Comprehensive Energy Audit
For
Chistochina Community Hall

Prepared For

Cheesh'Na Tribe

March 25, 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 Community Hall 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 Community Hall 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 $15,379 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 Community Hall

Fuel Use	Existing Building	With Proposed Retrofits	Predicted Annual Savings
Electricity	5,471 kWh	3,272 kWh	2,199 kWh
	$7,806	$4,669	$3,138
#1 Oil	2,025 gallons	807 gallons	1,302 gallons
	$6,297	$3,913	$4,388
Pellet District Heating	17.01 million BTU	45.62 million BTU	(28.61) million BTU
	$371	$956	($625)
Propane	258 gallons	258 gallons	0 gallons
	$904	$904	$0

Note: Estimated costs and savings based on $1.427 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 5,690 kWh and about 1,900 gallons of fuel oil was consumed. In 2017-2018, approximately 5,010 kWh and 2,330 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 Community Hall, 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	Programmable Thermostat: Community Hall	Replace the existing thermostat with a programmable thermostat. Reduce the building temperature to 60° - 65°F when it is unoccupied.	$926	$200	61.26	0.2
2	Refrigeration: Chest Freezer	Move contents to the top freezer refrigerator and turn off chest freezer whenever possible.	$130	$25	42.71	0.2
3	Electrical Controls: Wi-Fi Router	Turn off router when not in use.	$68	$25	22.76	0.4
4	Lighting: Bathroom	Replace the incandescent bulb with an LED equivalent.	$18 +$2 Maint. Savings	$18	15.81	0.9
5	Heating, Ventilation, and Domestic Hot Water	Clean and tune boiler. Perform an annual efficiency test. Install a Tigerloop and an oil filter. Flush the pellet boiler heat exchanger to improve heat exchange. Replace glycol in community building hydronic heating system. Insulate all hydronic heating plumbing and heat exchanger in the boiler room. Install faucet aerators in the bathrooms and kitchen to reduce hot water usage. Estimated hot water use reduction: 50%.	$2,341	$5,000	6.20	2.1
6	Electrical Controls: Microwave	Unplug microwave when not in use.	$12	$25	4.14	2.0
7	Lighting: Main Meeting Room	Remove the fluorescent fixture ballasts. Replace the existing fluorescent bulbs with direct wire, energy efficient LED equivalents.	$377 + $70 Maint. Savings	$2,999	2.19	6.7
8	Lighting: Kitchen	Remove the fluorescent fixture ballasts. Replace the existing fluorescent bulbs with direct wire, energy efficient LED equivalents.	$63 + $12 Maint. Savings	$522	2.09	7.0

Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR	Simple Payback (Years)
9	Shell Improvements: Ceiling	Add R-11 fiberglass batt to the attic space.	$151	$3,046	1.11	20.2
10	Air Tightening	Install weather stripping around exterior doors. Re-caulk windows as needed. Consider installing thermally insulating curtains and plastic shrink-wrap around the windows in the winter. Energy savings reflect a 5% reduction in draft.	$43	$775	0.50	18.1
11	Shell Improvements: Walls	Replace the existing fiberglass insulation in the wall stud cavity. Furr out the walls and install R-20 rigid foam board to the exterior. Cover with painted T1-11 siding or equivalent.	$794	$50,405	0.35	63.5
12	Lighting: Storage/Pantry	Remove the fluorescent fixture ballasts. Replace the existing fluorescent bulbs with direct wire, energy efficient LED equivalents.	$0 + $1 Maint. Savings	$33	0.35	42.1
TOTAL for the medium and high priority measures			**$4,086 + $84 Maint. Savings**	**$11,859**	**4.65**	**2.9**
TOTAL for all measures			**$4,922 + $85 Maint. Savings**	**$63,072**	**1.16**	**12.8**

In addition to adding insulation to the attic and sealing air gaps around the windows and doors, 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.

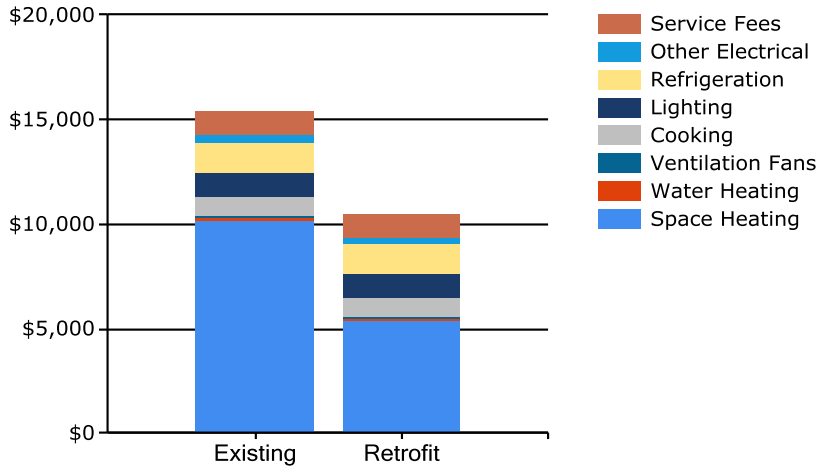


Figure 1.1: Annual energy costs by use before and after EEMs.

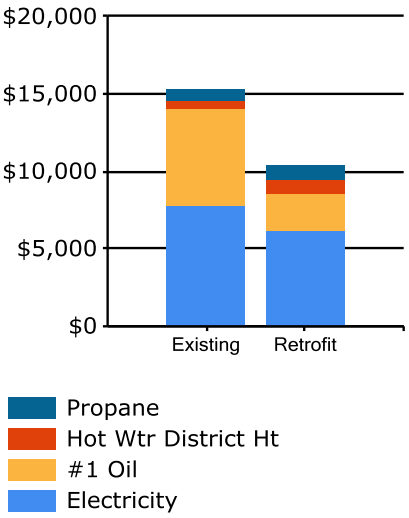


Figure 1.2: Annual energy costs by fuel type before and after EEMs. Note: "Hot Wtr District Ht" is the pellet-fired district heating system.

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 Community Hall	**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: 2,470 square feet	**Design Space Heating Load:** Design Loss at Space: 192,816 BTU/hour with Distribution Losses: 202,964 BTU/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 309,397 BTU/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 10 people	**Design Indoor Temperature:** 80°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	**#1 Fuel Oil Provider:** Crowley
Average Annual Cost/kWh: $1.427/kWh	**Average Annual Cost/gal.:** $3.11/gallon

Appendix B – Facility Description

The Chistochina Community Hall was constructed in 1986. The building serves as a meeting and reception hall for Cheesh'Na tribal members, featuring a large meeting area and a commercial kitchen with a pantry. The hall is used about once per week for small meetings, community-wide celebrations, and funeral and potlach services.

Building Shell

The interior and exterior of the building are in good condition, but the wall insulation likely needs to be replaced for two reasons. First, loose fill and fiberglass batting falls over time simply due to gravity. This can be problematic below windows if the batting or loose fill was not packed properly. Second, the building was constructed using inexperienced carpenters, so the insulation may not have been installed correctly in the first place. The two backdoors to the kitchen and janitor/storage spaces have visible gaps around them. Replacing the weather stripping and door sweeps around all of the doors is recommended.

Two of the skylights were damaged by ice and have been removed. If these are not going to be replaced, any damaged attic insulation should be replaced to reduce heat loss. Also, the roof patches should be checked occasionally for leaks. Fiberglass batt, which insulates the attic space, is easily damaged by water.

Total square footage (ft.^{2})	2,470
Average Wall Height (ft.)	8

Structural Component	Construction Type	Insulation
Walls	2x6 stick frame, 16" on-center	R-19 fiberglass batt
Floor	Above-grade, tight crawlspace	R-19 Fiberglass batt
Ceiling with Attic	Standard truss, 24" on-center	R-38 fiberglass batt
Windows (Nine total; three south-facing)	Double pane, low-E with insulated fiberglass frame	Not applicable
Skylights (Four total)	Tube skylights	Not applicable
Kitchen Exterior Door	Metal door, no window	Honeycomb core
Main Meeting Area Exterior Doors (two total)	Metal door, no window	Honeycomb core
Janitor Storage Room Exterior Door	Metal door, no window	Honeycomb core

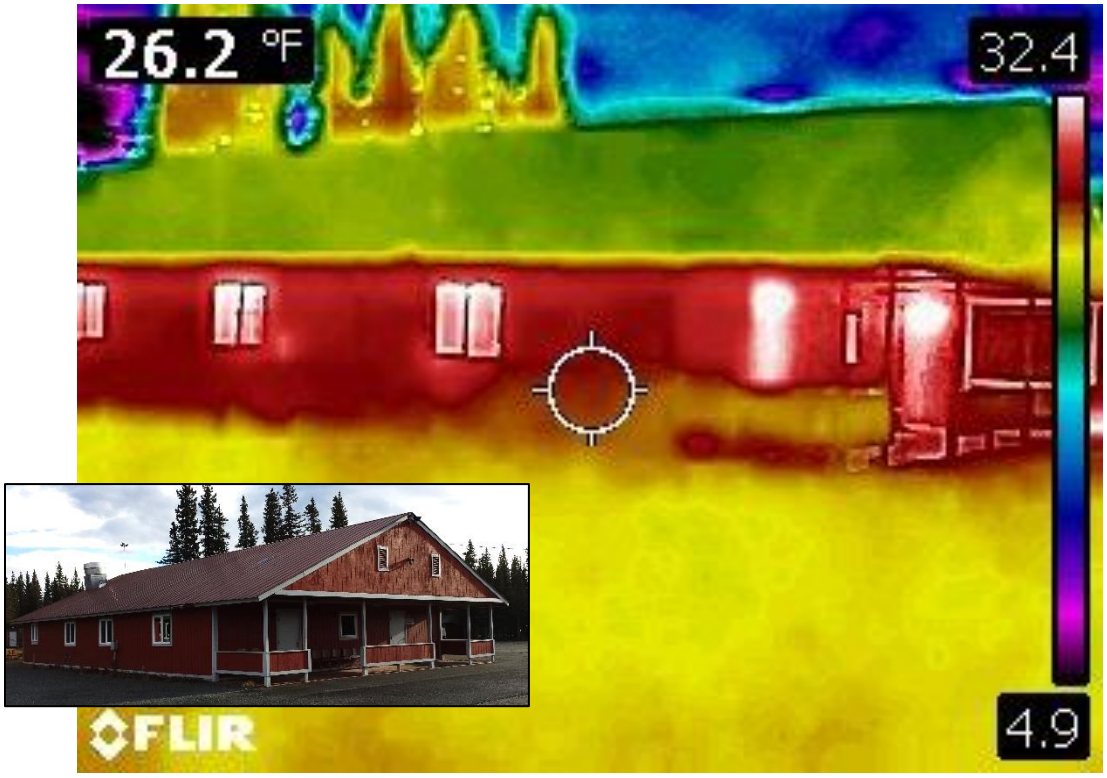


Figure B1. Thermal imaging of the Chistochina Community Hall (inset photo actual building). The color gradient on the right corresponds to degrees Fahrenheit, ranging from white (32.4°F) to black (4.9°F). The areas of white demonstrate a large amount of heat loss through the Community Hall windows and doors. The walls, shown in red, are the second largest source of heat loss.

Heating and Domestic Hot Water

The Chistochina Community Hall is heated year-round by an oil-fired boiler. It also heats a 41-gallon indirect hot water generator located in the hall's boiler room. The oil-fired boiler does not have a fuel filter or an oil de-aerator, and likely has not been serviced in some time. Unfortunately, the glycol piping, flue pipe, and boiler controls configuration would make brushing out the boiler cast iron sectionals difficult.

From November to about June of each year, the boiler return glycol supply is preheated by a pellet-fired district heating boiler. Heated glycol is circulated through approximately 90 feet of buried transmission line to a 210,000 BTU per hour brazed plate heat exchanger located in the Community Hall's boiler room. The transmission line is insulated (R-4.75 closed cell foam insulation); however, snowmelt is evident where the lines are buried.

Oil-fired Boiler	
Nameplate Information	Weil McLain WGO-4
Burner	Beckett AFG Series Oil Burner
Ignition Control	Genysis 7505
Nozzle Information	Delevan 1.25x60°, Type B
Fuel Type	#1 fuel oil
Input Rating	1.2 gal/hr. (160,800 BTU/hr.)
Combustion Efficiency	60% (estimated)
Idle Loss	1.5% (estimated)
Heat Distribution Type	50/50 glycol
Boiler Circulation Pump	Grundfos UPS15-58FC Cartridge Circulator

Pellet Boiler	
Nameplate Information	KOT Pyrot KRT 220
Fuel Type	Wood pellets (Superior Pellets, North Pole, AK)
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

Figure B2. Community Hall boiler (left) and district heating heat exchanger (right).

Ventilation

The community hall kitchen has an 11-foot industrial kitchen exhaust hood with a ¾ HP fan that is used sporadically (estimated 2,200 CFM). Both bathrooms have Broan exhaust fans that turn on with the lights (estimated 70 CFM and 23 Watts).

Lighting

Overhead interior lighting is supplemented by four tube skylights. All interior lights are controlled by manual light switches. Exterior lighting is provided by two LED security lights and five spotlights (assumed to be 70-Watt high-pressure sodium bulbs).

Location	Bulb Type	Fixtures	Bulbs per Fixture	Annual Usage (kWh)
Kitchen, Main Meeting Room	4ft. Fluorescent T-8 Tubes 32W	4	4	94
Main Meeting Room	4ft. Fluorescent T-8 Tubes 32W	23	4	541
Main Meeting Room	4ft. LED T-8 Equivalent 17W	2	4	33.2
Bathrooms, Boiler Room	Spiral CFL 13W	3	1	1.5
Bathroom	Incandescent 60W	1	1	3.1
Storage	LED Integrated Fixture 17W (emergency lighting)	1	1	186
Storage/Pantry	4ft. Fluorescent T-8 Tubes 32W	1	1	0.2
Exterior	High Pressure Sodium Wall Pack 70W	5	1	20.9
Exterior	LED Security Wall Pack 25W	2	2	3.2
Total Energy Consumption				**883**

Major Appliances

The Chistochina Community Hall 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)
True GDM-68	Three door refrigerator	1,380 W	Estimated two weeks per year.	116
Samsung Model RF18HFENBSR	Top freezer refrigerator	345 W	Used continuously.	594
GE Chest Freezer Model FCM15HDMB-WH	Chest Freezer	575 W	Used continuously.	450
Sharp Carousel Microwave	Microwave	1,550 W	Estimated 15 minutes per week.	40.4
100-cup Coffee Urn	Coffee and hot water brewing	1,250 W	Used occasionally.	130.4
Apple Wifi Router	Internet	12 W	Used continuously.	105.2
Total Energy Consumption				**1,436**

Appendix C – Energy Billing Data

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

Date	Usage (kWh)	Charge
September 2017	271	$194.92
October 2017	404	$291.81
November 2017	503	$362.23
December 2017	623	$448.79
January 2018	559	$402.30
February 2018	571	$410.96
March 2018	405	$291.43
April 2018	301	$216.49
May 2018	320	$230.70
June 2018	403	$290.44
July 2018	346	$249.47
August 2018	302	$217.34

2. #1 Fuel Oil Delivery (Crowley)

Date	Usage (gallons)	Charge
August 2017	252	$783.90
October 2017	154	$478.24
November 2017	301	$936.74
December 2017	137	$425.01
January 2018	347	$1,080.25
February 2018	384	$1,193.16
March 2018	331	$1,028.15
May 2018	381	$1,185.29
June 2018	45	$138.51

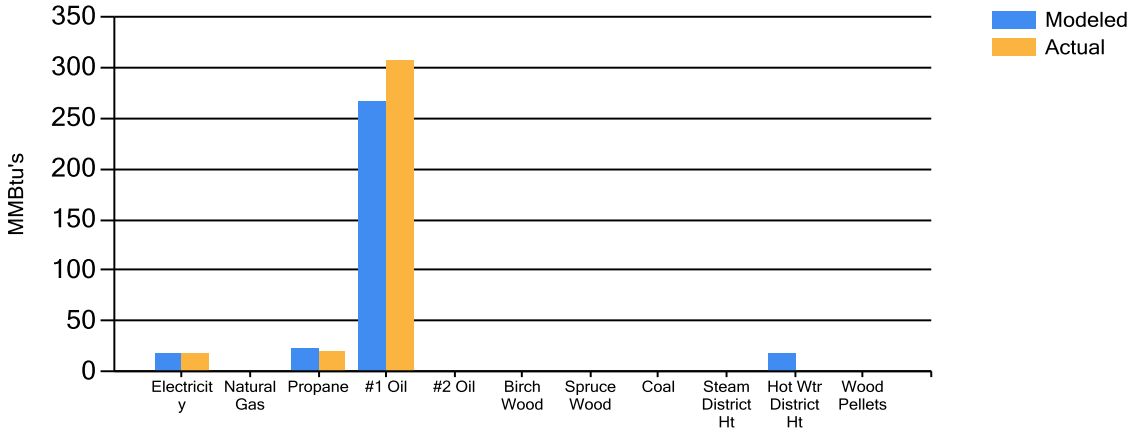
3. Propane Delivery

Date	Usage (gallons)	Charge
September 2017	65	$224.06
October 2017	36	$125.84
November 2017	43	$147.31
December 2017	30	$103.66
January 2018	17	$60.00
June 2018	19	$66.24

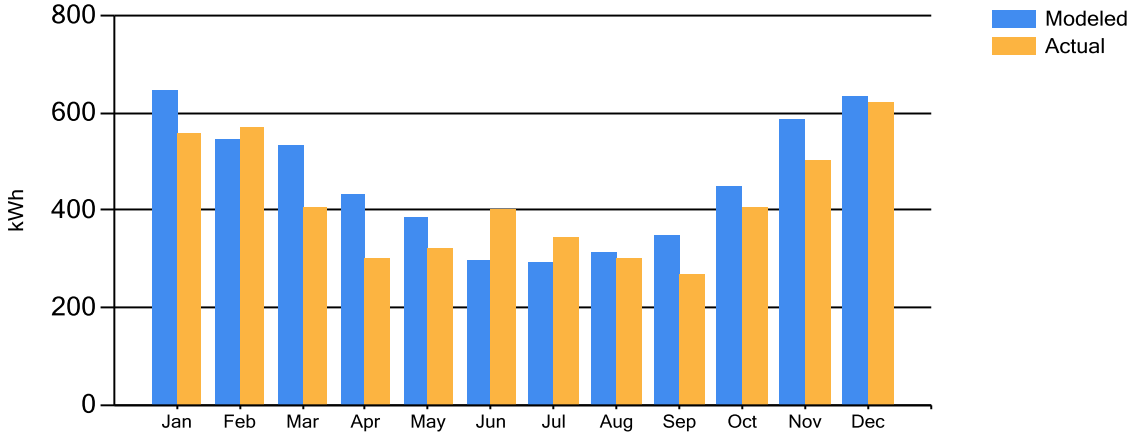
Appendix D – Actual Fuel Use versus Modeled Fuel Use

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.

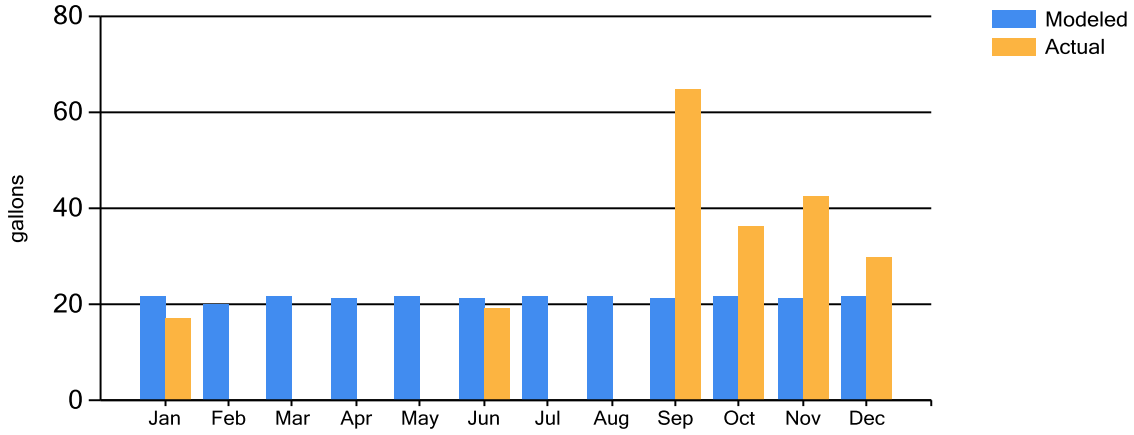
Annual Fuel Use



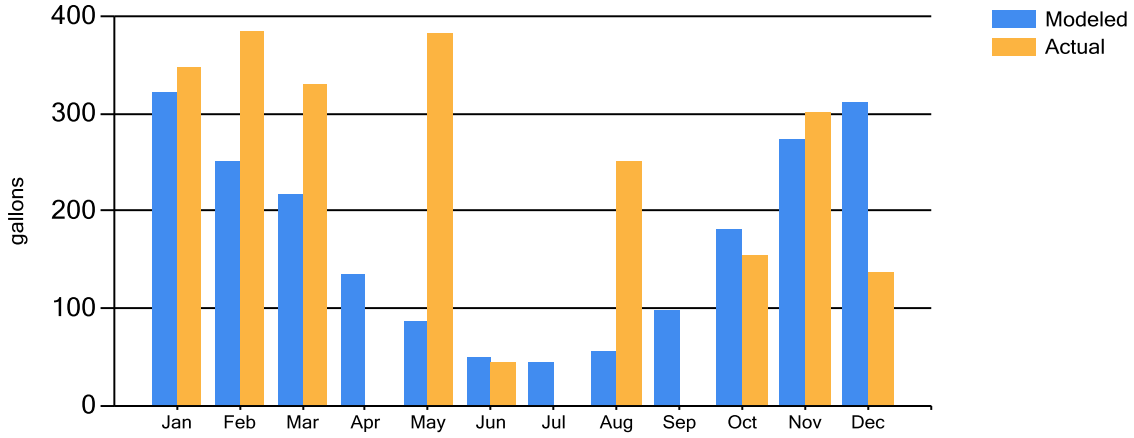
Electricity Fuel Use



Propane Fuel Use

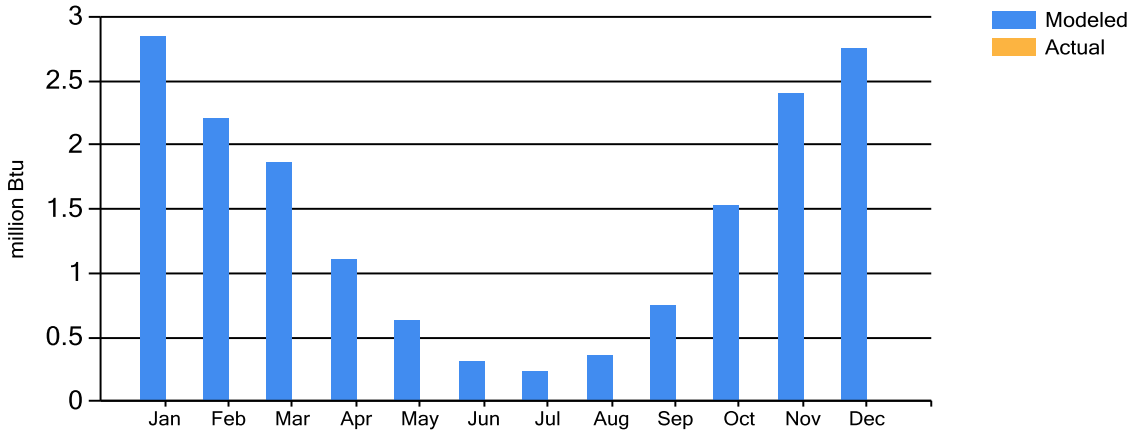


#1 Fuel Oil Fuel Use



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 Weil-McLain boiler.

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	160	$36.20	$5,792	-	200	$50,000
	R-19 Fiberglass batt	33	$42.50	$1,402			
	Furring lumber	110	$2.33	$256			
	Tyvek building wrap	2	$179.00	$358			
	T1-11 Siding	81	$39.57	$3,205			
	Exterior Paint	2	$122.00	$244			
	Additional installation materials (screws, staples, tape, spray foam insulation, contingency)	-	-	$1,000			
Attic	R-11 Un-faced fiberglass batt	2	$905.00	$1,810	32	-	$2,890
Lighting	T-8 LED equivalent bulbs	120	$12.24	$1,469	28	4	$3,520
Air Sealing	Weather stripping, caulking	-	-	$500	8	-	$780
HVAC and DHW	Boiler cleaning and tuning, combustion efficiency testing	-	-	$82	-	4	$1,290
	Tigerloop and fuel filter	-	-	$352	-	3	$900
	Replace building glycol and flush district heating heat exchanger	-	-	$332	-	5	$1,210
	Hydronic heating and DHW pipe insulation, heat exchanger jacket	-	-	$450	3	-	$600
	Programmable thermostat	1	$125.00	$125	1	-	$170
	Faucet aerators, Teflon tape	-	-	$14	2	-	$60

[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 (Heating)	Contractor (Exterior)	Local Labor
Category	**Cost ($)**	**Cost ($)**	**Cost ($)**	**Cost ($)**
Labor	400	1,200	20,000	838
Materials	-	1,266	12,258	4,380
Freight	-	184	1,839	657
Travel	470	596	4,044	-
Indirect	261	962	11,442	-
Subtotal	**$1,131**	**$4,168**	**$50,436**	**$6,079**
			Grand Total	**$61,813**

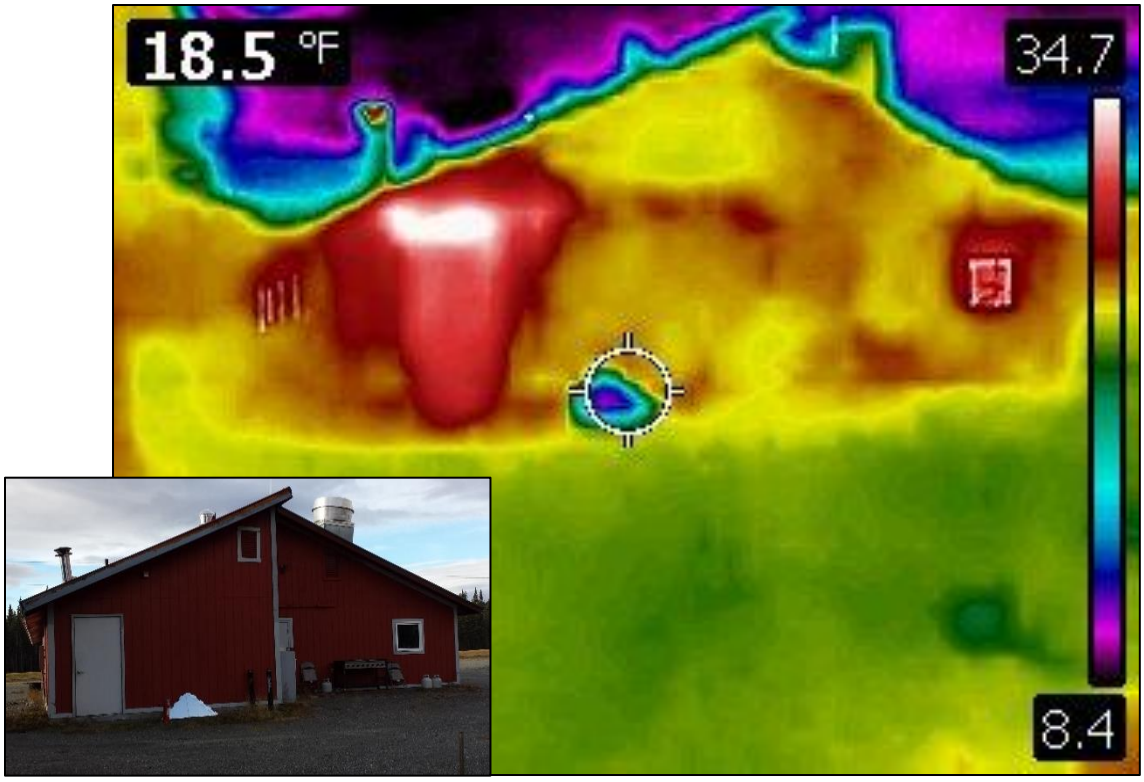
Appendix F – Example Materials

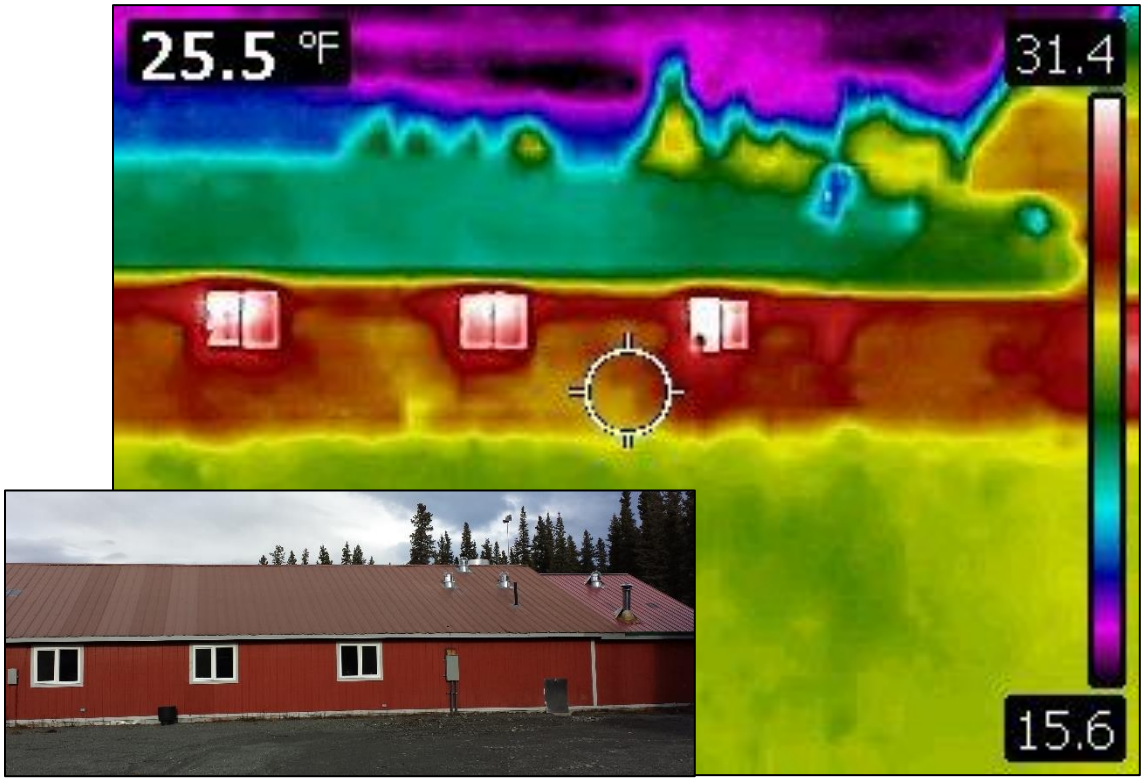
1. Lighting
   Thinklux LED Fluorescent Replacement Tube
   Thinklux Non-shunted Rapid Start Tombstones (4-pack)

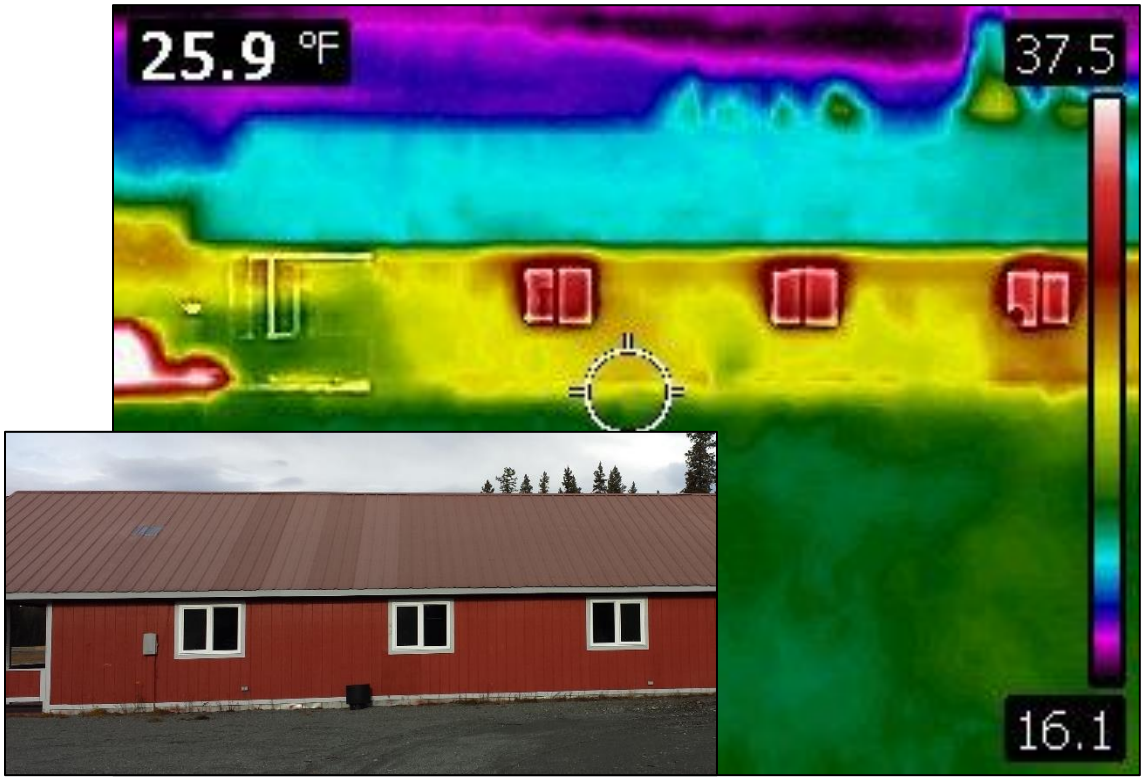
2. Heating
   Boiler Brushes
   Boiler Nozzle
   Electrodes
   Boiler Fuel Pump Pressure Gauge
   Smoke Dot Tester Kit

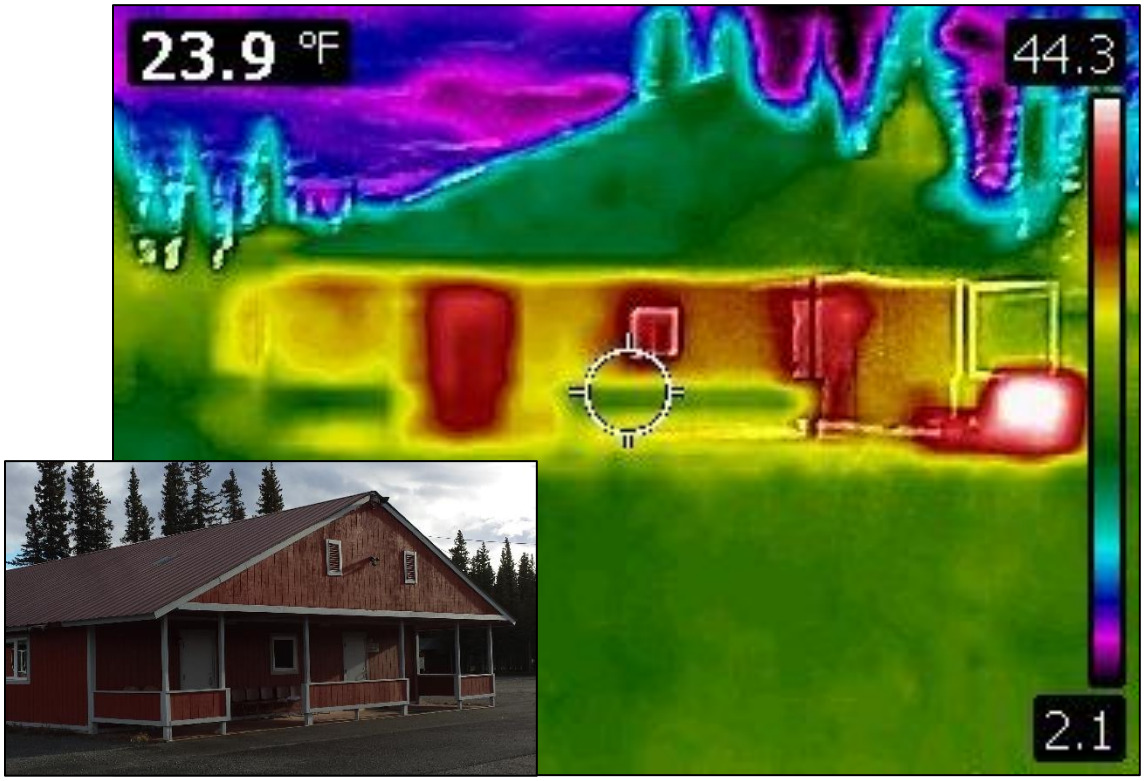
3. Insulation
   Pipe Insulation – 2 ½" Pipe OD
   Pipe Insulation – 1 ¼" Pipe OD
   Heat Exchanger Jacket Material

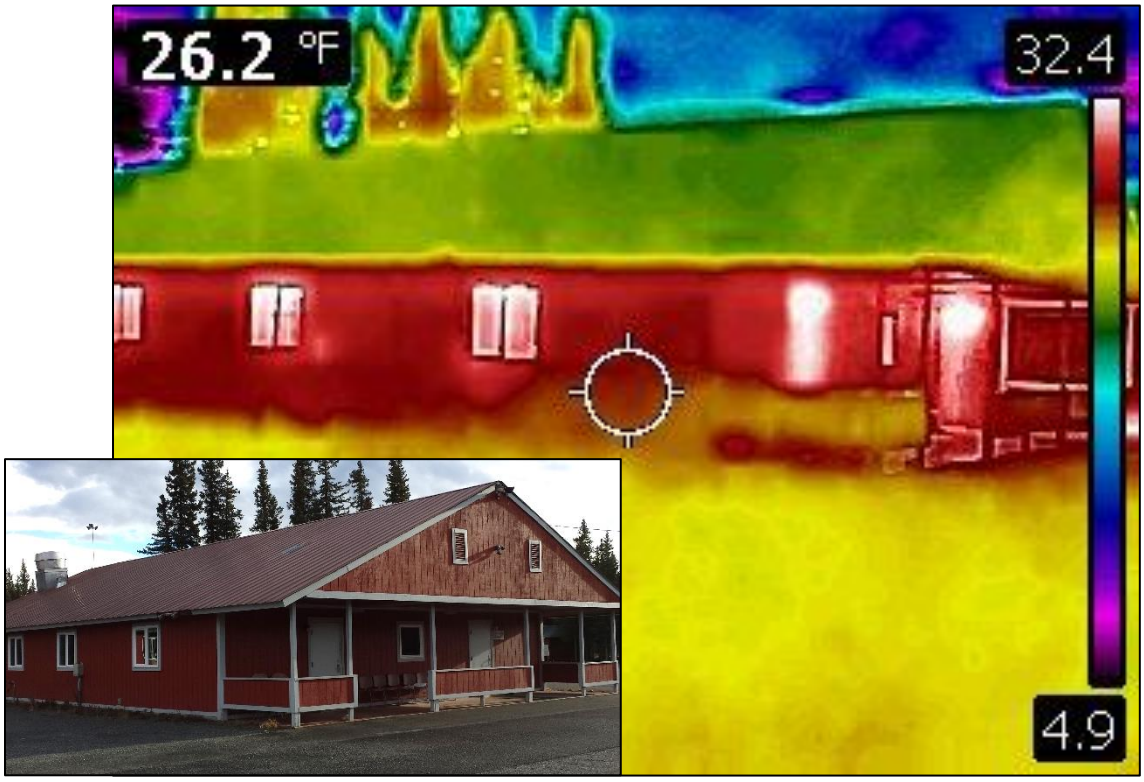
Appendix G – Additional Photos of the Chistochina Community Hall

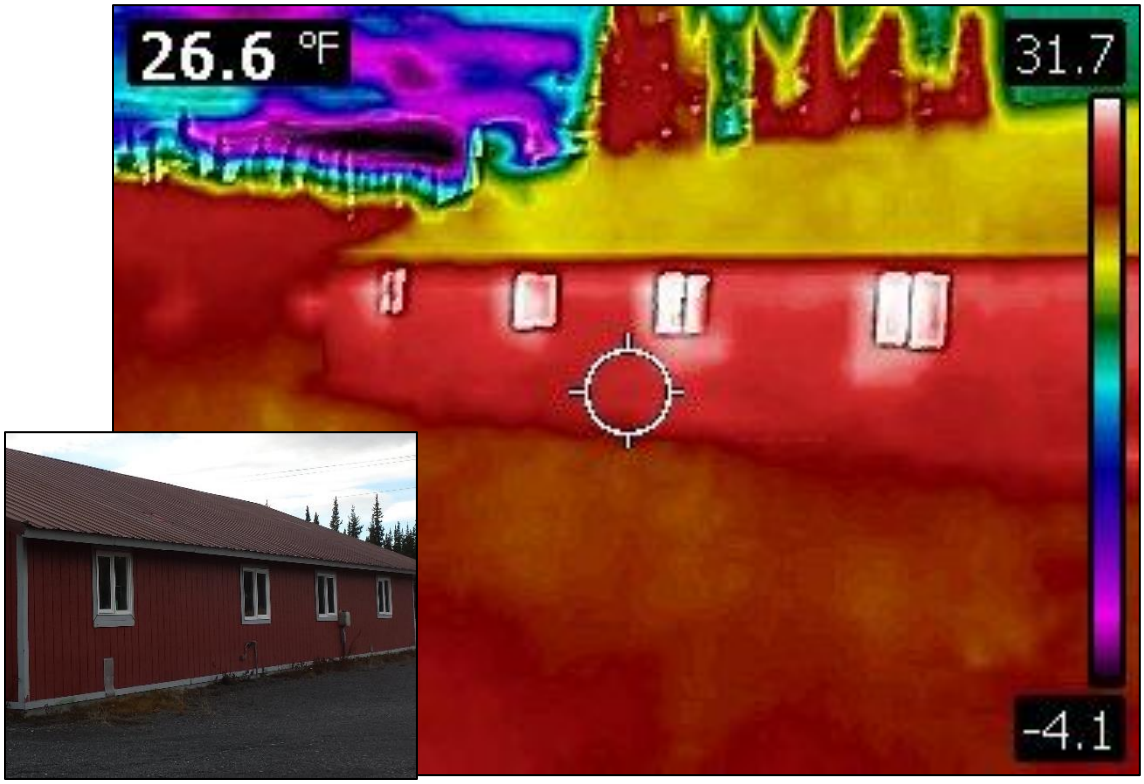



25.5 °F
31.4
15.6


25.9 °F
37.5
16.1


23.9 °F
44.3
2.1


26.2 °F
32.4
4.9


26.6 °F
31.7
-4.1