

# Comprehensive Energy Audit For

# **Chistochina VPSO Housing**



Prepared For Cheesh'Na Tribe

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## **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 Village Public Safety Officer (VPSO) Housing 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 VPSO Housing was created using the building modeling software AkWarm<sup>©</sup>. 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 boiler control improvements were added to the model. The AkWarm<sup>©</sup> 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 \$7,373 per year. Table 1.1 contains a breakdown of energy usage and costs by commodity.

Fuel Use	Existing Building	With Proposed Retrofits	Predicted Annual Savings
Floatricity	2,658 kWh	1,951 kWh	707 kWh
Electricity	\$3,268	\$2,400	\$870
#1 Oil	1,109 gallons	723 gallons	386 gallons
	\$3,448	\$2,249	\$1,200
Propane	187 gallons	102 gallons	85 gallons
	\$658	\$358	\$298

Note: Estimated costs and savings based on \$1.23 per kWh (includes high demand fees), \$3.11 for #1 fuel oil, and \$3.51 per gallon propane.

Little electrical billing and fuel consumption data was available for this facility. The electrical and fuel oil usage above are based on AkWarm© model calculations and assumptions by the modeler.

Table 1.2 below summarizes the energy efficiency measures (EEMs) recommended for the Chistochina VPSO Housing, 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 <sup>1</sup>	Simple Payback (Years) <sup>2</sup>
1	Lighting: Ceiling Mounted Fixtures	Replace all incandescent bulbs with LED equivalents.	\$77 + \$24 Maint. Savings	\$21	40.76	0.2
2	Lighting: Bathroom Vanity	Replace all incandescent bulbs with LED equivalents.	\$92 + \$32 Maint. Savings	\$28	37.40	0.2
3 Thermostat and Temperature Setback		Replace the existing building thermostat with a programmable model. Program the thermostat to maintain the building temperature at 60°-65°F when it is unoccupied.	\$225	\$200	14.91	0.9
4	Trailer Attic Space	Add R-38 fiberglass batt to the attic space.	\$292	\$1,771	3.77	6.1
5	Heating, Ventilation, and Domestic Hot Water	Clean and tune air furnace. Perform an annual efficiency test. Clean the ductwork and add insulation to the ducts. Change air filters. Insulate all DHW plumbing. Install a hot water tank blanket to reduce heat loss.	\$340	\$4,600	2.67	5.0
6	Attic Space Above the Kitchen, Bathroom	Add R-38 fiberglass batt to the attic space.	\$67	\$996	1.54	14.8
7	Air Tightening	Install weather stripping and door sweeps around all exterior doors. Caulk windows as needed. Estimated air leakage reduction: 5%.	\$18	\$300	0.56	16.2
8	Shell Improvement: Walls	Replace the R-11 fiberglass batt in the wall cavity. Install R-20 rigid foam board to the exterior and cover with painted T1-11 siding or equivalent.	\$666	\$35,673	0.43	53.5

Rank	Feature	Improvement Description	Annual Energy Savings	Installed	Savings to Investment Ratio SIR <sup>1</sup>	Simple Payback (Years) <sup>2</sup>
Nailk	reature	Replace existing wood	Javings	CUSI	Natio, Sik	(ieais)
9	Shell Improvements: Living Room Window	frame window across from front door with a low E/argon fiberglass or insulated vinyl window.	\$30	\$1,527	0.33	50.7
10	Shell Improvements: Bathroom Window	Replace the existing wood frame window with a low E/argon fiberglass or insulated vinyl window.	\$11	\$552	0.33	50.7
11	Shell Improvements: Front Bedroom Window	Replace the existing wood frame window facing the road with a low E/argon fiberglass or insulated vinyl window.	\$28	\$1,434	0.33	50.8
12	Shell Improvements: Middle Bedroom Window	Replace the existing wood frame window in the bedroom next to the living room with a low E/argon fiberglass or insulated vinyl window.	\$25	\$1,331	0.32	52.5
13	Shell Improvements: Back Bedroom Window	Replace the existing wood frame window in the back bedroom with a low E/argon fiberglass or insulated vinyl window.	\$29	\$1,527	0.32	52.4
14	Shell Improvements: Living Room Window	Replace the existing wood frame window on the same wall as the front door with a low E/argon fiberglass or insulated vinyl window.	\$25	\$1,323	0.32	52.4
15	Storm Door: Back Door	Install an insulated storm door to the exterior of the building's back door.	\$6	\$377	0.29	58.6
16	Storm Door: Front Door	Install an insulated storm door to the exterior of the building's front door.	\$7	\$383	0.33	51.5
TOTAL for high and medium priority measures		\$1,093 + \$57 Maint. Savings	\$4,716	3.74	4.1	
		TOTAL for all measures	\$1,941 + \$57 Maint. Savings	\$49,144	0.73	24.6

Additional energy efficiency recommendations (not included in the AkWarm© model):

Consider sealing the windows with plastic shrink-wrap during the winter and installing thermally insulating curtains. Close the curtains when the building is not in use to further reduce heat loss.

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 is 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

ENERGY AUDIT REPORT – PROJECT SUMMARY				
<b>General Project Information</b>				
PROJECT INFORMATION	AUDITOR INFORMATION			
Building: Chistochina VPSO Housing	Auditor Company: Alaska Native Tribal Health			
	Consortium			
Address: P.O. Box 241	Auditor Name: Kelli Whelan			
City: Chistochina	Auditor Address: 4500 Diplomacy Drive			
Client Name: Pete Peschang, James (Jim)	Anchorage, AK 99508			
Beeter				
Client Address: P.O. Box 241	Auditor Phone: (907) 729-3723			
Chistochina, AK 99586	Auditor FAX:			
Client Phone: (907) 822-3503	Auditor Comment:			
<b>Client FAX:</b> (907) 822-5179				
Design Data				
Building Area: 1,183 square feet	Design Space Heating Load: Design Loss at Space:			
	46,492 BTU/hour			
	with Distribution Losses: 48,939 BTU/hour			
	Plant Input Rating assuming 82.0% Plant Efficiency and			
	25% Safety Margin: 74,603 BTU/hour			
	Note: Additional Capacity should be added for DHW			
	and other plant loads, if served.			
Typical Occupancy: 1 person (assumed)	Design Indoor Temperature: 70°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: \$1.230/kWh	Average Annual Cost/gal.: \$3.11/gal.			

## Appendix A – Energy Audit Report – Project Summary

### Appendix B – Facility Description

The Chistochina VPSO Housing is a 1980s mobile home with a recent addition (the addition was constructed in the 2000s). It is a residential building owned and maintained by the Cheesh'Na tribe, and is available to house a VPSO officer for the community. The building was vacant at the time of the site visit (October 2018).

#### **Building Shell**

Part of the building is a prefabricated mobile home. Mobile homes constructed during the 1980s typically had 2x4, 16" on-center framing with R-13 fiberglass batt insulation in the stud cavity. It was assumed that the addition walls are of similar construction. Due to the building's age, the fiberglass batt in the wall cavity has likely compressed, creating voids in the walls, and may have moisture damage.

The building foundation is post on pad. It was assumed that the crawlspace under the floor was tight (protected by plywood), but not insulated.

Total square footage (ft. <sup>2</sup> )	1,183
Average Wall Height (ft.)	7' 5"

Structural Component	Construction Type	Insulation	
Walls	2x4 stick frame 16" on contor	R-13 fiberglass batt (likely	
wans	2X4 Stick Hame, 10 Off-center	damaged)	
Floor	Above-grade, tight crawlspace	R-19 fiberglass batt	
Ceiling with Attic Space	Standard truss, 16" on-center	R-25 fiberglass batt	
Cathedral Ceiling (Living Room)	Standard truss, 16" on-center	R-15 fiberglass batt	
Windows (Nine total; estimated	Wood frame, double pane	Neteralizable	
four south-facing)	windows filled with air	Not applicable	
Front Door	Fiberglass door, ¼ lite	Polyurethane core	
Back Door	Fiberglass door, 1/4 lite	Polyurethane core	



Figure B1. View of the Chistochina VPSO Housing from the road. The addition is to the right of the main part of the building.

#### **Heating and Domestic Hot Water**

The building's primary source of heating is a forced air furnace, which is controlled by a manual thermostat. Heating in the addition is supplemented by a direct vent, oil-fired stove (Monitor M-441). The Monitor stove was not connected to a fuel tank at the time of the site visit.

Hot water is produced by a propane-fired, 40-gallon hot water generator. The domestic hot water (DHW) lines were uninsulated and the hot water generator did not have any additional insulation.



Figure B2. Uninsulated DHW plumbing and hot water generator in the VPSO Housing.

Forced Air Furnace				
Nameplate Information	Thermo Pride			
Fuel Type	#1 Fuel oil			
Nozzle Size	0.60 x 80°, Type A			
Input Rating	0.58 gal/hr. (80,000 BTU/hr.)			
Combustion Efficiency	85.1% (efficiency test conducted 1/3/15)			
Idle Loss	5% (estimated)			
Heat Distribution Type	Air			

Oil-Fired Stove				
Nameplate Information	Monitor M-144			
Fuel Type	#1 Fuel oil			
Input Rating	0.32 gal./hr. (44,022 BTU/hr.)			
Combustion Efficiency	87% (manufacturer's literature)			
Idle Loss	0%			
Heat Distribution Type	Air			

Hot Water Generator	
Nameplate Information	Rheem LP model# 621487 – PROG40-32P RH59
Fuel Type	Propane
Input Rating	751,000 BTU/hr. (220 kW)
Combustion Efficiency	58% - 62% (manufacturer's literature)
Idle Loss	1.5% (estimated)
Heat Distribution Type	Water

#### **Ventilation**

The Chistochina VPSO Housing has a centralized, forced air furnace. The ductwork insulation should be checked for coverage and quality. Gaps should be patched and damaged insulation replaced.

The kitchen is outfitted with a range hood (Broan-Nu Tone LLC model#40 000-H). The unit uses 240 Watts and provides 160 cubic feet per minute (CFM) exhaust. It was estimated that the hood would be used about three hours per week when the building is occupied.

The bathroom exhaust fan is rated for 70 CFM and uses approximately 23 Watts. The estimated runtime for the fan was one hour per day.

#### **Lighting**

Most of the lighting in the Chistochina VPSO Housing at the time of the site visit was overhead, ceilingmounted fixtures outfitted with compact fluorescent (CFL) and incandescent bulbs. CFL and LED lightbulbs have similar lifespans, so there is no economic payback to replacing the CFL bulbs immediately. The CFL bulbs can be replaced with LED equivalents as the bulbs burn out.

It was assumed that the overhead lighting would be used an average of 2 ¼ hours per day, the bathroom vanity lighting about 2 hours every day, the kitchen track lighting for three hours per day, and the kitchen hood light for one hour per day, every day of the week.

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Overhead Lighting	Spiral CFL Bulbs 13W	16	1	170.9
<b>Overhead Lighting</b>	Incandescent Bulbs 60W	3	1	147.9
Bathroom Vanity	Incandescent Bulbs 60W	1	3	170.9
Kitchen Track Lighting	LED Modules 4W	2	4	44.0
Kitchen Range Hood	Incandescent Bulb 75W	1	1	28.8
Total Energy Consumption 562.5				

#### Major Appliances

The appliances below were documented when the Chistochina VPSO Housing was unoccupied. The annual electrical consumption will likely increase when the building is occupied again.

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption
Whirlpool model# WRT111SFAB00	Top-freezer refrigerator	747.5W	Used continuously	196 kWh
GE model# RGB530DEH1WW	Propane-fired oven	5,000 – 16,000 BTU/hr.	Estimated 3 hours per week	12 gal. propane
Hamilton Beach Coffee Maker	12-cup coffee maker	900W	Estimated 9 minutes per day	49.3 kWh
Whirlpool model# WET300XQ	Washer/dryer combo	1,850W	Estimated 3 hours per week	810.9
	1,056.2			
Total Propane Consumption (gallons)				12

## Appendix C – Energy Billing Data

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

Date	Usage (kWh)	Charge	
December 2017	560	\$403.21	
January 2018	215	\$155.05	
February 2018	156	\$114.51	
March 2018	29	\$20.62	
April 2018	28	\$20.00	
May 2018	28	\$20.00	
June 2018	28	\$20.00	
July 2018	28	\$20.00	
August 2018	28	\$20.00	

2. #1 Fuel Oil Delivery (Crowley)

Date	Usage (gallons)	Charge	
November 2017	237	\$736.00	

### 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<sup>©</sup> modeling software. The orange bars show actual fuel use, and the blue bars are AkWarm<sup>©</sup>'s prediction of fuel use.



#### **Annual Fuel Use**

#### **Electricity Fuel Use**





*Note: The "actual" fuel usage above is by delivery, not the amount used during the month.* 

15



				Total	Hours		Total
Energy			Cost per	Materials	Local	Hours	Project
Retrofit	Materials	Quantity <sup>a</sup>	Item	Cost	Labor	Contractor	Cost <sup>b</sup>
	R-20 Foam insulation	49	\$54.00	\$19,043		160	\$35,700
	R-11 Faced	1	\$799.00	\$919			
	fiberglass batt	1	\$799.00	<i>2313</i>			
	Furring lumber	66	\$2.33	\$154			
	T1-11 Siding	49	\$39.57	\$1,939			
Walls	Exterior Paint	1	\$122.00	\$122	-		
	Additional installation materials (screws, staples, tape, spray foam insulation, contingency)	-	-	\$1,000			
Attic	R-11 Un-faced fiberglass batt (pallet)	3	\$483.00	\$1,449	6	-	\$1,820
Exterior	Insulated storm	2	\$296.00	\$592	8	-	\$740
Doors	doors			,	_		
Windows	insulated vinyl window	2	\$208.00	\$416	-	12	
	35"x60" Two-paned insulated vinyl window	1	\$208.00	\$208	-	6	
	40"x46" Two-pane insulated vinyl window	2	\$178.00	\$356	-	12	\$9,380
	22.25"x35" Two- paned insulated vinyl window	1	\$187.35	\$187	-	6	
	Additional installation materials (lumber, insulation, nails, contingency)	-	-	\$1,500	-	-	
Lighting	60W LED-equivalent (4 pack)	1	\$13.48	\$14	0.25	-	\$40
Air Sealing	Weather stripping, caulking	-	-	\$200	4	-	\$330
HVAC and DHW	Clean and tune air furnace	-	-	\$300	-	3	\$820
	Clean ductwork	-	-	\$400	-	4	\$740
	Change air filter	2	\$30.00	\$60	1	-	\$100
	Insulate DHW plumbing	-	-	\$100	2		\$170
	Hot water tank blanket	1	\$28.56	\$29	1	-	\$60

## Appendix E – Materials List and Labor Estimation

<sup>a</sup> 10% surplus included.

<sup>b</sup> 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 (Heating)	Contractor (Exterior)	Local Labor
Category	Cost (\$)	Cost (\$)	Cost (\$)
Labor	700	19,600	400
Materials	150	7,827	2,443
Freight	23	1,399	366
Travel	406	4,690	-
Indirect	384	10,055	-
Subtotal	\$1,662	\$43,571	\$3,210
		Grand Total	\$48,440

## Appendix F – Example Materials

- 1. Lighting 60W LED Equivalent Light Bulbs
- 2. Heating <u>Pipe Insulation</u> <u>Hot Water Tank Jacket</u> <u>Air Furnace Filter</u>
- 3. Air Tightening <u>Electrical Socket Gaskets</u> <u>Weather Stripping</u> <u>Door Sweep</u> <u>Window Plastic Shrink Wrap</u>

# Appendix G – Additional Photos of the Chistochina VPSO Housing



VPSO Housing Exterior.







Typical Window.

