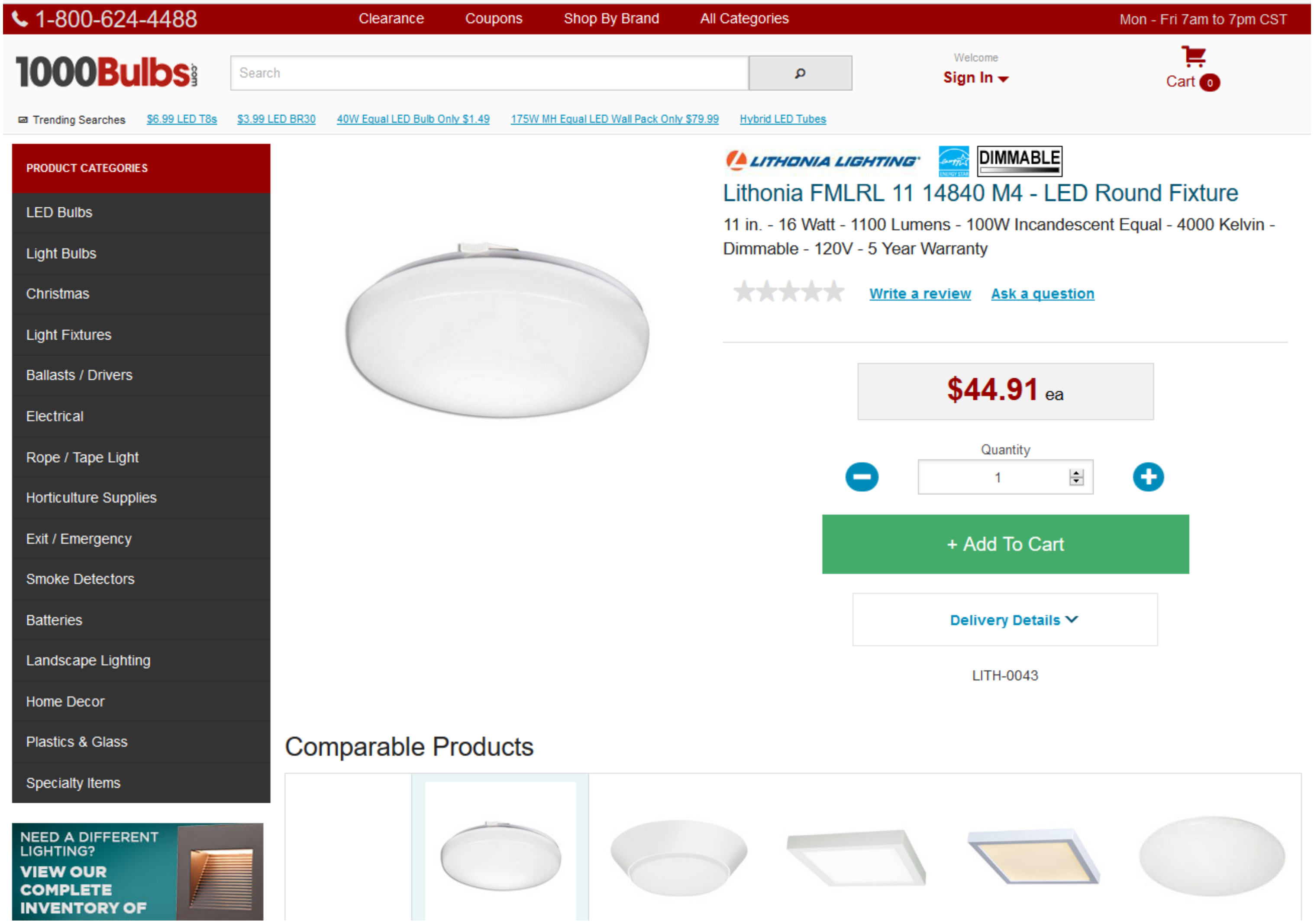
New Arrivals

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)[2]	60	5,500	92	70
NEUTRAL WHITE (3985K +/- 275K)[2]	60	5,400	90	70
BAFFLE (BAFY) WITH CLEAR LENS				
COOL WHITE (5200K +/- 475K)[2]	60	5,500	92	70
NEUTRAL WHITE (3985K +/- 275K)[2]	60	5,300	88	70
FROSTED LENS (FROST)				
COOL WHITE (5200K +/- 475K)[2]	60	4,500	75	70
NEUTRAL WHITE (3985K +/- 275K)[2]	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)

[1]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)

[4]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)

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

LED Wall Pack replacement for entry lighting – replacement for 50w HPS

Questions? Give us a call! 800-701-1371 M-F 7:30am - 5:00pm CST

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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

Add to cart

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

WALLPACKS DIRECT
LED Lighting Supplier
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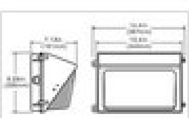
Home > Forward Throw Wall Packs > 60W Forward Throw LED Wall Pack



60W Forward Throw LED Wall Pack

$219.90

60W Forward Throw LED Wall Pack

Quantity

1

Add to cart

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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LED Lighting Supplier • 855-620-9651

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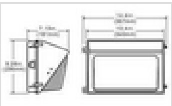
Home > LED Wall Pack Lighting > 90W Forward Throw LED Wall Pack - Bronze

90W Forward Throw LED Wall Pack - Bronze



90W Forward Throw LED Wall Pack - Bronze

$298.90

WP3FT-90-BRZ

Quantity

1

Add to cart

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)

HID LED Directional Replacement 70 Watt Retrofit 5500K 110-277V

Olympia

CL-20W8-55K-E26R

$84.11

POWERED BY CREE

Qty: 0 Add to Cart

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McAfee SECURE

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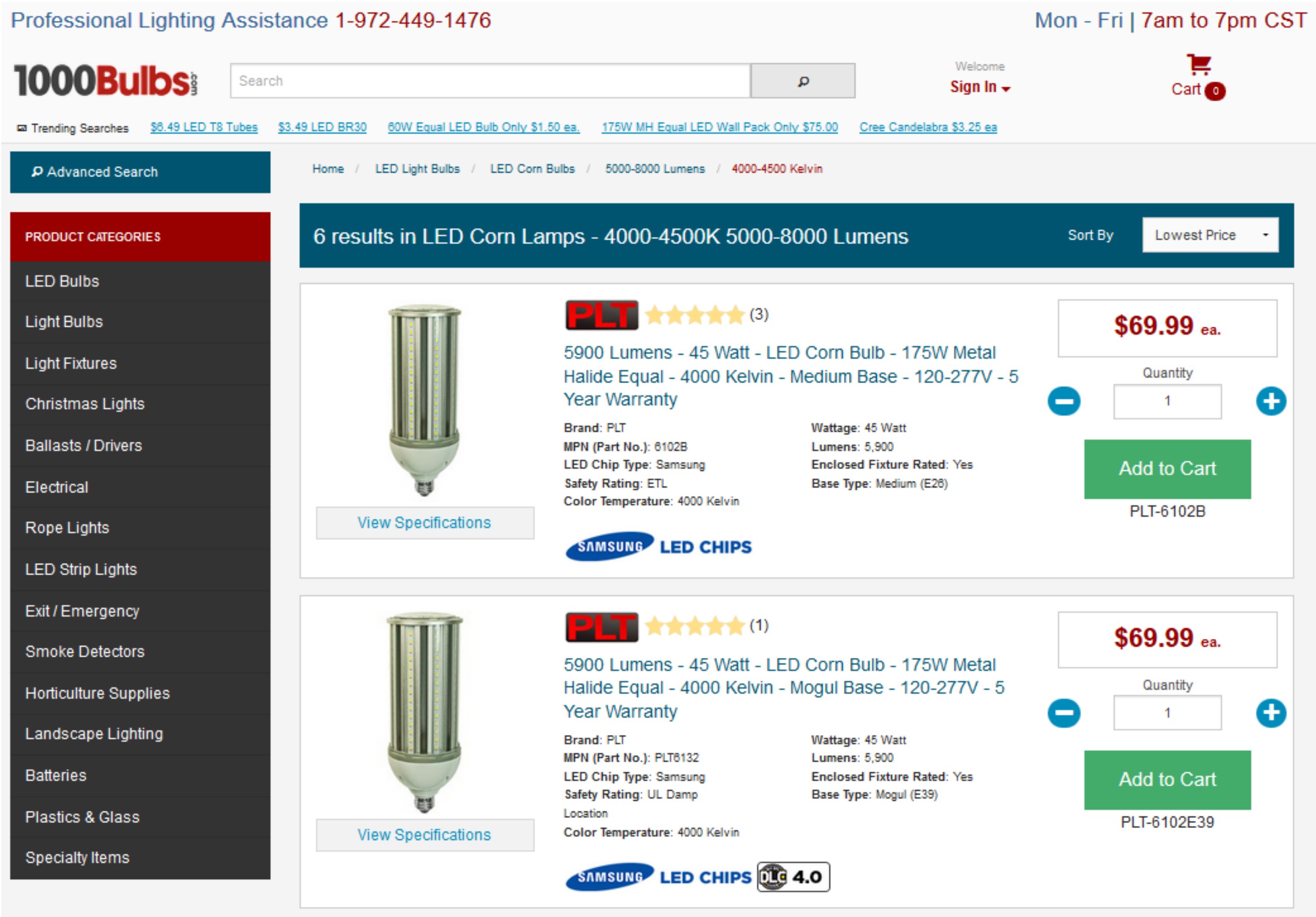
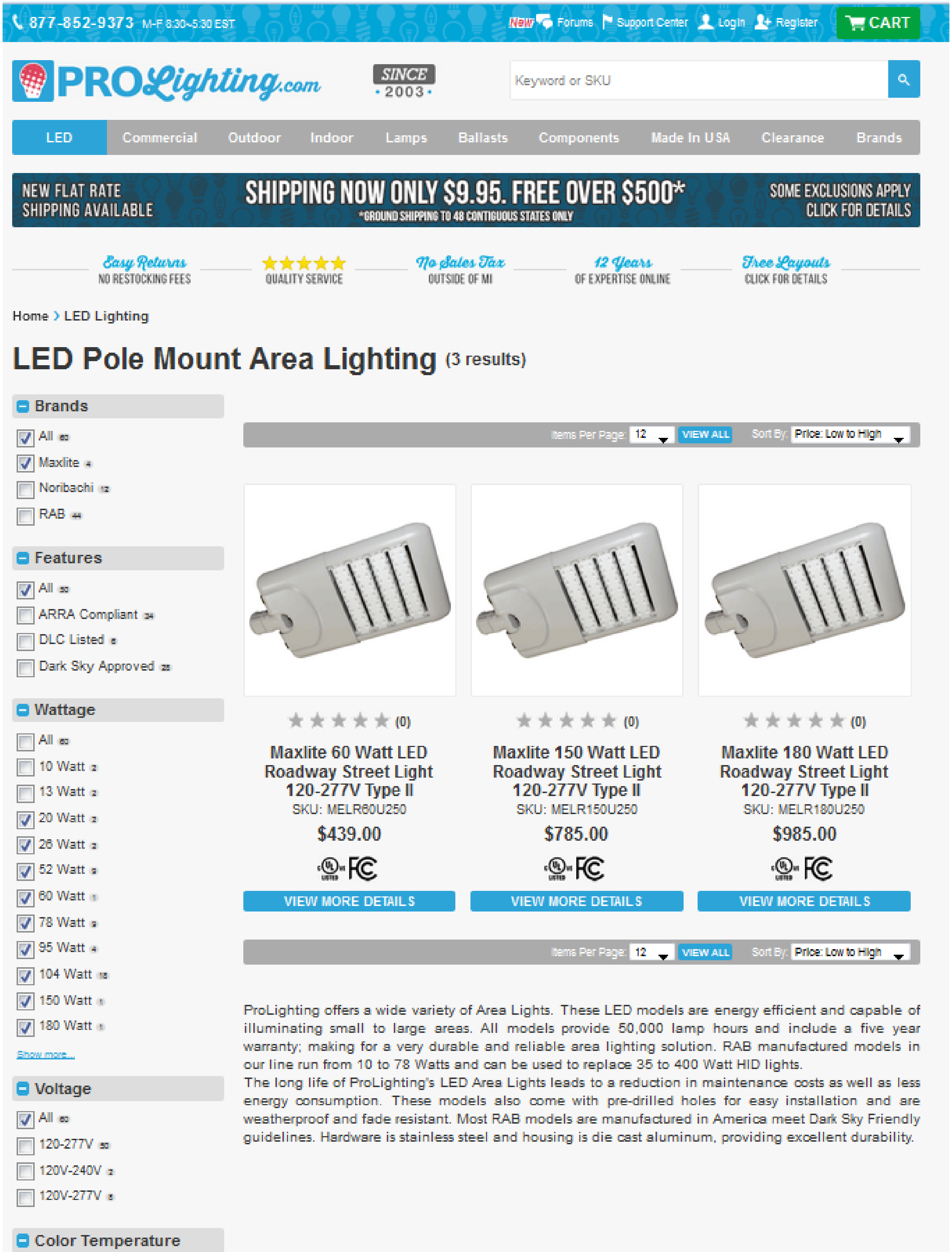
Quick Overview of HID LED Directional Replacement 70 Watt Retrofit 5500K 110-277V

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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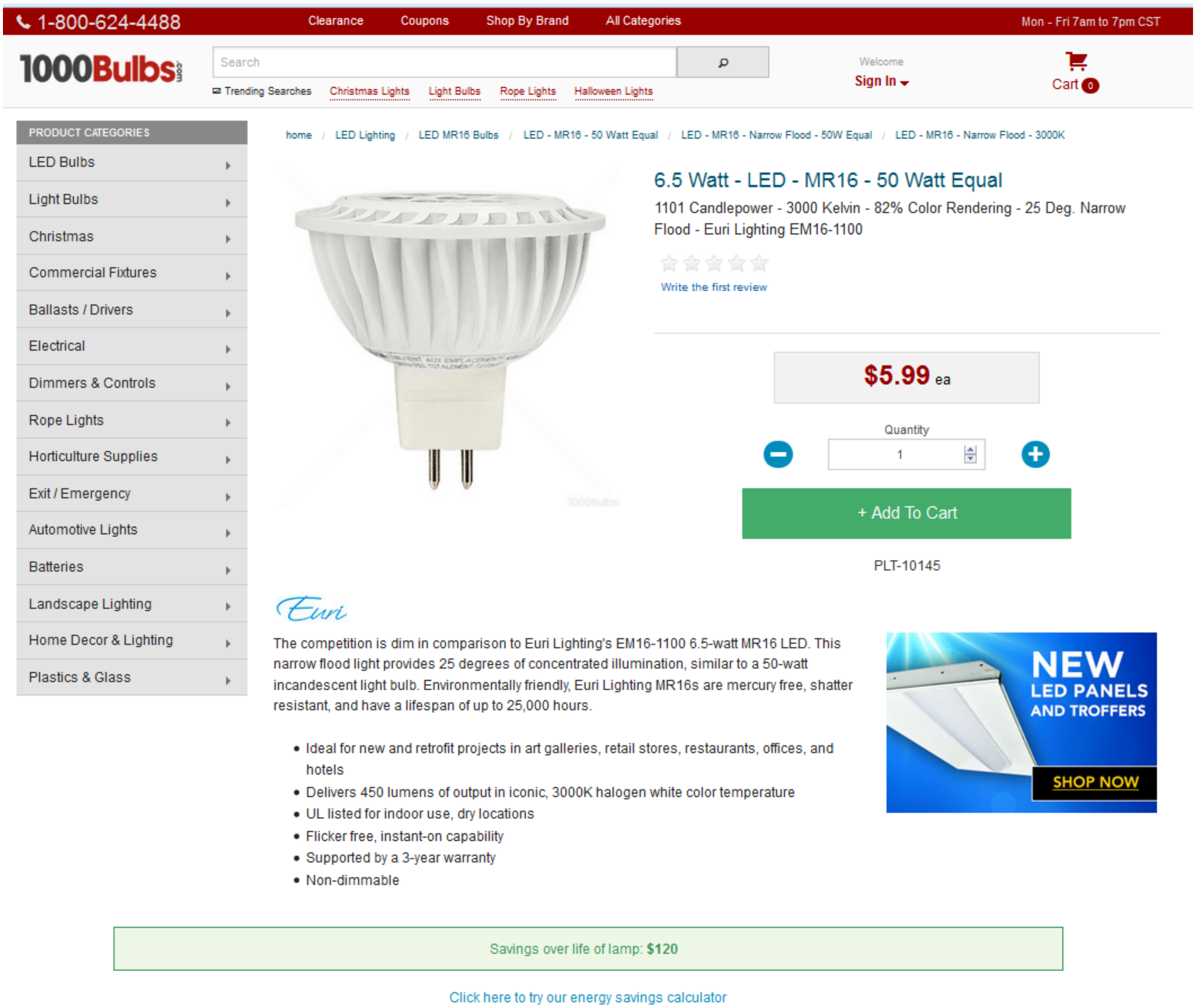
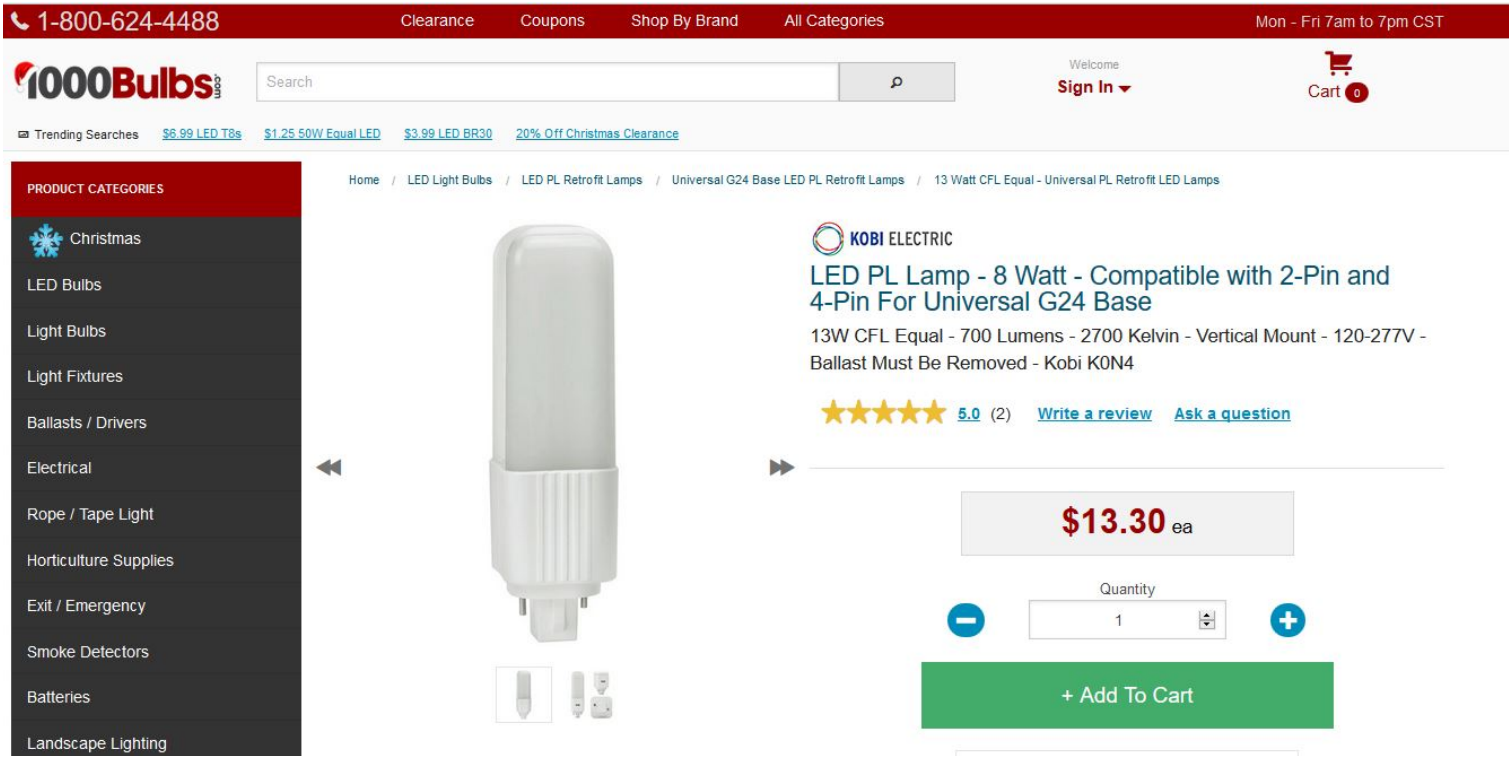
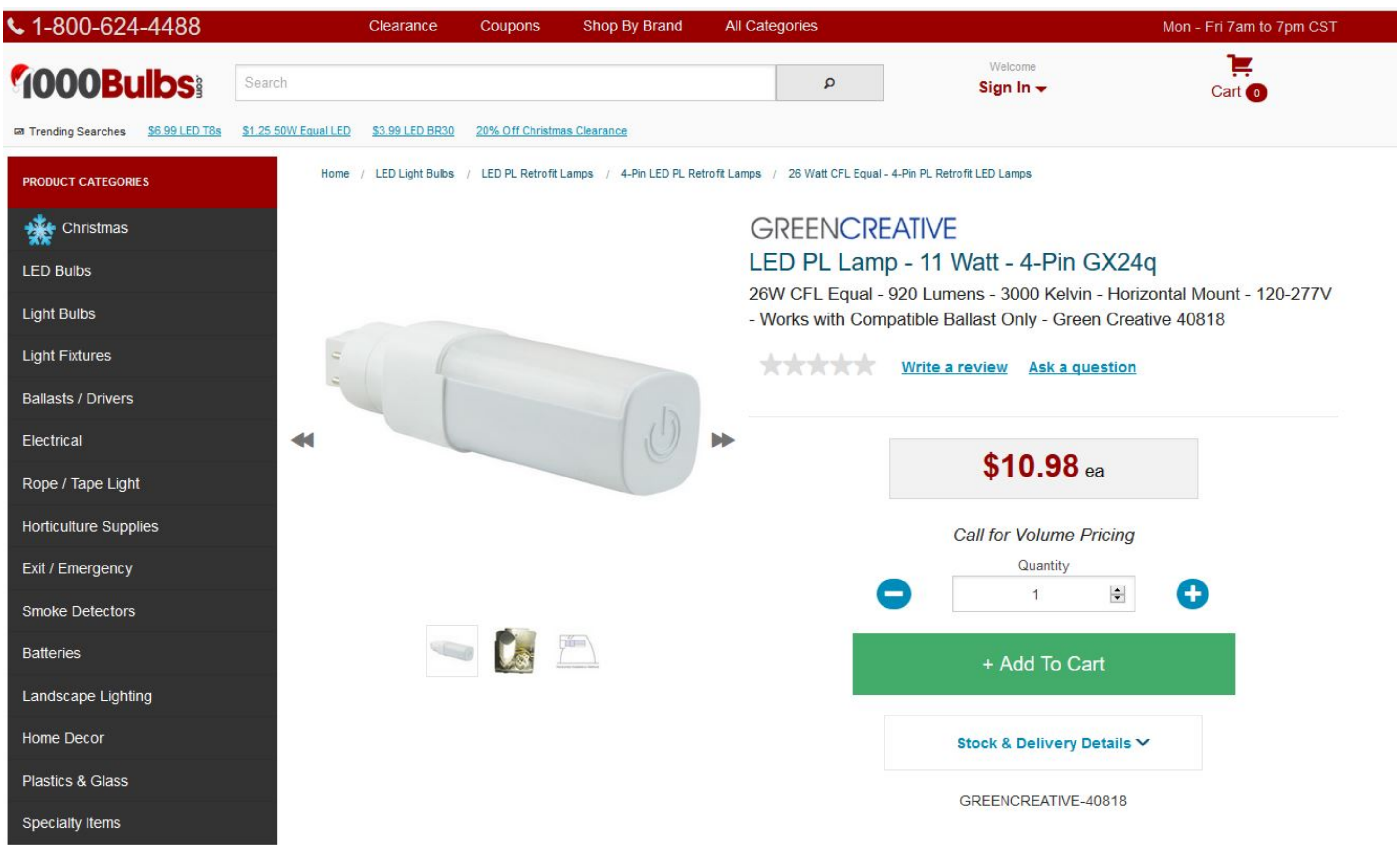
LED replacement for 50w MR-16 lamp



LED replacement for 13w & 26 w CFL Plug-in lamps

(ballast may need to be removed or bypassed, depending on fixture)





LED retrofit for recessed can

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now in: recessed lighting > led recessed lighting > led retrofit modules for recessed lights > 6 inch - 9.5 watt - 50 watt replacement - dimmable led downlight retrofit module - gu24 base - wet location - cree

6 Inch - 9.5 Watt - 50 Watt Replacement - Dimmable LED Downlight Retrofit Module - GU24 Base - Wet Location - Cree

ACCREDITED BUSINESS BBB. Click for Review | STELLA SERVICE EXCELLENT

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

Add to my cart safe. secure.

Need Assistance?

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GU24 Socket Adapter for LED Retrofit Modules

ACCREDITED BUSINESS BBB. 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

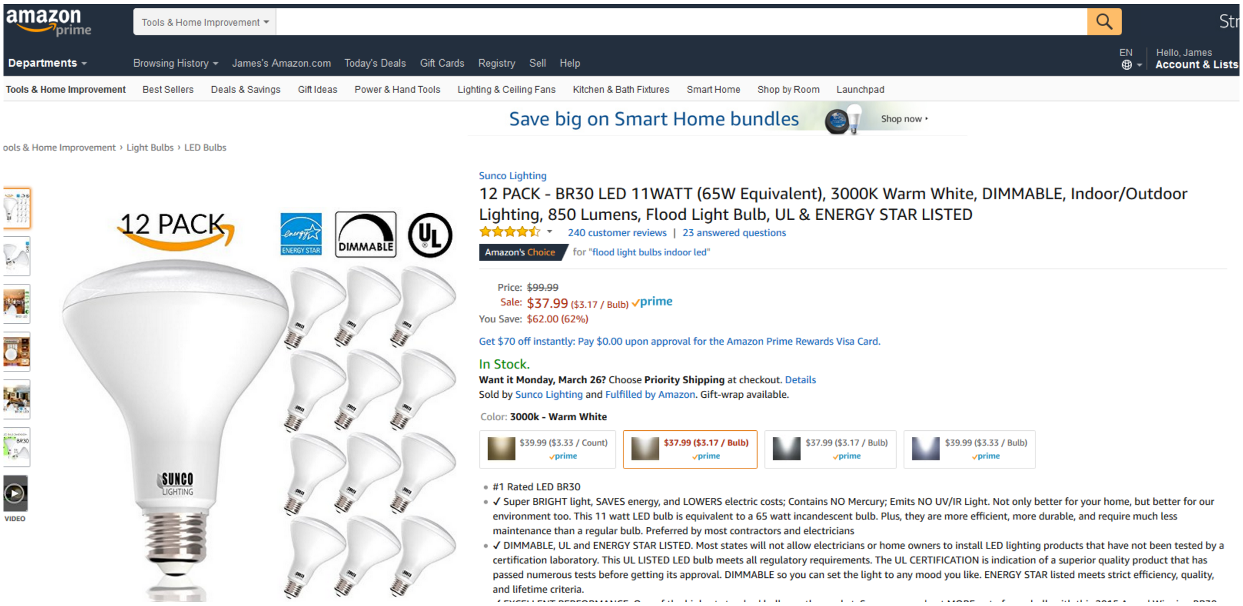
Description

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

Free ground shipping on orders over $100
For large or tax exempt orders, click here

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Renu Energy Efficient Home Commercial Electric Vehicle Home Automation Bundles Promotions

Click the image to zoom.

2

Videos

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).

Quantity: 1

Availability: Usually ships in 1 to 2 days

add to cart

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

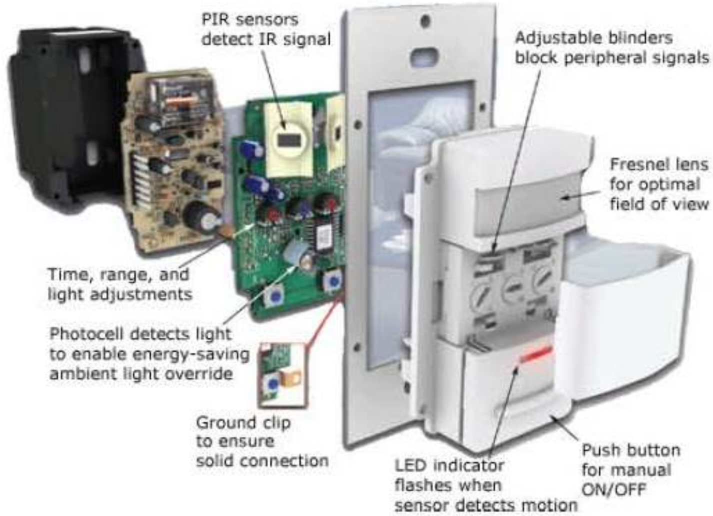
* Segmented Fresnel lens contains 79 segments for optimum sensitivity and detection performance

For California residents, click here for Proposition 65 Warning.

Switch mounted occupancy sensors

LEVITON 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

OSFHU

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

OSFHU

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

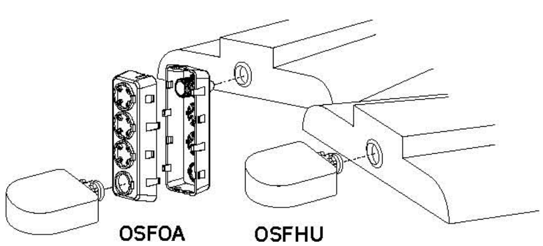
High Inrush Stability (H.I.S. Technology):
- Zero crossing circuitry optimizes relay operation for reliable, long-life operation
- Robust mechanical latching relay is durable for all load types

Auto temperature calibration: automatically adjusts the PIR sensitivity as ambient temperature rises to increase detection of heat movement through the field-of-view

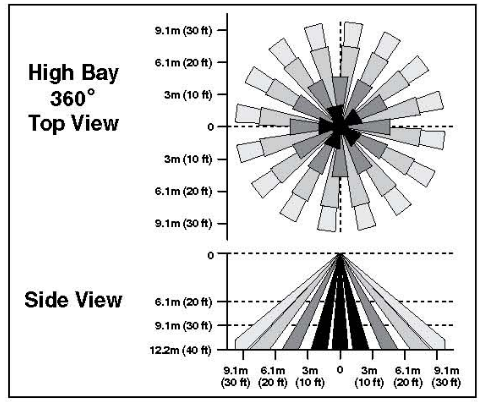
Return to last state: for safety and energy savings, the OSFHU contains a latching relay so that in the event power is lost to the device, the device will return to the last known state of the relay

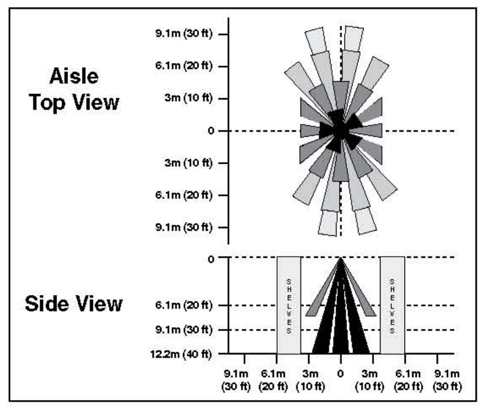
False detection intelligence: for increased energy savings and to mitigate nuisance tripping, the super bright LED indicates advanced detection has been activated and the lights will only turn ON when true occupancy has been determined

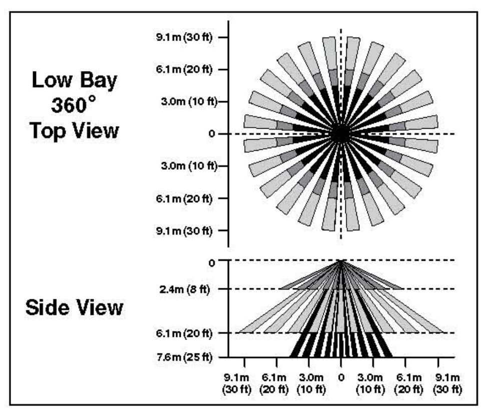
ASSEMBLY WITH OFF-SET ADAPTOR



FIELD-OF-VIEW





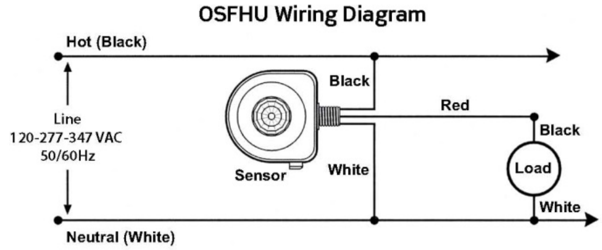


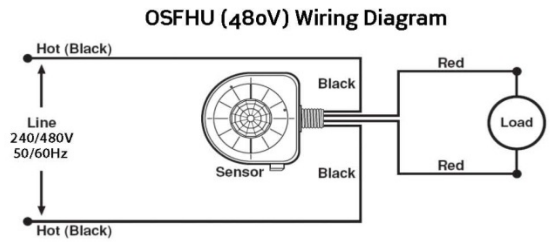
LEVITON®

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
201 N. Service Rd. Melville, NY 11747-3138 Tech Line: 1-800-824-3005 Fax: 1-800-832-9538 www.leviton.com/les

DHW re-circulation pump with integral timer

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

ADD TO CART

Add to list

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**
Brand	TORK
Mfr. Model #	DZS100BP
Ship Qty.	1
Sell Qty. (Will-Call)	1
Ship Weight (lbs.)	1.95
Usually Ships**	Today
Catalog Page No.	405
Country of Origin (Country of Origin is subject to change.)	USA

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Qty.

Add Grainger TripleGuard® repair & replacement coverage for $75.95 each.

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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

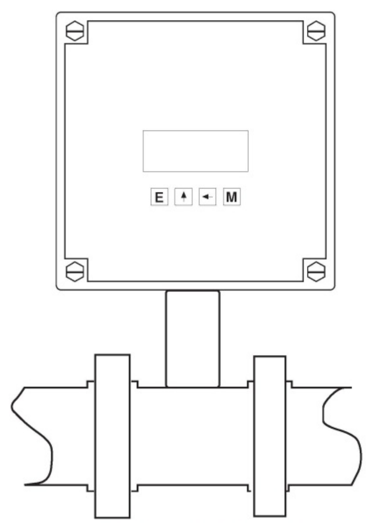
Brand: TORK
Grainger Item #: 4JNE4
Price: $103.15
Qty | Add to Order

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.

"Where Quality is Measurable"

9201 Independence Avenue
Chatsworth, CA 91311

(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.

Bulletin FMT - 4/99 PAGE 1 OF 4

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

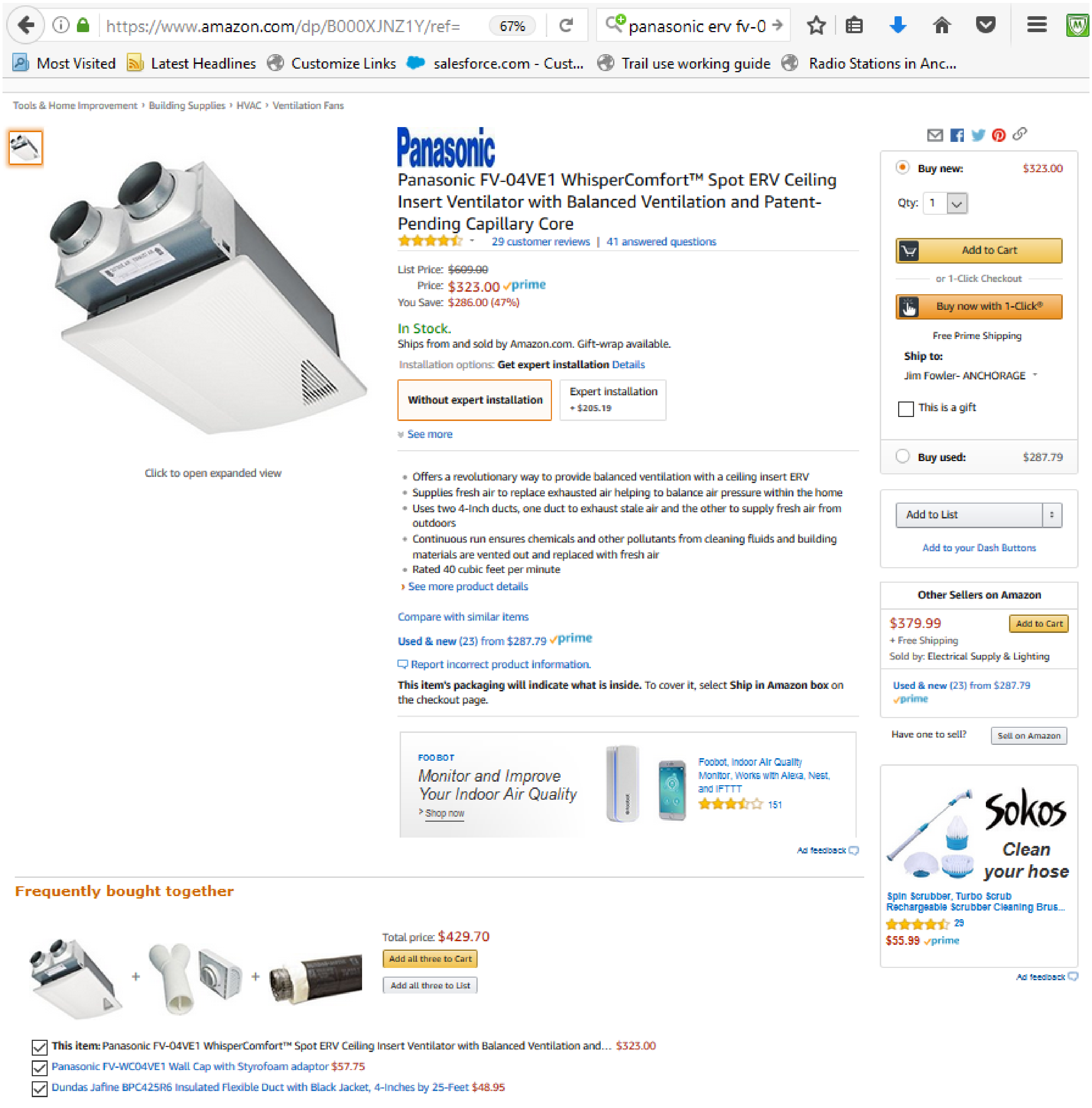
Delivery: 1 - 2 Weeks ARO
F.O.B. Factory
Quoted prices are firm for 60 days

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%

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)

ADD TO CART

Add to My Lists

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

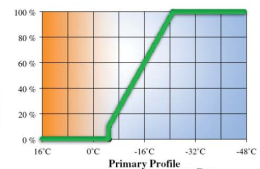
Integrated Parking Lot Controls (head bolt heater controls)
Estimated cost $250 ea. + 1 hr. installation

- 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

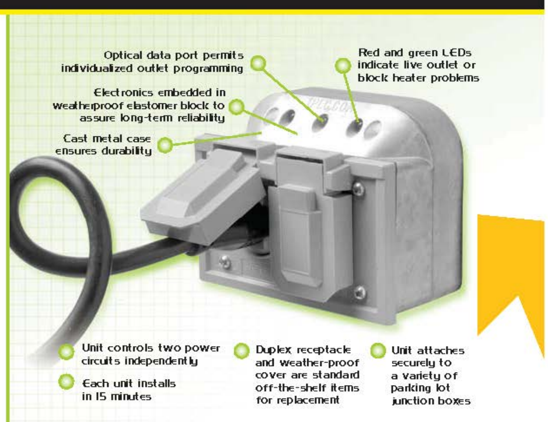


"The IPLC is the most advanced, flexible and cost effective parking lot power management device on the market today."
– Dr. Glenn Rosendahl, Ph.D., P.Eng., President, Vantera Incorporated

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
© 2006 Vantera Incorporated, all rights reserved.
IPLC / Vantera Incorporated
P.O. Box 334
Elie, MB, R0H-0H0
CANADA
www.iplc.com
1-866-353-2785
IPLC.COM
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

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

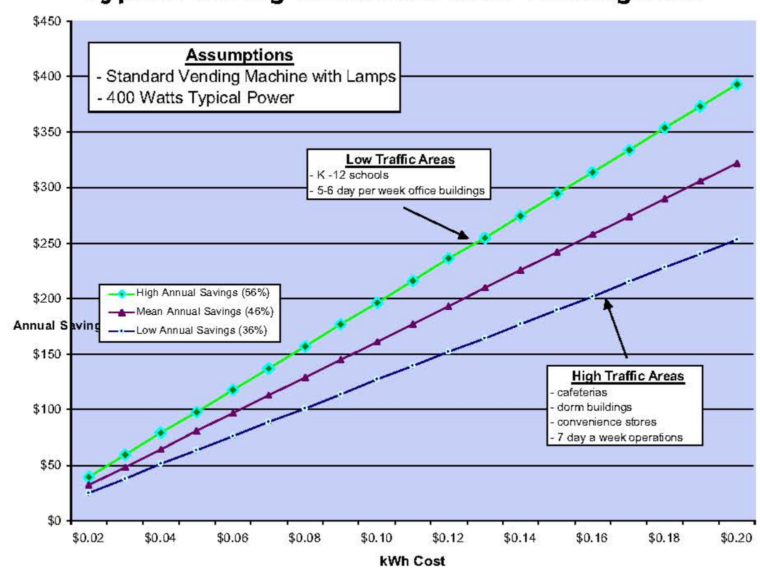
Size:	4.5"W x 1.75"H x 3.25"D
Weight:	2.2 lb. (incl. power cable)

REGULATORY APPROVALS

Safety:	UL/C-UL Listed Information Technology Equipment (ITE) 9T79

UL LISTED c UL LISTED

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)
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Power Consumption:	Less than 1 Watt (Standby)

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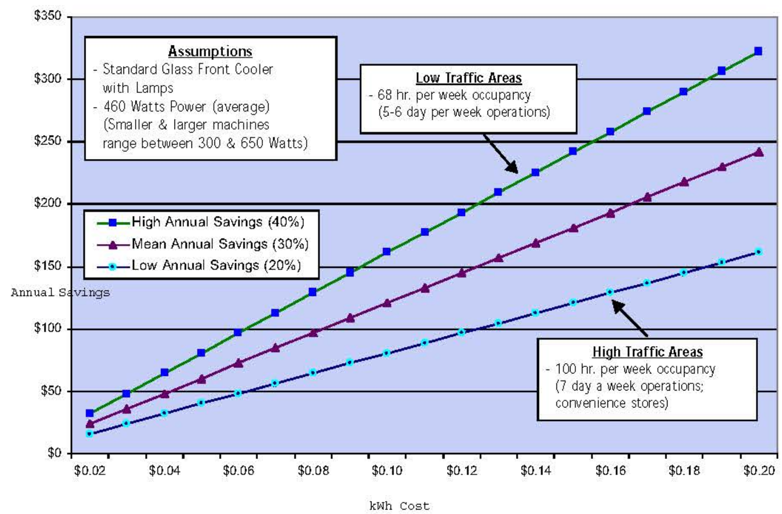

CoolerMiser™ Products

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