Comprehensive Energy Audit
For
Chistochina Village Office

Prepared For

Cheesh'Na Tribe

March 19, 2019

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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 Office 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 Village Office 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 boiler control 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 $10,152 per year. Table 1.1 contains a breakdown of energy usage and costs by commodity.

Table 1.1: Predicted Annual Use and Savings for the Chistochina Village Office

Fuel Use	Existing Building	With Proposed Retrofits	Predicted Annual Savings
Electricity	9,395 kWh	7,579 kWh	1,816 kWh
	$8,384	$6,760	$1,620
#1 Oil	457 gallons	184 gallons	273 gallons
	$1,420	$572	$849
Pellet District Heating	14.96 million BTU	10.12 million BTU	4.84 million BTU
	$347	$223	$106

Note: Estimated costs and savings based on $0.892 per kWh (includes high demand fees), $3.11 for #1 fuel oil, $21.83 per million BTU for the pellet-fired district heating system, and $3.51 per gallon propane.

Actual electrical and fuel consumption varied by year. In 2016-2017, the annual electrical consumption was approximately 9,010 kWh and about 620 gallons of fuel oil was consumed. In 2017-2018, approximately 9,431 kWh and 429 gallons of fuel oil were consumed. The AkWarm© model was an attempt to capture an average annual usage.

Table 1.2 below summarizes the energy efficiency measures (EEMs) recommended for the Chistochina Village Office, 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	Simple Payback (Years)
1	Setback Temperature: Toyo Stove and Monitor Stove	Program both direct vent, oil-fired stoves to maintain the building temperature at 60°F - 65°F when the office is unoccupied.	$350	$25	187.03	0.1
2	Lighting: Bathroom	Replace the incandescent light bulb with a 60 W LED equivalent.	$24 + $2 Maint. Savings	$10	35.33	0.4
3	Lighting: Main Entrance (4-bulb fixtures)	Remove the lighting ballast. Replace the fluorescent tube lights with direct wire, LED equivalents. T-12 replacement bulbs do not require a tombstone.	$468 + $30 Maint. Savings	$747	9.39	1.5
4	Lighting: Conference Room and Storage Closet	Remove the lighting ballast. Replace the fluorescent tube lights with direct wire, LED equivalents. T-12 replacement bulbs do not require a tombstone.	$702 + $44 Maint. Savings	$1,121	9.38	1.5
5	Lighting: Main Entrance (two T-12 bulbs in LED fixture)	Remove the lighting ballast. Replace the fluorescent tube lights with direct wire, LED equivalents. T-12 replacement bulbs do not require a tombstone.	$35 + $2 Maint. Savings	$56	9.34	1.5
6	Lighting: Small Storage/Server Room	Replace the incandescent light bulb with a 60 W LED equivalent.	$4 + $2 Maint. Savings	$10	7.93	1.8
7	Lighting: Tribal Administrator Office	Remove the lighting ballast. Replace the fluorescent tube lights with direct wire, LED equivalents. T-12 replacement bulbs do not require a tombstone.	$109 + $10 Maint. Savings	$249	6.67	2.1
8	Shell Improvements: Ceiling Insulation	Add R-30 fiberglass batts to the attic space.	$68	$1,876	0.84	27.7
9	Heating, Ventilation, and Domestic Hot Water	Insulate all hydronic heating and domestic hot water plumbing, and pellet boiler heat exchanger.	$20	$600	0.72	30.0
10	Shell Improvements: Conference Room Door	Install an insulated storm door on the exterior of the conference room door.	$12	$389	0.54	31.3

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
11	Shell Improvements: Main Entrance Door	Install an insulated storm door on the exterior of the entrance door.	$9	$371	0.42	40.7
12	Shell Improvements: Walls	Furr out walls. Install R-20 rigid foam board to the building exterior and cover with painted T1-11 siding or equivalent.	$405	$23,120	0.41	57.0
13	Shell Improvements: Tribal Administrator Office Window	Replace the existing wood frame window with a low E/argon fiberglass or insulated vinyl window.	$21	$1,455	0.24	70.2
14	Shell Improvements: Main Office Window (not south facing)	Replace the existing wood frame window with a low E/argon fiberglass or insulated vinyl window.	$21	$1,447	0.24	70.3
15	Shell Improvements: Conference Room Windows (not south facing)	Replace the existing three wood frame window with low E/argon fiberglass or insulated vinyl windows.	$62	$4,380	0.24	70.5
16	Shell Improvements: Conference Room Window (south facing)	Replace the existing wood frame window with a low E/argon fiberglass or insulated vinyl window.	$25	$1,836	0.23	73.2
17	Shell Improvements: Main Office (south facing)	Replace the existing wood frame window with a low E/argon fiberglass or insulated vinyl window.	$25	$1,844	0.23	73.3
18	Air Tightening	Caulk windows as needed. Install weather stripping and new door sweeps around exterior doors. Estimated to reduce air leakage by 5%.	$13	$775	0.16	58.6
19	Shell Improvements: Double Doors	Install two insulated storm doors to the exterior of the double doors to the right of the main entrance.	$6	$771	0.14	123.3
TOTAL for the high and medium priority measures			**$1,692 + $91 Maint. Savings**	**$2,219**	**11.19**	**1.2**
TOTAL for all measures			**$2,380 + $91 Maint. Savings**	**$41,083**	**0.96**	**16.6**

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.

- Plug in all printers and computers to power strips. Turn off power to the power strips when the devices are not in use. This will ensure that the appliances are not drawing phantom loads (small amounts of electricity that power devices in standby mode, small indicator lights, or remote sensors, even if the device is off).
- Store brewed coffee and hot water in insulated carafes rather than using the appliances' warming function.

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.

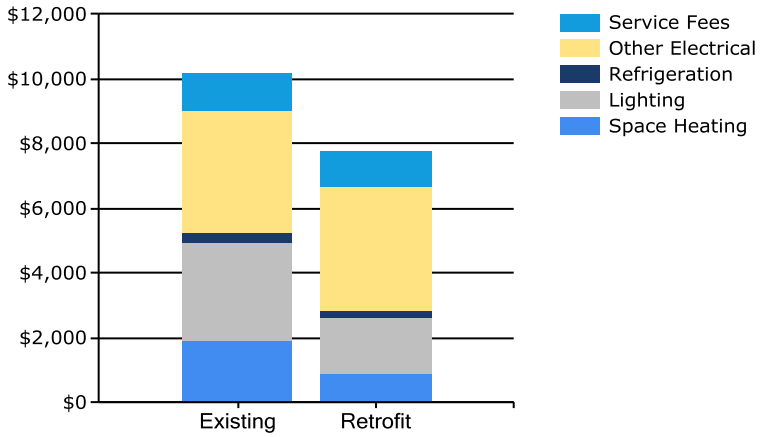


Figure 1.1: Annual energy costs by use before and after EEMs.

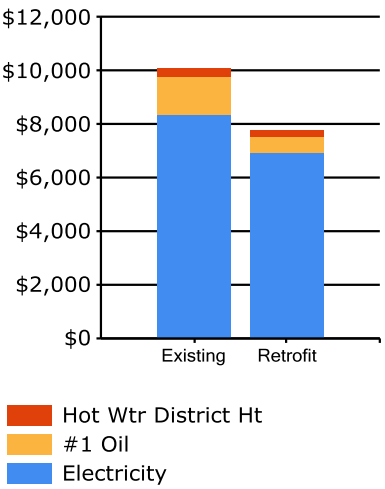


Figure 1.2: Annual energy costs by fuel type before and after EEMs. Note: "Hot Wtr District Ht" is the pellet-fired district heating system.

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

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Chistochina Village Office	**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: 1,055 square feet	**Design Space Heating Load:** Design Loss at Space: 15,681 BTU/hour with Distribution Losses: 15,846 BTU/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 24,156 BTU/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 4 people	**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: $0.892/kWh	**Average Annual Cost/gal.:** $3.11/gal.

Appendix B – Facility Description

The Chistochina Village Office was constructed in the 1970s. The building serves as an office and meeting space for the Cheesh'Na Tribe; it also has a small breakroom and a bathroom. The Chistochina Village Office hours are Monday through Friday from 8:00AM to 4:00PM, with a typical occupancy of four people.

Building Shell

The exterior of the building is constructed of 8" whole logs and is in very good condition. No points of heat loss through the log walls were visible in infrared thermal imaging. High rates of heat loss were much more apparent through the building's windows and double door to the right of the main entrance (see Appendix G for reference).

Total square footage ($ft.^2$)	1,055
Average Wall Height (ft.)	7' 10"

Structural Component	Construction Type	Insulation
Walls	8" Whole log	No additional insulation
Floor	Above-grade, insulated crawlspace	R-19 Fiberglass batt
Ceiling with Attic	Standard truss, 16" on-center	R-38 fiberglass batt
Windows (Nine total; three south-facing)	Double pane, wood frame (two are insulated, low-E fiberglass framed)	Not applicable
Main Entrance Exterior Door	Fiberglass door, ½ lite	Polyurethane core
Double Exterior Doors	Metal door (2), no window	Polyurethane core
Conference Room Exterior Door	Metal door, no window	EPS core (assumed)

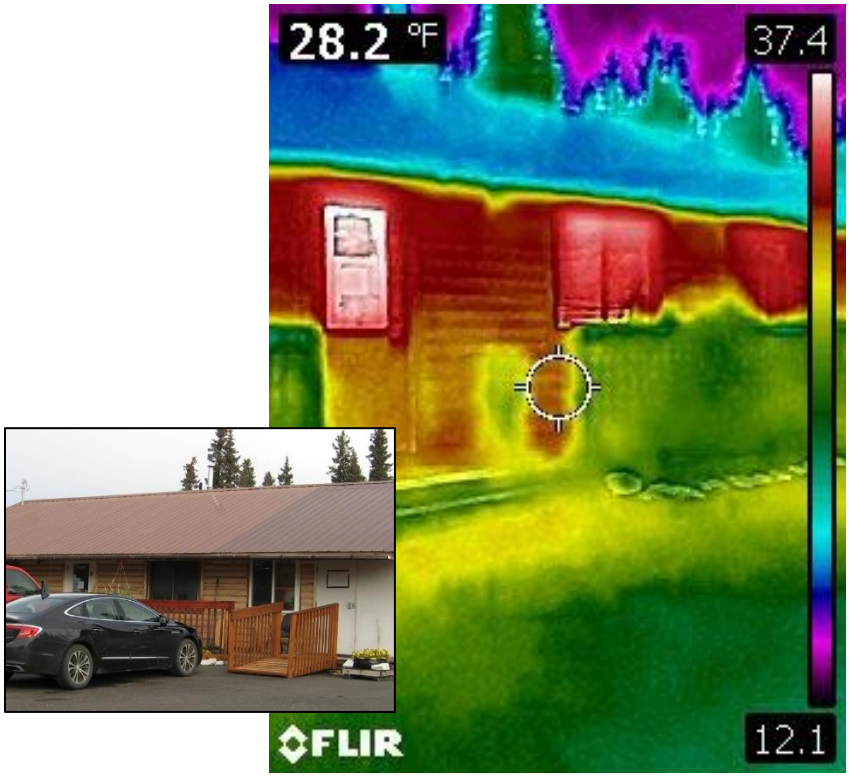


Figure B1. Thermal imaging of the Chistochina Village Office (inset photo actual building). The color gradient on the right corresponds to degrees Fahrenheit, ranging from white (37.4°F) to black (12.1°F). The areas of white and pink demonstrate a large amount of heat loss through the Village Office windows and doors. The walls, shown in red and yellow, are the second largest source of heat loss.

Heating and Domestic Hot Water

The Chistochina Village Office is heated year-round by two direct vent, oil-fired stoves. Hot water is produced by an on-demand, propane-fired hot water generator. A pellet-fired district heating boiler, located near the office building, supplements the Chistochina Village Office Building heat from November to June. Heated glycol is circulated between the pellet boiler building and the office through about 150 linear feet of buried, insulated transmission line. Heat is transferred to the office hydronic heating system through a heat exchanger.

At the time of the site visit, tribal members mentioned that the pellet boiler heating was not evenly distributed through the building. The Cheesh'Na Tribe plans to install a secondary heating loop off of the office building's existing heating loop with an additional circulation pump to address this issue.

Oil-fired Boiler	
Nameplate Information	Monitor M-441
Fuel Type	#1 fuel oil
Input Rating	0.16 gal/hr. (22,080 BTU/hr.)
Combustion Efficiency	87% (estimated)
Idle Loss	0% (estimated)
Heat Distribution Type	Air

Oil-fired Boiler	
Nameplate Information	Toyotomi Laser 73
Fuel Type	#1 fuel oil
Input Rating	0.20 gal/hr. (28,017 BTU/hr.)
Combustion Efficiency	87% (estimated)
Idle Loss	0% (estimated)
Heat Distribution Type	Air

Pellet Boiler	
Nameplate Information	KOT Pyrot KRT 220
Fuel Type	Wood pellets
Maximum Output Rating	751,000 BTU/hr. (220 kW)
Combustion Efficiency	85% (manufacturer's literature)
Heat Distribution Type	50/50 glycol
Boiler Circulation Pump	Grundfos MAGNA 65-120F
Building Circulation Pump	Grundfos UPS 15-58FC

Ventilation

The office space does not have a centralized ventilation system. The bathroom has a small exhaust fan, but the fan did not work at the time of the site visit.

Lighting

Fluorescent tube fixtures provide a majority of the overhead lighting. Two of the fixtures have had LED upgrades. All interior lights are controlled by manual light switches.

Exterior lighting is provided by an LED security light located above the main entrance door. The light has an integrated motion sensor, so its energy usage was considered minimal and was excluded from this assessment.

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Main Entrance	4ft. Fluorescent T-12 Tubes 40W (one fixture has two LED bulbs)	7	4	1,462.2
Main Entrance	4ft. LED T-12 Equivalent 17W	-	2	63.7
Conference Room, Storage Closet	4ft. Fluorescent T-12 Tubes 40W	9	4	1,349.2
Tribal Administrator Office	4ft. Fluorescent T-12 Tubes 40W	2	4	303.6
Tribal Administrator Office	4ft. LED T-12 Equivalent 17W	1	4	84.1
Bathroom	60W Incandescent Bulb	1	1	15.7
Small Storage, Server Room	60W Incandescent Bulb	1	1	6.3
			Total Energy Consumption	**3,959.5**

Major Appliances

The Chistochina Village Office has an E/one pressure sewer system installed (1 HP motor), but it is not used. Instead, the hall is presently connected to a gravity-fed septic tank and drainage field. The pressure sewer system was not included in this analysis.

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption (kWh)
Desktop Computers and Computer Equipment	Tribal business and administration	Varies (60.2W – 980W)	Office hours (estimated off 30% of the time)	3,843.1
Porche Design LACIE	External hard drive	24W	Used continuously.	105.2
Printers	Tribal business and administration	Varies (690W - 1,173W)	Used continuously.	205.2
Telecom Equipment (switchboards, Wi-Fi router)	Tribal business and administration	Varies (3.3W - 120W)	Used continuously.	344.1
Timecard Punch Machine	Tribal business and administration	2W	Used continuously.	17.5
GE model# SMR03BAVBWW	Mini-refrigerator	149.5W	Used continuously.	330
GE Microwave	Microwave	1,100W	Used daily.	137.8
Hamilton Beach Hot Water Pot	Hot water	1,500W	Used occasionally.	93.9
Keurig 2.0	Coffee brewing	300W	Used occasionally.	37.6
Mr. Coffee 12-Cup Coffee Maker	Coffee brewing	900W	Used daily.	112.7
			Total Energy Consumption	**5,227.1**

Appendix C – Energy Billing Data

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

Date	Usage (kWh)	Charge
September 2017	538	$387.57
October 2017	1,070	$770.15
November 2017	1,805	$1,299.36
December 2017	1,634	$1,176.74
January 2018	632	$454.80
February 2018	780	$561.28
March 2018	652	$469.60
April 2018	336	$241.59
May 2018	395	$284.40
June 2018	526	$378.36
July 2018	526	$378.36
August 2018	539	$388.30

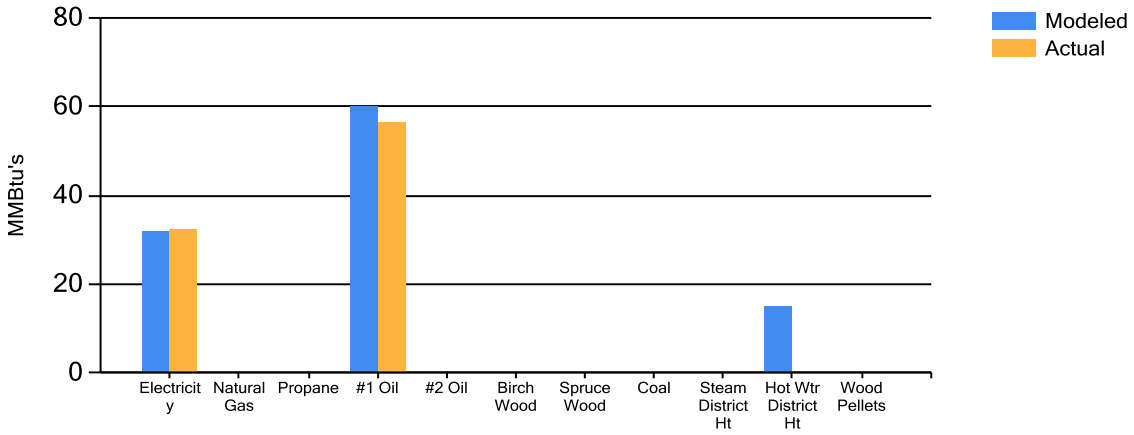
2. #1 Fuel Oil Delivery (Crowley)

Date	Usage (gallons)	Charge
August 2017	79	$246.64
October 2017	81	$251.43
November 2017	64	$200.00
December 2017	101	$126.82
January 2018	41	$127.33
June 2018	62	$193.91

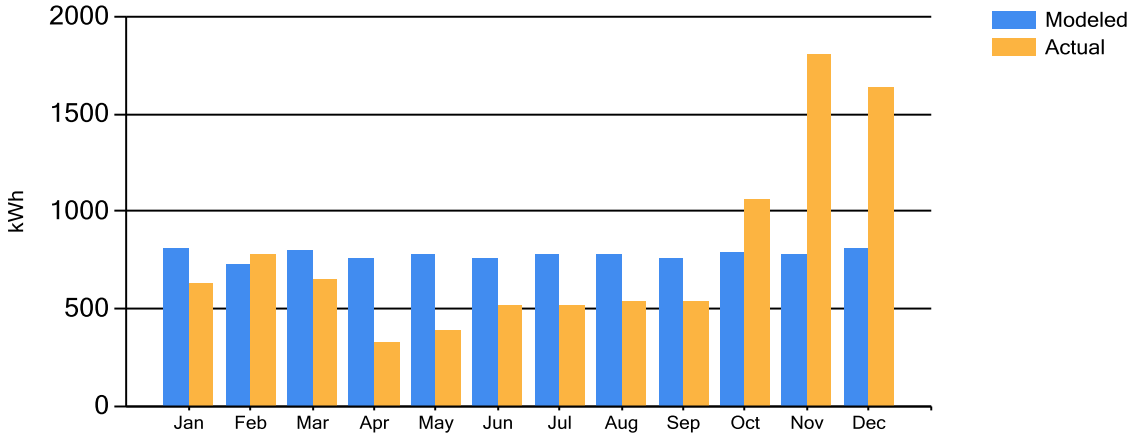
Appendix D – Actual Fuel Use versus Modeled Fuel Use

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

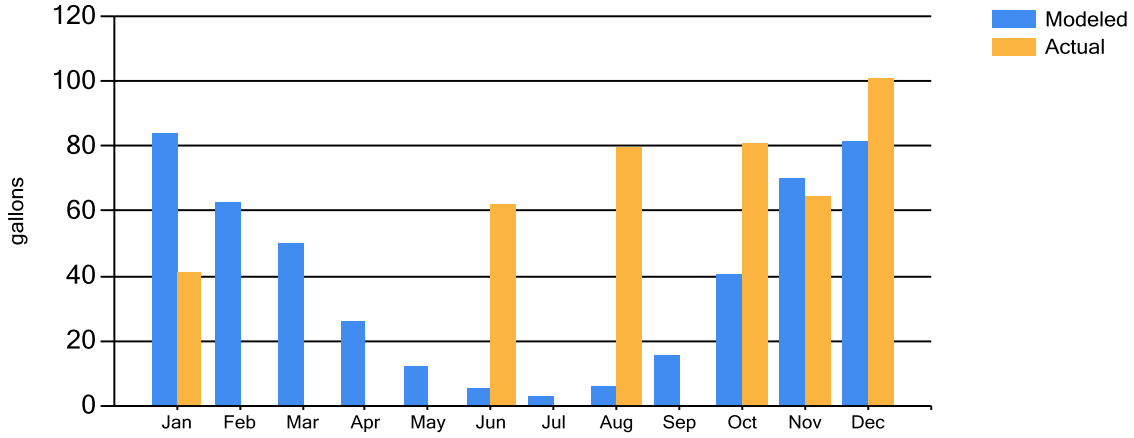


Electricity Fuel Use



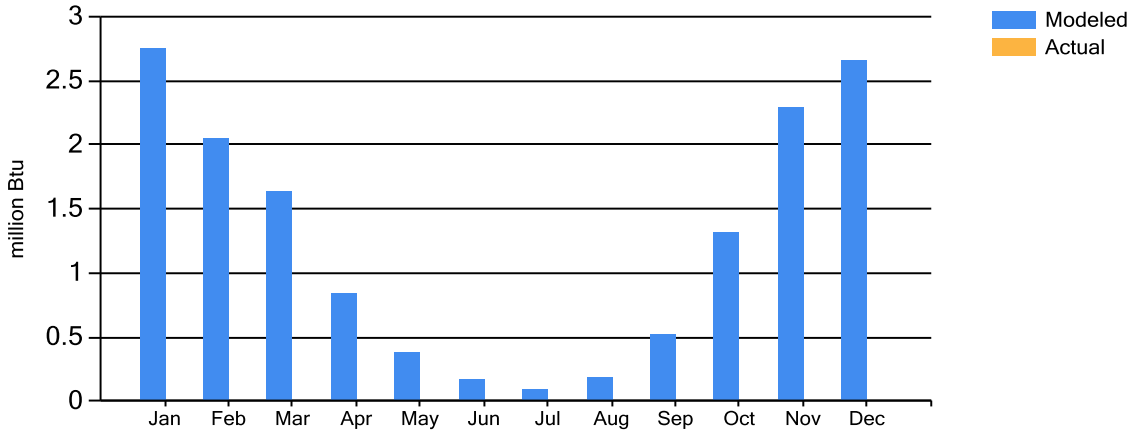
Note: The spike in electrical usage in November and December in the graph above is likely due to electrical heat tape usage.

#1 Fuel Oil Fuel Use



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

Pellet-Fired District Heating System



Note: The pellet-fired boiler is only used from November through June. Any heating requirements in the chart above would be supplied by the direct vent, oil-fired stoves.

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-20 Foam insulation	75	$36.20	$2,715	-	96	$23,100
	Furring lumber	59	$2.33	$138			
	Tyvek building wrap	1	$179.00	$179			
	T1-11 Siding	39	$39.57	$1,543			
	Exterior Paint	1	$122.00	$122			
	Additional installation materials (screws, staples, tape, spray foam insulation, contingency)	-	-	$800			
Attic	R-21 Un-faced fiberglass batt (pallet)	2	$506.00	$1,012	10	-	$1,420
Exterior Doors	Insulated storm doors	4	$295.00	$1,180	8	-	$1,560
Windows	46”x46” Insulated vinyl window	5	$450.00	$2,250	-	20	$4,590
	58”x46” insulated	2	$500.00	$1,000		8	$1,950
	Additional lumber, shims, and insulation for installation (estimated at $200 per window)	-	-	$1,400	-	-	$1,610
Lighting	T-12 LED equivalent bulbs	77	$10.49	$808	18	2	$1,570
	60W LED-equivalent (4 pack)	1	$12.32	$12.32	0.25	-	$20
Air Sealing	Weather stripping, caulking	-	-	$500	8	-	$780
HVAC and DHW	Hydronic heating and DHW pipe insulation, heat exchanger jacket	-	-	$400	1	-	$600

[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	200	12,400	1,219
Materials	-	10,147	3,912
Freight	-	1,522	587
Travel	425	2,290	-
Indirect	188	7,908	-
Subtotal	**$813**	**$34,266**	**$5,718**
Grand Total			**$40,796**

Appendix F – Example Materials

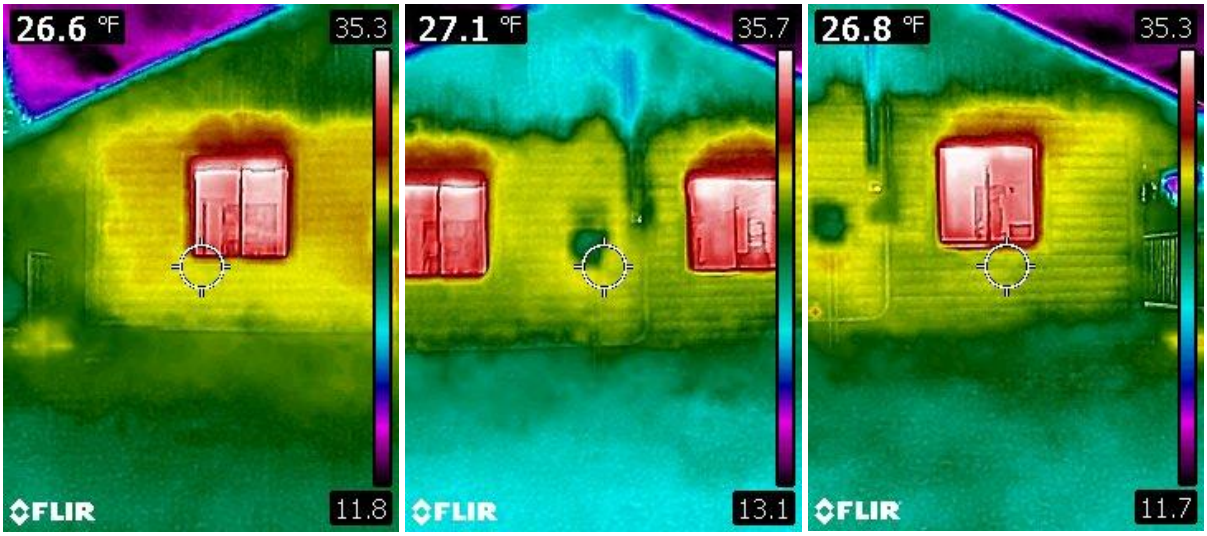
1. Lighting
   Thinklux LED Fluorescent Replacement Tube

2. Heating
   Pipe Insulation– 2 ½" OD Copper Pipe
   Pipe Insulation – 1 ¼" OD PEX Pipe
   Heat Exchanger Jacket Material

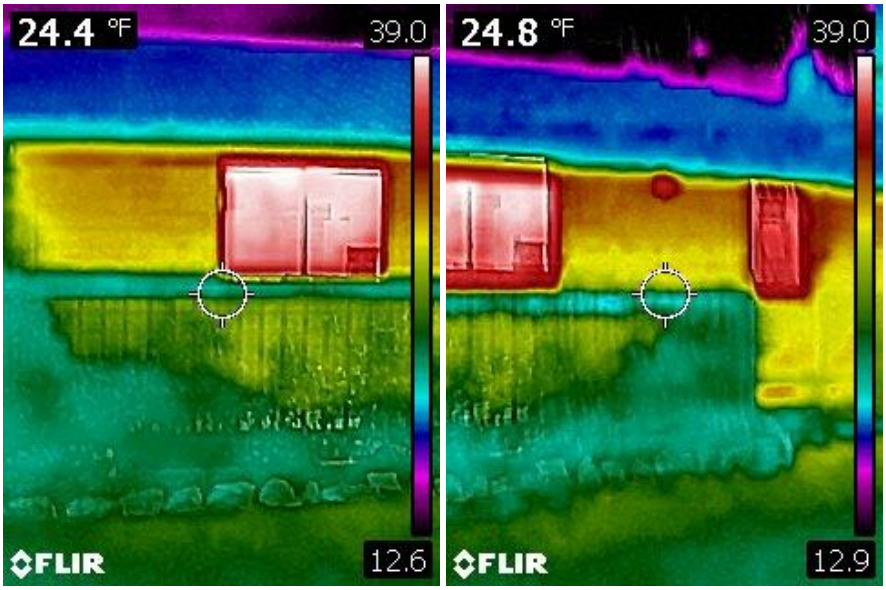
3. Air Tightening
   Electrical Socket Gaskets
   Weather Stripping
   Door Sweep
   Window Plastic Shrink Wrap

Appendix G – Additional Photos of the Chistochina Village Office

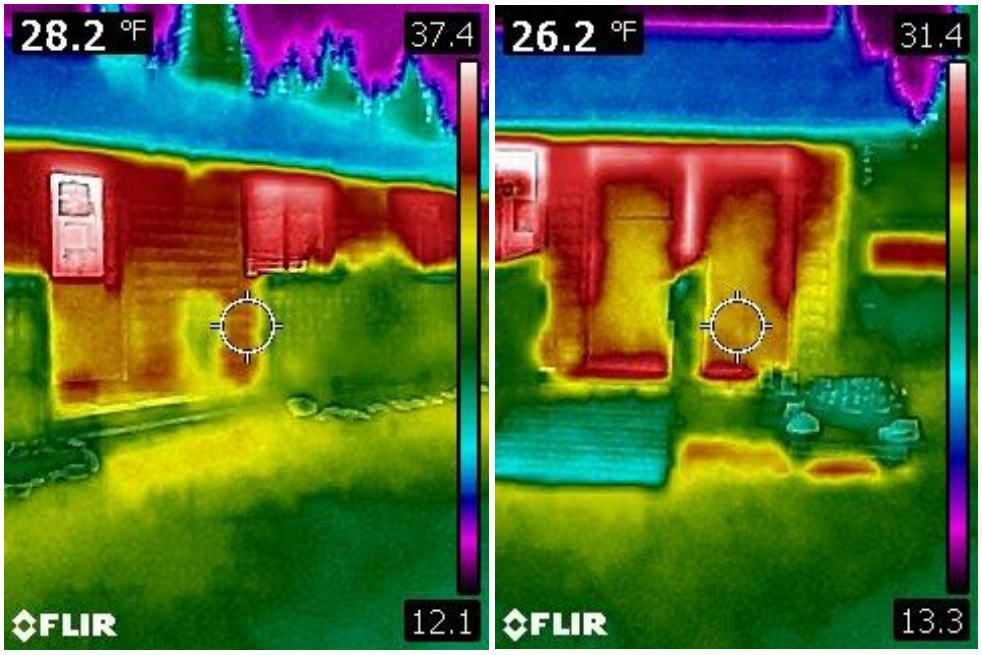
West facing exterior wall.



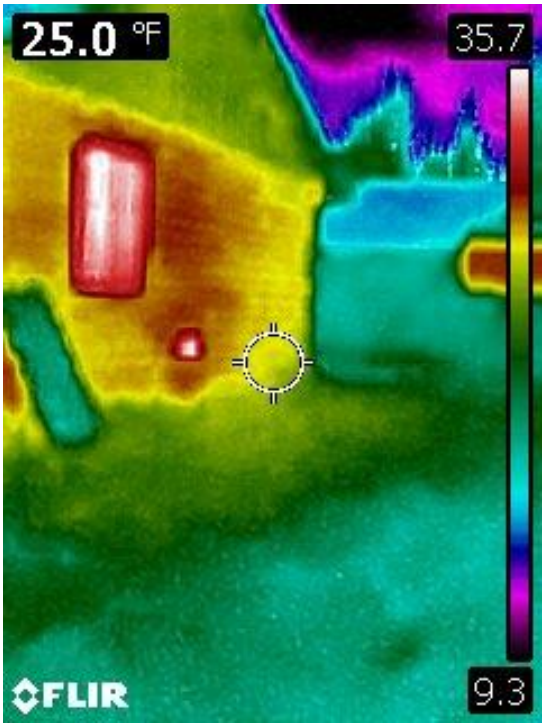
South facing exterior wall (southwest corner to main entrance door).



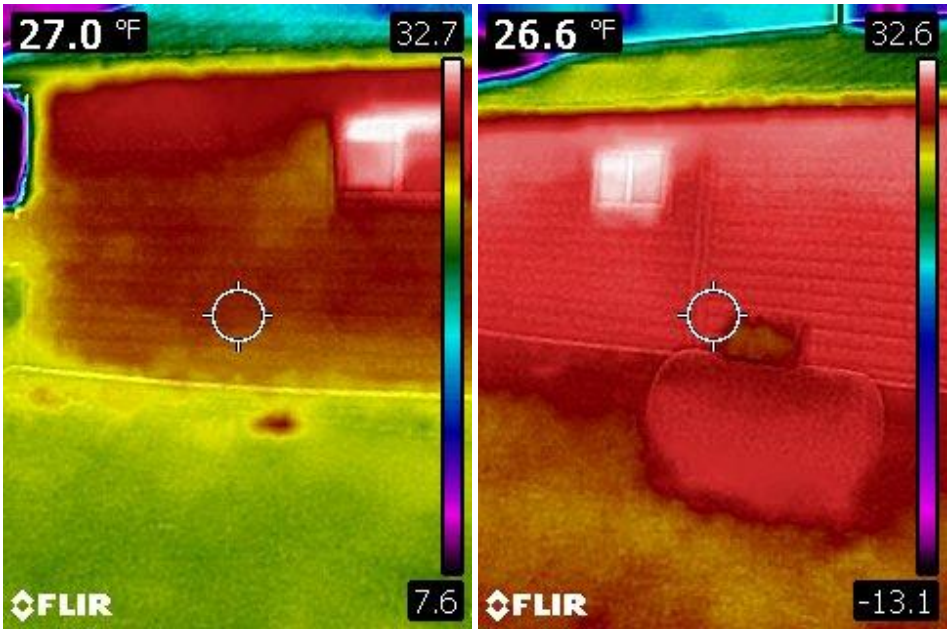
South facing exterior wall (main entrance door to southeast corner).



East facing exterior wall.



North facing exterior wall (northeast corner to the propane tank).



North facing exterior wall (near the propane tank to the northwest corner).