Comprehensive Energy Audit
For
Chistochina Maintenance Shed

Prepared For

Cheesh'Na Tribe

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Table of Contents

OVERVIEW

The purpose of this report is to provide guidance in reducing facility operating costs and enhance the sustainability of this community. An energy audit of the Chistochina Maintenance Shed was conducted in October of 2018 by the ANTHC Rural Energy Initiative for the Cheesh'Na Tribal Council. An energy audit is a comprehensive energy study, which includes an analysis of building shell, interior and exterior lighting systems, heating and ventilation systems, and electric loads.

Using field data, a virtual representation of the Chistochina Maintenance Shed was created using the building modeling software AkWarm©. The model was validated by comparing the initial results with at least one year of historical energy use data. Next, energy efficiency measures (EEMs) such as LED lighting and heating improvements were added to the model. The AkWarm© software calculates the annual cost savings and payback period for the investment, and then ranks all EEMs based on their payback period.

There are limitations using this software, which may affect the accuracy of the EEMs cost savings. This report should serve as a guide when deciding which EEMS to pursue further. All EEMs and installation costs should be verified with a certified professional in that field before construction begins.

ACKNOWLEDGMENTS

The ANTHC Rural Energy Initiative gratefully acknowledges the assistance of James (Jim) Beeter, Maintenance Manager; and Pete Peschang, Cheesh'Na Tribal Council Administrator.

Funding for the project was provided by the U.S. Department of Energy – Office of Indian Energy.

ENERGY BASELINE

Based on electricity and fuel oil prices in effect at the time of the audit, the total predicted energy costs are $3,396 per year. Table 1.1 contains a breakdown of energy usage and costs by commodity. It should be noted that only fuel usage data was provided. The electrical usage and savings in the table below are based on AkWarm© estimates.

Table 1.1: Predicted Annual Use and Savings for the Chistochina Maintenance Shed

Fuel Use	Existing Building	With Proposed Retrofits	Predicted Annual Savings
Electricity	1,777 kWh	1,276 kWh	501 kWh
	$2,569	$1,845	$724
#1 Oil	313 gallons	128 gallons	202 gallons
	$974	$398	$576

Note: Estimated costs and savings based on $1.446 per kWh (includes high demand fees) and $3.11 for #1 fuel oil.

Table 1.2 below summarizes the energy efficiency measures (EEMs) recommended for the Chistochina Maintenance Shed, and ranks the EEMs by economic viability. Green highlighted cells are high priority measures, yellow are medium priority, and orange highlighted cells are the lowest priority recommendations.

- Installed Cost: Includes materials, 15% surcharge on materials for freight fees, local and specialist labor time, specialist travel, and indirect labor charges when applicable.
- Savings to Investment Ratio (SIR): The annual savings divided by the installation cost. It is an indication of the profitability of an EEM: the higher the SIR, the more profitable the project. It should be noted that the SIR is dependent on the EEMs rank in the overall list and assumes that the measures above it are implemented first.
- Simple Payback (SP): The investment cost divided by the expected first-year savings. The SP estimates the length of time required to pay back the installed cost through the energy savings, not counting interest on the investment and any future changes in energy prices.
- Maintenance Savings (Maint. Savings): Any operations or maintenance costs that are unnecessary after the EEM is installed (i.e. changing fluorescent light bulbs). The maintenance savings includes materials, 15% freight, and labor, and is divided over the expected lifespan of the EEM.

Table 1.2: Summary of Recommended Energy Efficiency Measures

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
1	Toyo Stove Temperature Set Point	Program Toyo Stove to reduce the building temperature to 60°F when the building is unoccupied.	$141	$25	76.10	0.2
2	Overhead lighting	Remove the lighting ballast. Replace the fluorescent bulbs with direct wire, energy efficient LED lighting.	$295 + $12 Maint. Savings	$1,007	4.39	3.4

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]
3	Ceiling Insulation	Add R-30 fiberglass batts to the attic.	$88	$812	2.54	9.3
4	Garage Door	Replace the existing garage door with an R-7, 2" polyurethane core door.	$183	$1,721	2.50	9.4
5	Outdoor Lighting	Replace the existing wall pack with a LED equivalent, equipped with an integrated photo sensor	$0 + $16 Maint. Savings	$248	0.91	16.4
7	Wall Insulation	Install R-15 rigid foam board to the exterior and cover with T1-11 siding. Exterior paint included in the estimate.	$127	$13,256	0.23	104.3
8	Air Tightening	Install new weather stripping around the exterior door and windows if needed. Re-caulk all windows. Estimated to reduce air leakage by 5%.	$4	$215	0.16	58.5
TOTAL, cost-effective measures			**$707 + $12 Maint. Savings**	**$3,564**	**3.51**	**5.0**
TOTAL, all measures			**$838 + $28 Maint. Savings**	**$17,284**	**0.90**	**20.6**

Figure 1.1 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 EEMs shown in this report. Figure 1.2 shows the change in fuel usage after the recommended EEMs are installed.

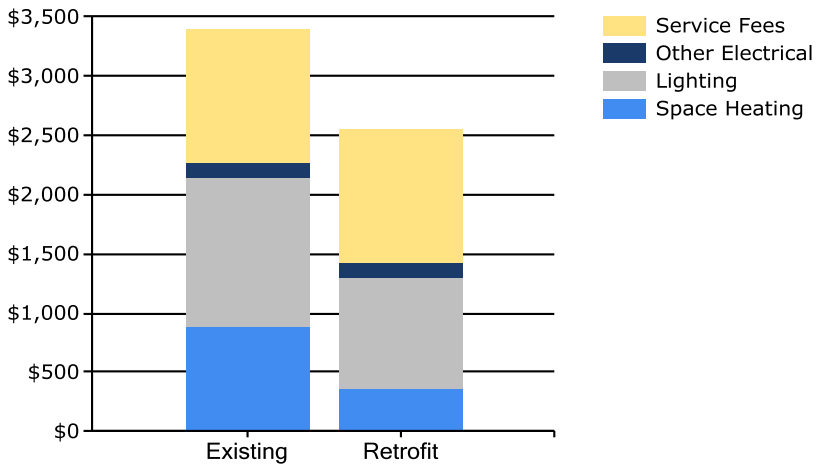


Figure 1.1: Annual energy costs by use before and after EEMs.

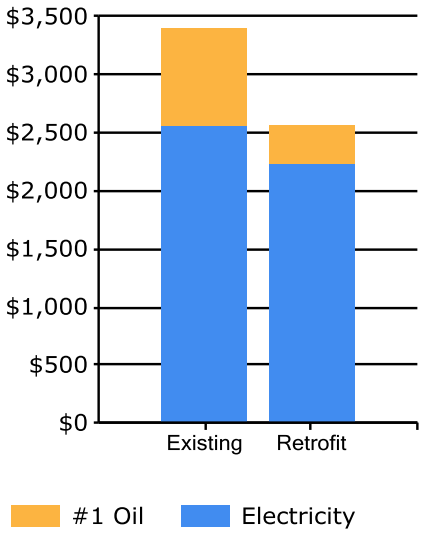


Figure 1.2: Annual energy costs by fuel type before and after EEMs.

Interactive Effects of Projects

The annual energy savings for the EEMs in Table 1.2 are calculated assuming all recommended EEMs coming before that measure are implemented. If some EEMs are not implemented, savings for the remaining EEMs will be affected. For example, if ceiling insulation is not added, then savings from a project to replace the heating system will be increased, because the heating system for the building supplies a larger load.

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

Interior lighting, electrical loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements, like converting incandescent and fluorescent bulbs to LEDs, are

anticipated to slightly increase heating requirements. This increase in heating cost was factored into the lighting EEMs annual savings.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Chistochina Maintenance Shed	**Auditor Company:** Alaska Native Tribal Health Consortium
Address: P.O. Box 241	**Auditor Name:** Kelli Whelan
City: Chistochina	**Auditor Address:** 4500 Diplomacy Drive Anchorage, AK 99508
Client Name: Pete Peschang, James (Jim) Beeter	
Client Address: P.O. Box 241 Chistochina, AK 99586	**Auditor Phone:** (907) 729-3723
	Auditor FAX:
Client Phone: (907) 822-3503	**Auditor Comment:**
Client FAX: (907) 822-5179	
Design Data	
Building Area: 285 square feet	**Design Space Heating Load:** Design Loss at Space: 11,909 BTU/hour with Distribution Losses: 11,909 BTU/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 18,153 BTU/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 1 person	**Design Indoor Temperature:** 72°F (building average)
Actual City: Chistochina	**Design Outdoor Temperature:** -38.2°F
Weather/Fuel City: Chistochina	**Heating Degree Days:** 13,238°F-days
Utility Information	
Electric Utility: Alaska Power and Telephone	**Fuel Oil Distributer:** Crowley
Average Annual Cost/kWh: $1.446/kWh	**Average Annual Cost/gal.:** $3.11/gal.

Appendix B – Facility Description

The Chistochina Maintenance Shed was constructed in the 1990s – 2000s, originally serving as a four-wheeler and snow machine garage. Today, the maintenance shed is utilized as a shop and an office. The office is occupied intermittently by one person Monday through Friday from 7:00AM to 4:00PM.

Building Shell

The maintenance shed is in good condition, but is not appropriately insulated for the climate. The roll-up garage door, which takes up a large portion of the western wall, is uninsulated and has large air gaps around the sides. The maintenance manager intends to replace the garage door with insulated barn doors; these were modeled as an insulated garage door retrofit in AkWarm©.

Total square footage ($ft.^2$)	285
Average Wall Height (ft.)	13.4

Structural Component	Construction Type	Insulation
Walls	2x6 stick frame, 16” on-center	R-13 fiberglass batt
Foundation	Above-grade, on blocks	None
Ceiling with Attic	Standard truss, assumed 16” on-center	R-13 fiberglass batt
Windows (Two total; one south-facing)	Double pane, low-E with insulated fiberglass frame	Not applicable
Side Entrance Door	Fiberglass door with a polyurethane core, no window	Polyurethane core
Garage Door	6’ 2 ½” x 7’ 3 ½” Metal roll-up garage door	None

Heating and Domestic Hot Water

The maintenance shed is heated by a direct vent oil-fired heater. The building is not connected to the community water or sewer system.

Oil-fired Boiler	
Nameplate Information	Toyotomi Laser 30
Fuel Type	#1 fuel oil
Input Rating	0.11 gal/hr. (14,904 BTU/hr.)
Combustion Efficiency	87% (estimated)
Idle Loss	0.0% (estimated)
Heat Distribution Type	Air

Appendix C – Energy Billing Data

1. Electricity Billing Data (Utility: Alaska Power and Telephone)

   No electric data was available for the building.

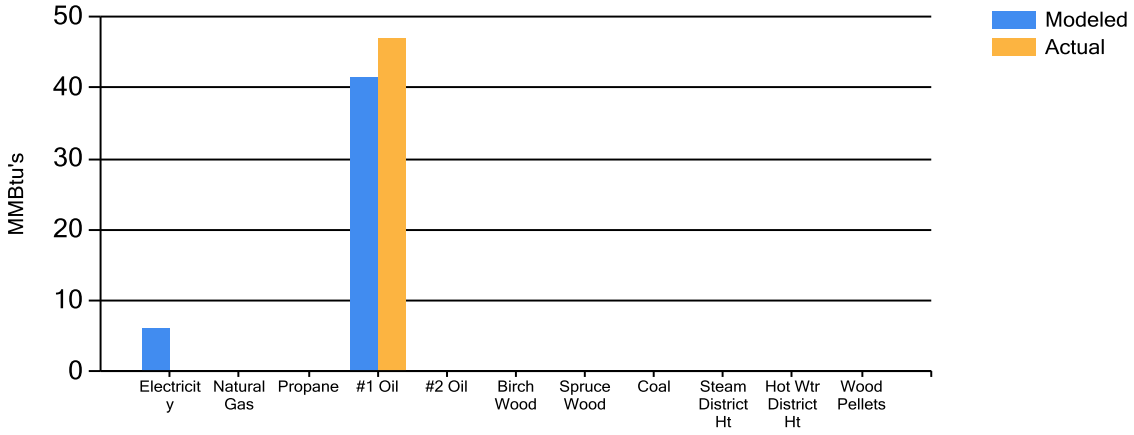
2. #1 Fuel Oil Delivery (Crowley)

Date	Usage (gallons)	Charge
February 2017	74	$178.29
March 2017	24	$58.06
April 2017	29	$69.01
August 2017	38	$92.67
October 2017	52	$129.29
November 2017	51	$125.01
December 2017	39	$97.00
January 2018	49	$134.41

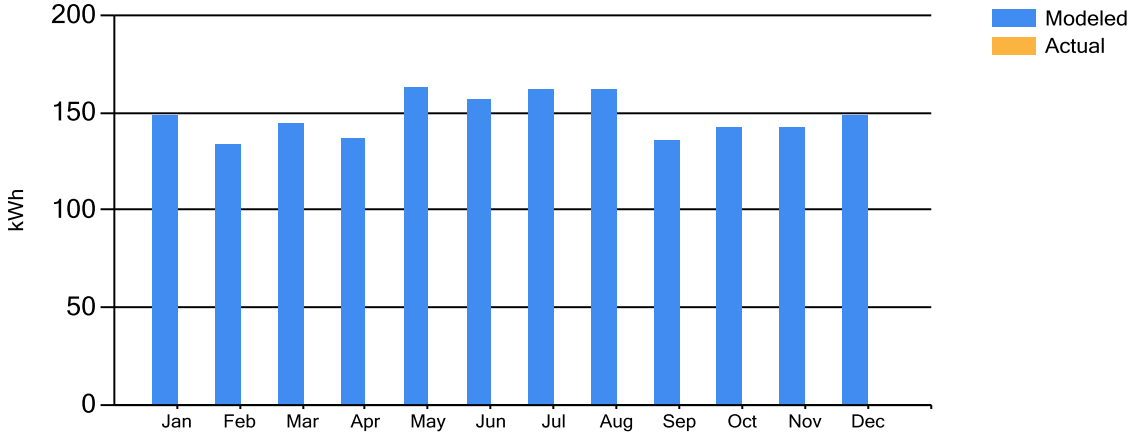
Appendix D – Actual Fuel Use versus Modeled Fuel Use

The graphs below show the modeled energy usage results of the energy audit process compared to the actual energy usage report data. The model was completed using AkWarm© modeling software. The orange bars show actual fuel use, and the blue bars are AkWarm©'s prediction of fuel use.

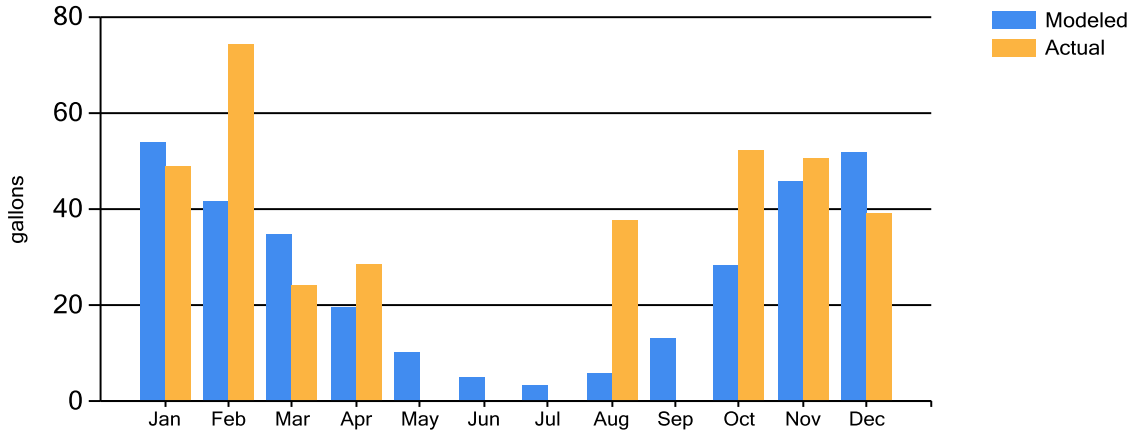
Annual Fuel Use



Electricity Fuel Use



#1 Fuel Oil Fuel Use



Appendix E – Materials List and Labor Estimation

Energy Retrofit	Materials	Quantity [a]	Cost per Item	Total Materials Cost	Hours Local Labor	Hours Contractor	Total Project Cost [b]
Walls	R-15 Foam insulation	19	$54.00	$1,026	-	264	$14,370
	Furring lumber	33	$2.33	$77			
	Tyvek building wrap	1	$179.00	$179			
	T1-11 Siding	19	$39.57	$752			
	Exterior Paint	1	$122.00	$122			
	Additional installation materials (screws, staples, tape, spray foam insulation, contingency)	-	-	$500			
Attic	R-30 Un-faced fiberglass batt (pallet)	1	$619.00	$619	32	-	$820
Lighting	T-8 LED equivalent bulbs	18	$12.24	$221	4	1	$460
	LED Wall Pack	1	$129.00	$129	1	-	$180
Air Sealing	Weather stripping, caulking	-	-	$100	4	-	$220
HVAC and DHW	Program Toyo stove temperature set back	-	-	-	1	-	$25

[a] *10% surplus included.*
[b] *Project costs include materials, freight (15% of materials cost), labor, and contractor fees when applicable (travel, per diem 30% indirect). Cost rounded up to the nearest $10.*

	Contractor (Electrician)	Contractor (Exterior)	Local Labor
Category	**Cost ($)**	**Cost ($)**	**Cost ($)**
Labor	400	6,400	575
Materials	-	2,656	2,343
Freight	-	398	351
Travel	403	1,596	-
Indirect	151	3,315	-
Subtotal	**$654**	**$14,365**	**$3,270**
		Grand Total	**$18,288**

Appendix F – Example Materials

1. Lighting
   Thinklux LED Fluorescent Replacement Tube
   Thinklux Non-shunted Rapid Start Tombstones (4-pack)
   LED Dusk-to-Dawn Motion Sensing Security Light

2. Air Tightening
   Electrical Socket Gaskets
   Weather Stripping
   Door Sweep
   Window Plastic Shrink Wrap

Appendix G – Additional Photos of the Chistochina Maintenance Shed

Maintenance Shed front.

Maintenance Shed rear.

Interior of garage door is covered with thin foam insulation, but it is inadequate.

Maintenance Shed interior.