



# Comprehensive Energy Audit For Chistochina Recreation Center



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 Recreation Center 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 Recreation Center 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 \$3,592 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 Recreation Center**

Fuel Use	Existing Building	With Proposed Retrofits	Predicted Annual Savings
Electricity	1,218 kWh	785 kWh	496 kWh
	\$2,673	\$1,723	\$1,089
#1 Oil	226 gallons	144 gallons	82 gallons
	\$702	\$448	\$255
Pellet District Heating	9.96 million BTU	12.39 million BTU	(2.43) million BTU
	\$216	\$270	(\$53)

*Note: Estimated costs and savings based on \$2.195 per kWh (includes high demand fees), \$3.11 for #1 fuel oil, and \$21.83 per million BTU for the pellet-fired district heating system.*

*No electrical billing data was provided for this facility. The electrical usage above is based on AkWarm© model calculations.*

*Actual fuel consumption varied by year. In 2016-2017, about 132 gallons of fuel oil was consumed. In 2017-2018, 334 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 Recreation Center, 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**

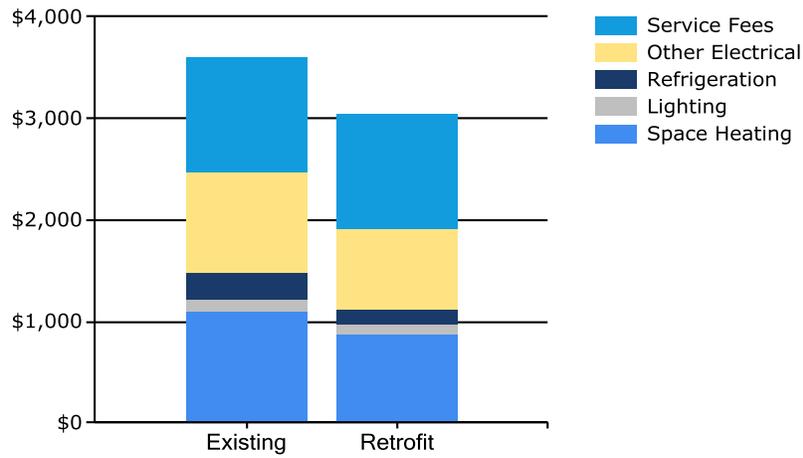
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
1	Electrical Controls: Wi-Fi Router	Unplug the Wi-Fi router when the office area is not in use.	\$146	\$25	49.08	0.2
2	Electrical Controls: Exercise Equipment	Unplug all exercise machines when not in use. Estimated 2% electrical usage reduction.	\$25	\$25	8.55	1.0
3	Toyo Stove: Exercise Room	Program the Toyotomi stove to maintain the exercise room at 60°F when the facility is least used.	\$15	\$25	8.16	1.6
4	Refrigeration: Mini-Refrigerator	Replace the existing refrigerator with an Energy Star rated model.	\$74	\$230	3.71	3.1
5	Lighting: Floor Lamp	Replace all incandescent bulbs with LED equivalents.	\$0 + \$4 Maint. Savings	\$27	2.15	6.7
6	Lighting: Exercise Room	Remove the lighting ballasts. Install direct wire, energy efficient LED equivalents. Note: T-12 replacements do not require a tombstone.	\$54 + \$10 Maint. Savings	\$565	1.64	8.9
7	Heating, Ventilation, and Domestic Hot Water	Insulate all district heating hydronic heating plumbing and the heat exchanger in the building crawlspace.	\$26	\$900	0.60	34.4
8	Lighting: Seasonal Office Space	Remove the ballasts in the four-bulb overhead lights. Install direct wire, energy efficient LED equivalents. Cost estimate includes one tombstone per bulb.	\$19 + \$15 Maint. Savings	\$826	0.59	24.1
9	Lighting: Seasonal Office Space	Remove the ballasts in the two-bulb overhead lights. Install direct wire, energy efficient LED equivalents. Cost estimate includes one tombstone per bulb.	\$2 + \$2 Maint. Savings	\$83	0.59	24.1
10	Shell Improvements: Ceiling	Add unfaced R-11 fiberglass batt to the attic space.	\$34	\$1,557	0.51	45.4
11	Electrical Controls: Television and VCR	Unplug the television and VCR in the exercise room when not in use. Estimated 2% electrical usage reduction.	\$1	\$25	0.34	24.4

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
12	Shell Improvements: Exercise Room Exterior Doors	Install insulated storm doors on the exterior of both doors.	\$12	\$754	0.28	61.1
13	Air Tightening	Install weather stripping and new door sweeps around all exterior doors. Caulk around windows as needed. Install foam gaskets behind electrical sockets. Estimated to reduce air leakage by 5%.	\$10	\$445	0.20	44.9
14	Shell Improvements: Seasonal Office Space Exterior Doors	Install insulated storm doors on the exterior of both doors.	\$4	\$744	0.09	178.1
15	Shell Improvements: Walls	Replace existing fiberglass batt with new R-19 in wall cavity. Install R-10 rigid foam board to the exterior and cover with painted T1-11 siding or equivalent.	\$130	\$33,268	0.09	255.2
<b>TOTAL for high and medium priority measures</b>			<b>\$314 + \$14 Maint. Savings</b>	<b>\$897</b>	<b>3.88</b>	<b>2.7</b>
<b>TOTAL for all measures</b>			<b>\$553 + \$31 Maint. Savings</b>	<b>\$39,498</b>	<b>0.22</b>	<b>67.6</b>

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.
- Use excess rigid board insulation to insulate the attic hatch in the office area and crawlspace door.
- Replace the wall-mounted exterior light near the entrance door with a motion sensor LED fixture with an integrated dusk-to-dawn sensor to reduce electrical consumption. Estimated cost: \$80 (includes materials, shipping, and labor).

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
<b>Building:</b> Chistochina Recreation Center	<b>Auditor Company:</b> Alaska Native Tribal Health Consortium
<b>Address:</b> P.O. Box 241	<b>Auditor Name:</b> Kelli Whelan
<b>City:</b> Chistochina	<b>Auditor Address:</b> 4500 Diplomacy Drive Anchorage, AK 99508
<b>Client Name:</b> Pete Peschang, James (Jim) Beeter	
<b>Client Address:</b> P.O. Box 241 Chistochina, AK 99586	<b>Auditor Phone:</b> (907) 729-3723
<b>Client Phone:</b> (907) 822-3503	<b>Auditor FAX:</b>
<b>Client FAX:</b> (907) 822-5179	<b>Auditor Comment:</b>
Design Data	
<b>Building Area:</b> 1,260 square feet	<b>Design Space Heating Load:</b> Design Loss at Space: 22,036 BTU/hour with Distribution Losses: 22,326 BTU/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 34,034 BTU/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
<b>Typical Occupancy:</b> 1 - 6 people	<b>Design Indoor Temperature:</b> 63.9°F (building average)
<b>Actual City:</b> Chistochina	<b>Design Outdoor Temperature:</b> -38.2°F
<b>Weather/Fuel City:</b> Chistochina	<b>Heating Degree Days:</b> 13,238°F-days
Utility Information	
<b>Electric Utility:</b> Alaska Power and Telephone	<b>Fuel Oil Distributer:</b> Crowley
<b>Average Annual Cost/kWh:</b> \$2.195/kWh	<b>Average Annual Cost/gal.:</b> \$3.11/gal.

## ***Appendix B – Facility Description***

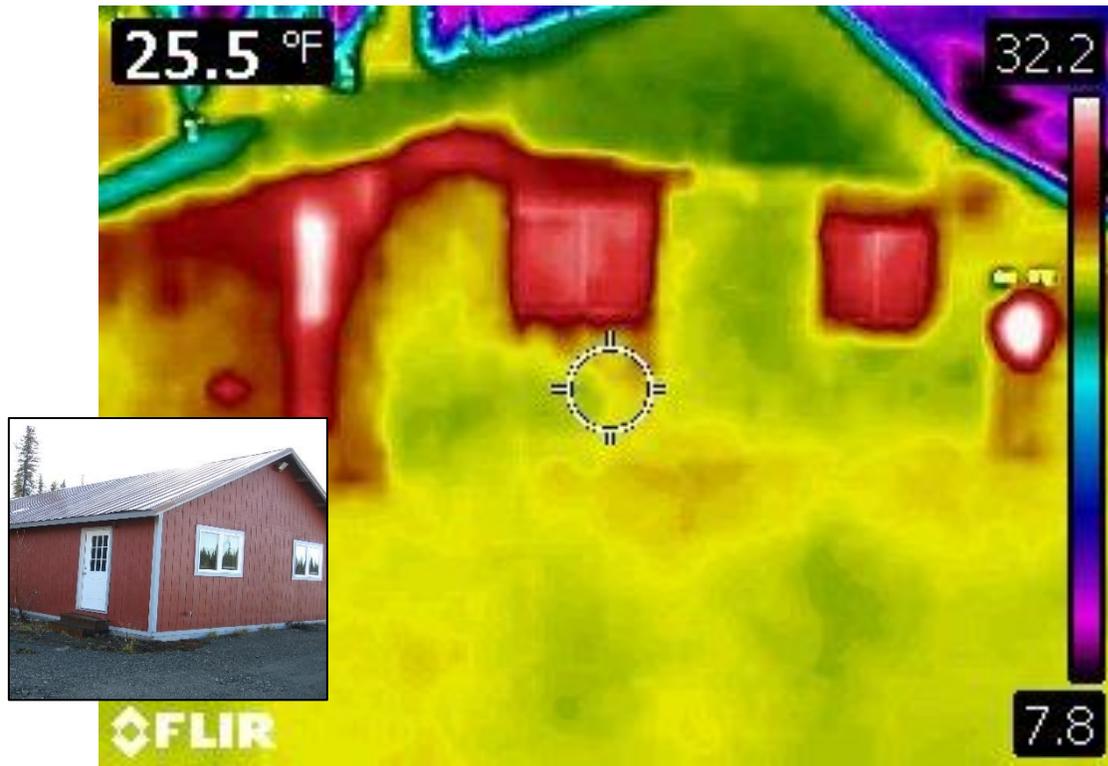
The Chistochina Recreation Center was constructed in the mid-1980s. The building has a small workout facility that is open to tribal members and office space that is used seasonally. The exercise facility was estimated to be used about four hours per week. The office space is used during the summer months (assumed June to August).

### **Building Shell**

The exterior of the building is stick built: 2x6 framing with 16” on-center studs. The stud cavity is filled with R-19 fiberglass batt insulation. There are concerns about the age of the stud cavity insulation and the quality of the installation, so the insulation likely needs to be replaced. The building crawlspace was recently insulated with 4” of extruded polystyrene (EPS, otherwise known as Styrofoam) to protect the pellet boiler district heating hydronic plumbing. Aside from a short length of carrier pipe, the hydronic heating plumbing and building heat exchanger are uninsulated. The crawlspace door is uninsulated.

<b>Total square footage (ft.<sup>2</sup>)</b>	1,261
<b>Average Wall Height (ft.)</b>	8'

<b>Structural Component</b>	<b>Construction Type</b>	<b>Insulation</b>
Walls	2x6 stick frame, 16” on-center	R-19 fiberglass batt (likely damaged)
Floor	Above-grade, insulated crawlspace	R-38 Fiberglass batt
Ceiling with Attic	Standard truss, 16” on-center	R-38 fiberglass batt
Windows (Nine total; two south-facing)	Low-E, insulated fiberglass or vinyl framed	Not applicable
Office Space Exterior Doors (two total)	Fiberglass door, no glass	Polyurethane core
Exercise Room Exterior Doors	Fiberglass door, ½ lite	Polyurethane core



**Figure B1.** Thermal imaging of the Chistochina Recreation Center (inset photo actual building). The color gradient on the right corresponds to degrees Fahrenheit, ranging from white (31.9°F) to black (-6.6°F). The areas of white and red demonstrate a large amount of heat loss through the Center’s windows and doors.

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

The exercise room is heated year-round by a direct vent, oil-fired stove. A pellet-fired district heating boiler supplements the recreation center’s heat from November to June. Heated glycol is circulated between the pellet boiler building and the Chistochina Community Hall through about 90 linear feet of buried, insulated transmission line. Heat is transferred at the community hall to a secondary heating loop (about 200 linear feet of buried, insulated carrier pipe), which is connected to the recreation center’s hydronic heating system via a heat exchanger in the building’s crawlspace. As mentioned above and illustrated in Figure B2, the building’s hydronic heating system plumbing and heat exchanger are uninsulated, but the crawlspace is insulated (4” EPS foam board).



**Figure B2. Uninsulated hydronic heating plumbing and heat exchanger in the Recreation Hall crawlspace.**

There is not adequate heat transfer at the community hall to the recreation center heating loop. The Chistochina Community Hall has a large heating demand and typically uses most of the available district heat. The Cheesh’Na Tribe plans to replace the existing Recreation Center circulation pump with a larger pump to increase the heating loop circulation and provide more heat to the building.

<b>Oil-fired Boiler</b>	
Nameplate Information	Toyotomi Laser 56
Fuel Type	#1 Fuel oil
Input Rating	0.11 gal/hr. (15,594 BTU/hr.)
Combustion Efficiency	87% (estimated)
Idle Loss	0% (estimated)
Heat Distribution Type	Air

<b>Pellet Boiler</b>	
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 (set on high)

### **Ventilation**

The building does not have a centralized ventilation system.

## Lighting

Fluorescent tube fixtures provide a majority of the lighting in both the exercise room and the seasonal office space. All interior lights are controlled by manual light switches.

Exterior lighting is provided by a wall-mounted fixture near the exercise room entrance and a 70-Watt high pressure sodium (HPS) fixture mounted at the roof apex on the west facing wall. The small wall-mounted fixture did not have a bulb at the time of the site visit and the HPS fixture was assumed to be used infrequently. All exterior lighting was excluded from is analysis. It is recommended that the wall-mounted fixture be replaced with a motion sensing security light fixture that has an integrated dusk-to-dawn sensor (estimated replacement cost: \$80).

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Office Space	4ft. Fluorescent T-8 Tubes 32W	1	2	5.1
Office Space	4ft. Fluorescent T-8 Tubes 32W	5	4	49.9
Office Space	75W Incandescent Bulb (floor lamp)	1	2	0.0
Exercise Room	4ft. Fluorescent T-12 Tubes 40W	2	4	60.0
Exterior Lighting	Incandescent Bulb (wall-mounted fixture; bulb missing)	1	1	0.0
Exterior Lighting	70W HPS Bulb	1	1	0.0
<b>Total Energy Consumption</b>				<b>115</b>

## Major Appliances

The Chistochina Recreation Center has an E/one pressure sewer system installed (1 HP motor), but the building is currently not connected to the community's water or sewer systems. The pressure sewer system was not included in this analysis.

Major Equipment	Purpose	Rating	Operating Schedule	Annual Energy Consumption (kWh)
Desktop Computers	Tribal programs	460W	Seasonal (June-August)	122.2
Toyotomi ETK-20E	Air cleaner	30W	Seasonal (June-August)	2.7
Wi-Fi Router	Tribal programs	34.5W	Used continuously.	302.4
GE model# SC4SSB	Mini-refrigerator	92W	Seasonal (June-August)	203
Exercise Equipment	Health care	Varies (4.5W-1,440W)	Four hours per week.	316.7
Audiovisual Equipment	Health care (television and VCR)	25.5W	Four hours per week.	25.5
<b>Total Energy Consumption</b>				<b>972.5</b>

## ***Appendix C – Energy Billing Data***

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

*No electrical data was provided for this facility.*

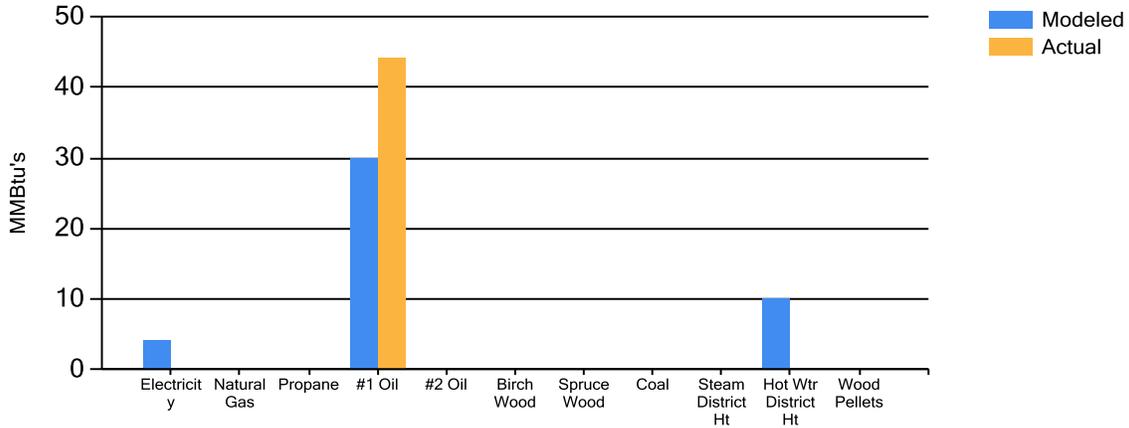
2. #1 Fuel Oil Delivery (Crowley)

<b>Date</b>	<b>Usage (gallons)</b>	<b>Charge</b>
February 2017	54	\$168.00
March 2017	40	\$124.88
October 2017	92	\$284.65
November 2017	64	\$200.00
December 2017	66	\$206.75
January 2018	18	\$55.02

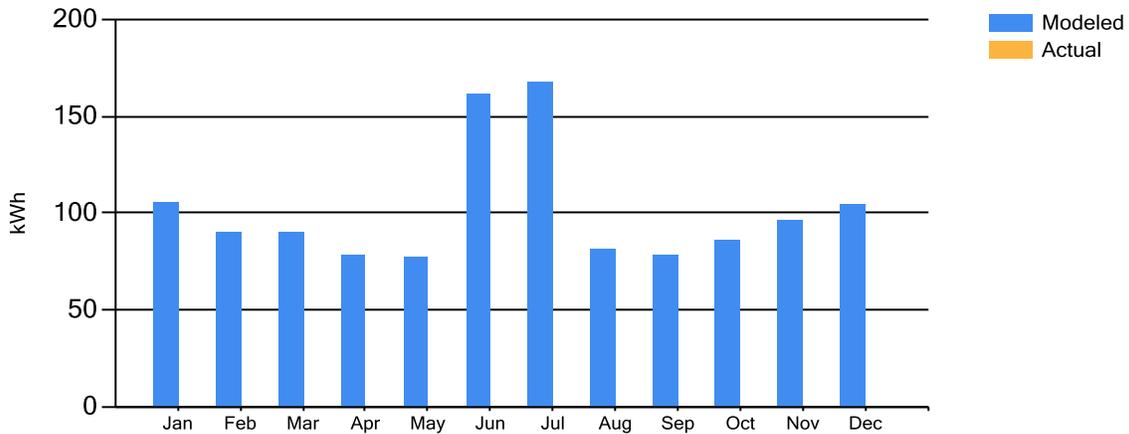
## Appendix D – Actual Fuel Use versus Modeled Fuel Use

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.

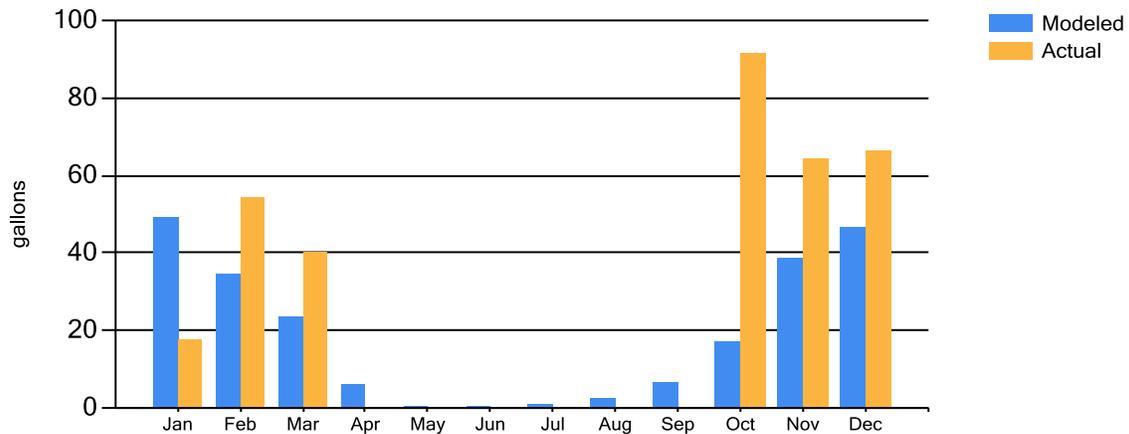
### Annual Fuel Use



### Electricity Fuel Use

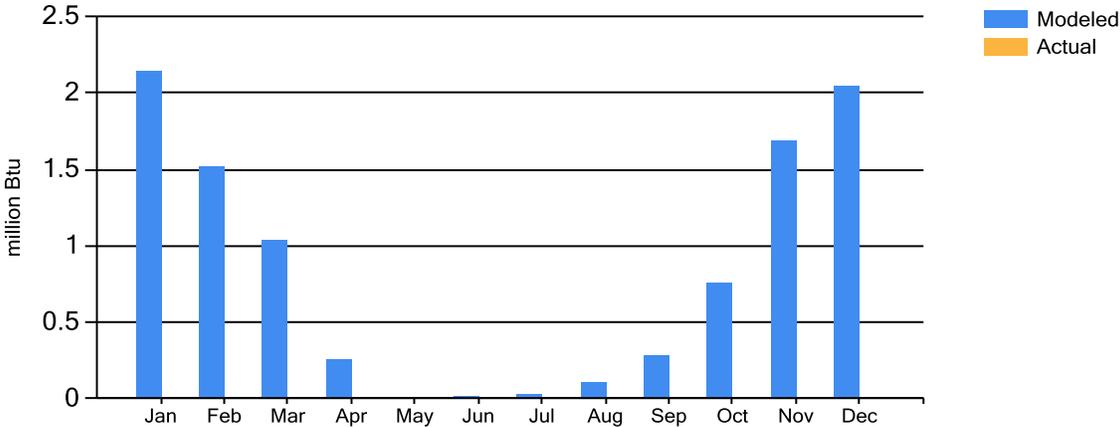


### #1 Fuel Oil Fuel Use



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 <sup>a</sup>	Cost per Item	Total Materials Cost	Hours Local Labor	Hours Contractor	Total Project Cost <sup>b</sup>
Walls	R-10 Foam insulation	44	\$36.20	\$1,593	-	160	\$33,590
	R-19 Faced fiberglass batt (10-bag pallet)	2	\$479.00	\$958			
	Furring lumber	129	\$2.33	\$301			
	T1-11 Siding	44	\$39.57	\$1,741			
	Exterior Paint	1	\$122.00	\$122			
	Additional installation materials (screws, staples, tape, spray foam insulation, contingency)	-	-	\$1,00			
Attic	R-11 Un-faced fiberglass batt (pallet)	1	\$905.00	\$905	16	-	\$1,440
Exterior Doors	Insulated storm doors	4	\$300.00	\$1,200	8	-	\$1,580
Lighting	T-12 LED equivalent bulbs	9	\$10.49	259	2	1	\$565
	T-8 LED equivalent bulbs (tombstone included)	25	\$12.24	\$306	6	1	\$910
	60W LED-equivalent (4 pack)	1	\$12.32	\$12.32	0.25	-	\$30
Air Sealing	Weather stripping, caulking	-	-	\$300	5	-	\$820
HVAC and DHW	Hydronic heating and DHW pipe insulation, heat exchanger jacket	-	-	\$650	6	-	\$900

<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.

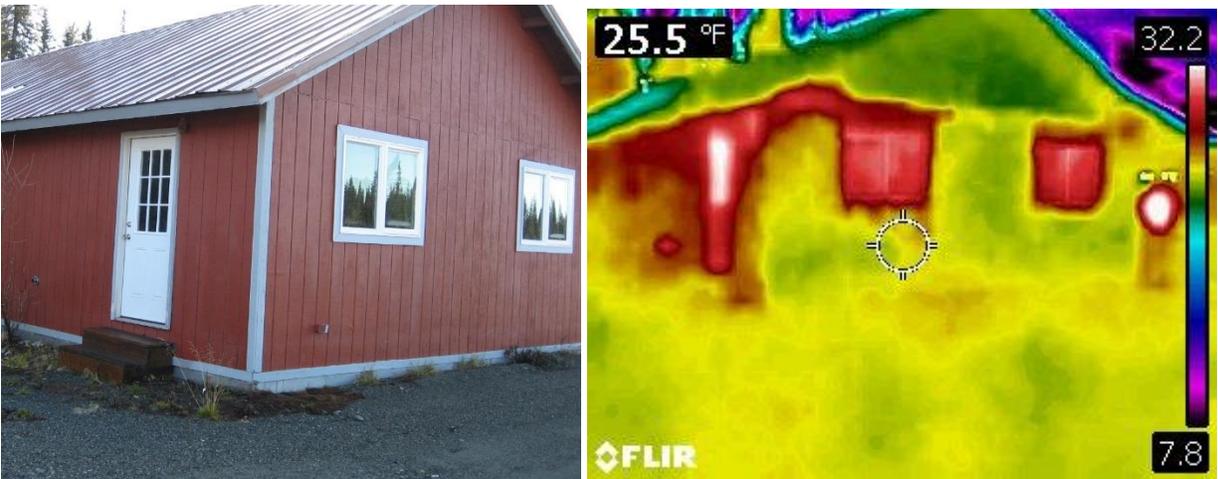
	Contractor (Electrician)	Contractor (Exterior)	Local Labor
Category	Cost (\$)	Cost (\$)	Cost (\$)
Labor	200	16,000	1,000
Materials	-	5,714	3,468
Freight	-	857	520
Travel	425	3,260	-
Indirect	188	7,749	-
<b>Subtotal</b>	<b>\$813</b>	<b>\$33,581</b>	<b>\$4,988</b>
<b>Grand Total</b>			<b>\$39,382</b>

## ***Appendix F – Example Materials***

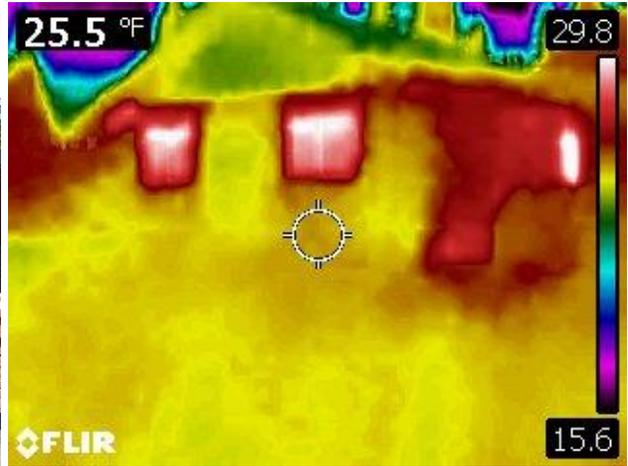
1. Lighting  
[Thinklux LED Fluorescent Replacement Tube](#)
2. Heating  
[Pipe Insulation– 2 ½” OD Copper Pipe](#)  
[Pipe Insulation – 1 ¼” OD PEX Pipe](#)  
[Heat Exchanger Jacket Material](#)
3. Air Tightening  
[Electrical Socket Gaskets](#)  
[Weather Stripping](#)  
[Door Sweep](#)  
[Window Plastic Shrink Wrap](#)

## ***Appendix G – Additional Photos of the Chistochina Recreation Center***

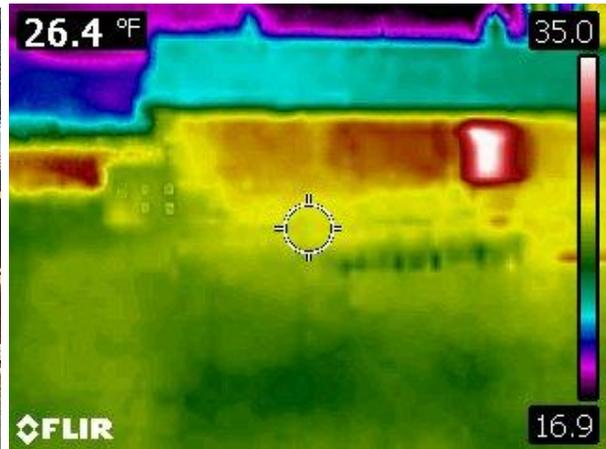
West facing exterior wall.



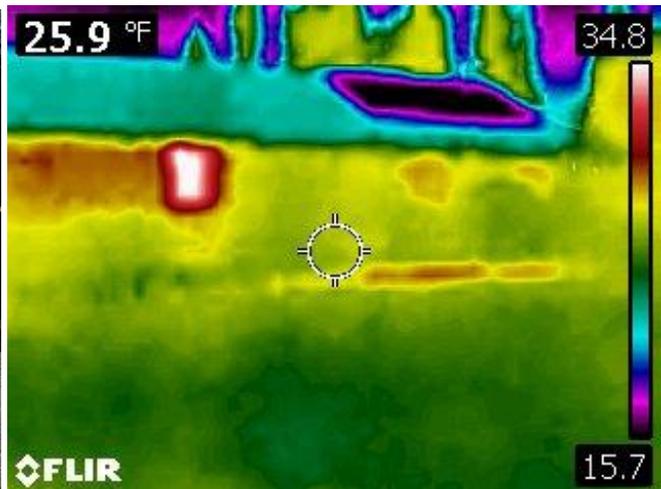
West facing exterior wall.



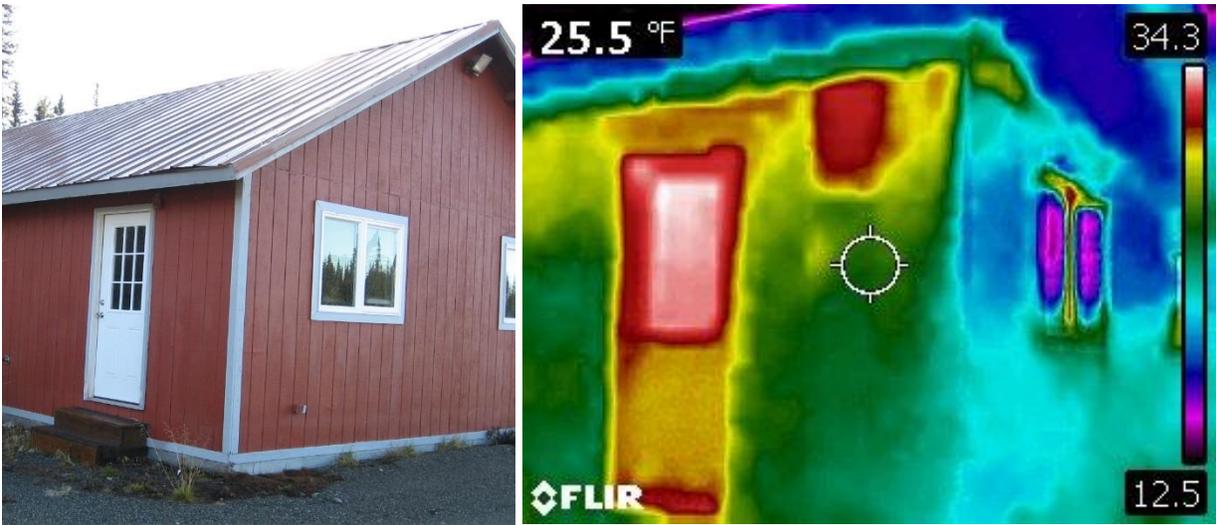
South facing exterior wall (southwest corner to exercise room entrance).



South facing exterior wall (exercise room door to southeast corner).



North facing wall (northwest corner to exercise room exterior door).



North facing wall.

