Comprehensive Energy Audit
For

Golovin Washeteria

Prepared For
City of Golovin

August 24, 2016

Prepared By:

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PREFACE

This energy audit was conducted using funds from the United States Department of Agriculture Rural Development as well as the State of Alaska Department of Environmental Conservation. Coordination with the State of Alaska Remote Maintenance Worker (RMW) Program and the associated RMW for each community has been undertaken to provide maximum accuracy in identifying audits and coordinating potential follow up retrofit activities.

The Rural Energy Initiative at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for The City of Golovin, Alaska. The author of this report is Kevin Ulrich, Energy Manager-in-Training (EMIT). Assistance for this energy audit report was provided by Stephen Sutton, Utility Operations Specialist; Max Goggin-Kehm, Engineering Project Manager; and Darrin Bartz, Supervisor of Utility Operations.

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in April of 2016 by the Rural Energy Initiative of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy conservation measures. Discussions of site-specific concerns, non-recommended measures, and an energy conservation action plan are also included in this report.

ACKNOWLEDGMENTS

The ANTHC Rural Energy Initiative gratefully acknowledges the assistance of Golovin Utilities Clerk Joann Fayers and Golovin City Clerk Virginia Olanna.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Golovin. The scope of the audit focused on the Golovin Washeteria and the associated water systems. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC systems, and plug loads.

An additional energy audit was conducted for the new Golovin Water Treatment Plant at the same time as this audit. The buildings are related in their interactions. This is reflected in the energy audit report.

In the near future, a representative of ANTHC will be contacting the City of Golovin to follow up on the recommendations made in this report. Funding has been provided to ANTHC through a Rural Alaska Village Grant to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

The total predicted energy cost for the Golovin Washeteria is $44,511. Electricity represents the largest portion with an annual cost of approximately $27,902. This includes $10,962 paid by the community and $16,940 paid by the Power Cost Equalization (PCE) program through the State of Alaska. Fuel oil represents the remaining portion with an annual cost of $16,605. There is an active heat recovery system from the power plant to the Golovin Washeteria that is used for heating purposes. The power plant is owned and operated by the City of Golovin and as a result the use of recovered heat is offered at no charge to the washeteria.

The State of Alaska PCE program provides a subsidy to rural communities across the state to lower electricity costs and make energy affordable in rural Alaska. In Golovin, the cost of electricity without PCE is $0.56/kWh and the cost of electricity with PCE is $0.22/kWh.

The heat recovery system was installed in 2006 with the construction of the washeteria. The system transports heat from the generator cooling loops in the nearby power plant to the circulating glycol line within the washeteria. The power plant is owned and operated by Golovin Power Utilities, an organization of the City of Golovin. The washeteria receives the heat free of charge, but the pumps and components of the heat recovery system within the power plant are accounted for within the washeteria electricity bills.

Table 1.1 lists the total usage of electricity, #1 oil, and recovered heat before and after the proposed retrofits.

Table 1.1: Predicted Annual Fuel Usage for Each Fuel Type

Predicted Annual Fuel Use		
Fuel Use	**Existing Building**	**With Proposed Retrofits**
Electricity	49,825 kWh	39,383 kWh
#1 Oil	3,321 gallons	1,844 gallons
Heat Recovery	483.18 million Btu	452.02 million Btu

Benchmark figures facilitate comparing energy use between different buildings. Table 1.2 lists several benchmarks for the audited building. More details can be found in section 3.2.2.

Table 1.2: Building Benchmarks for the Golovin Washeteria

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	639.9	45.89	$26.09
With Proposed Retrofits	486.4	34.88	$18.33
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

Table 1.3 below summarizes the energy efficiency measures analyzed for the Golovin Washeteria. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

Table 1.3: Summarized Priority List of All Energy Recommendations for the Golovin Washeteria

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	**Feature**	**Improvement Description**	**Annual Energy Savings**	**Installed Cost**	**Savings to Investment Ratio, SIR[1]**	**Simple Payback (Years)[2]**	**CO_2 Savings**
1	Lighting: Office Lights	Replace with new energy-efficient LED lighting.	$367	$160	26.96	0.4	1,355.5
2	Lighting: Washeteria Room Lights	Replace with new energy-efficient LED lighting.	$1,468	$640	26.95	0.4	5,410.4
3	Lighting: Arctic Entry	Replace with new energy-efficient LED lighting.	$108	$50	25.40	0.5	398.2
4	Lighting: Exterior Lights	Replace with new energy-efficient LED lighting.	$1,110	$1,500	8.70	1.4	4,362.6
5	Force Main Heat Add	Expand the size of the pipe from the existing 1/2" to a 1" line to maximize heat recovery capability. Shut off heating controls in the summer time. Lower temperature set points to 40 deg. F.	$3,464	$6,000	7.82	1.7	14,618.3

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
6	Lighting: Boiler Room	Replace with new energy-efficient LED lighting and add new occupancy sensor	$561	$900	7.32	1.6	2,063.9
7	Lighting: Storage Room	Replace with new energy-efficient LED lighting.	$87	$160	6.42	1.8	321.6
8	Other – Water Storage Tank Heat-Add	Replace heat-add pumps for the water storage tank so that the tank does not freeze when the head of the tank is less than 5 ft in relation to the pumps. This causes the tank to heat almost twice as much water as needed. Replace the pumps with more efficient models to account for the pressure drops within the water storage tank. The existing pumps cannot suck the water through the line and need 5ft of water pressure to function properly (level of 17ft. total). (This will be fixed by construction)	$843	$2,000	5.26	2.4	5,094.3
9	Other Electrical: Water Plant Heat Recovery Pump (Power Plant Bldg)	Adjust heat recovery controls in the power plant to reduce the pump run time when washeteria demand is not calling for heat.	$1,004	$3,000	3.93	3.0	3,945.8

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
10	Other Electrical: Water Supply Waste Heat Pump	Shut off pump in summer.	$160	$500	3.76	3.1	599.5
11	Other Electrical: Water Supply Heat Add Pump	Shut off pump in summer.	$156	$500	3.67	3.2	585.3
12	Lighting: Restrooms - 2ft. Lights	Replace with new energy-efficient LED lighting.	$26	$120	2.50	4.7	92.7
13	HVAC And DHW	Install Tigerloop deaerators on each boiler for cleaner-burning fuel. Install Honeywell T775 boiler controls to replace the analog thermostats and allow the heat recovery system to fully operate within the building. This is in addition to other retrofits including the expansion of heat-add pipes for the transfer line and force main line, controls work for the heat-add systems, and rerouting of piping.	$3,523	$25,000	2.45	7.1	11,390.6
14	Lighting: Restrooms - 4ft. Lights	Replace with new energy-efficient LED lighting.	$49	$240	2.40	4.9	178.0
15	Lighting: Dryer Plenum	Replace with new energy-efficient LED lighting.	$22	$160	1.61	7.3	81.5

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
16	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	$72	$1,000	0.85	13.8	1,997.0
17	Setback Thermostat: Mechanical Room	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Mechanical Room space.	$33	$1,000	0.39	30.4	910.0
18	Clothes Dryers	Clean and replace filters regularly.	$19	$100	0.36	5.4	72.6
19	Lighting: Plumbing Chase	Replace with new energy-efficient LED lighting.	$5	$240	0.23	51.1	17.7
20	Water Supply Heat Add	Allow transfer line to bypass washeteria. Increase from 1/2" diameter to 1" diameter to increase flow through washeteria heat exchanger.	$77	$8,500	0.12	110.7	1,183.4

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
21	Transfer Line Heat Add	Replace Transfer Line with 2-inch buried pipe to expand heat recovery capabilities. This line will bypass the main plumbing of the washeteria and feed directly into the water storage tank transfer line to maximize efficiency. Lower temperature set points. Because much of this work is associated with the heating system retrofits, some of the cost is represented in that retrofit.	$76	$8,500	0.12	112.0	1,169.8
22	Air Tightening	Add weather stripping around the exterior doors and insulate around the window seams.	$5	$1,000	0.04	208.2	132.6
	TOTAL, all measures		**$13,235**	**$61,270**	**2.97**	**4.6**	**55,981.1**

Table Notes:

[1] Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

[2] Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by $13,235 per year, or 29.7% of the buildings' total energy costs. These measures are estimated to cost $61,270, for an overall simple payback period of 4.6 years.

Table 1.4 below is a breakdown of the annual energy cost across various energy end use types, such as Space Heating and Water Heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

Table 1.4: Annual Energy Cost Estimate Broken Down by Usage Category

Annual Energy Cost Estimate									
Description	**Space Heating**	**Water Heating**	**Ventilation Fans**	**Clothes Drying**	**Lighting**	**Other Electrical**	**Water Circulation Heat**	**Tank Heat**	**Total Cost**
Existing Building	$1,734	$12,425	$1,229	$6,445	$5,725	$13,775	$542	$2,636	**$44,511**
With Proposed Retrofits	$1,656	$5,279	$1,229	$5,583	$1,894	$12,452	$1,128	$2,056	**$31,277**
Savings	$79	$7,146	$0	$861	$3,831	$1,323	-$586	$580	**$13,235**

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Golovin Washeteria. The scope of this project included evaluating building shell, lighting and other electrical systems, and HVAC equipment, motors and pumps. Measures were analyzed based on life-cycle-cost techniques, which include the initial cost of the equipment, life of the equipment, annual energy cost, annual maintenance cost, and a discount rate of 3.0%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information was gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is used and what opportunities exist within a building. The entire site was surveyed to inventory the following to gain an understanding of how each building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment
- Water consumption, treatment (optional) & disposal

The building site visit was performed to survey all major building components and systems. The site visit included detailed inspection of energy consuming components. Summary of building occupancy schedules, operating and maintenance practices, and energy management programs provided by the building manager were collected along with the system and components to determine a more accurate impact on energy consumption.

Details collected from the Golovin Washeteria enable a model of the building's energy usage to be developed, highlighting the building's total energy consumption, energy consumption by specific building component, and equivalent energy cost. The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the building.

Golovin Washeteria is comprised of the following activity areas:

1) Washeteria: 1,354 square feet
2) Mechanical Room: 352 square feet

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:

- Occupancy hours

- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; HVAC; lighting, plug load, and other electrical improvements; and motor and pump systems that will reduce annual energy consumption.

EEMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. Energy savings are calculated based on industry standard methods and engineering estimations.

Our analysis provides a number of tools for assessing the cost effectiveness of various improvement options. These tools utilize **Life-Cycle Costing**, which is defined in this context as a method of cost analysis that estimates the total cost of a project over the period of time that includes both the construction cost and ongoing maintenance and operating costs.

Savings to Investment Ratio (SIR) = **Savings** divided by **Investment**

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the Department of Energy are included. Future savings are discounted to the present to account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation includes the labor and materials required to install the measure. An SIR value of at least 1.0 indicates that the project is cost-effective—total savings exceed the investment costs.

Simple payback is a cost analysis method whereby the investment cost of a project is divided by the first year's savings of the project to give the number of years required to recover the cost of the investment. This may be compared to the expected time before replacement of the system or component will be required. For example, if a boiler costs $12,000 and results in a savings of $1,000 in the first year, the payback time is 12 years. If the boiler has an expected life to replacement of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the project life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money). Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

Measures are implemented in order of cost-effectiveness. The program first calculates individual SIRs, and ranks all measures by SIR, higher SIRs at the top of the list. An individual measure must have an individual SIR>=1 to make the cut. Next the building is modified and re-simulated with the highest ranked measure included. Now all remaining measures are reevaluated and ranked, and the next most cost-effective measure is implemented. AkWarm goes through this iterative process until all appropriate measures have been evaluated and installed.

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first, and then cycling through the list to find the next most cost effective measure. Implementation of more than one EEM often affects the savings of other EEMs. The savings may in some cases be relatively higher if an individual EEM is implemented in lieu of multiple recommended EEMs. For example implementing a reduced operating schedule for inefficient lighting will result in relatively high savings. Implementing a reduced operating schedule for newly installed efficient lighting will result in lower relative savings, because the efficient lighting system uses less energy during each hour of operation. If multiple EEM's are recommended to be implemented, AkWarm calculates the combined savings appropriately.

Cost savings are calculated based on estimated initial costs for each measure. Installation costs include labor and equipment to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers.

2.4 Limitations of Study

All results are dependent on the quality of input data provided, and can only act as an approximation. In some instances, several methods may achieve the identified savings. This report is not intended as a final design document. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

3. Golovin Washeteria

3.1. Building Description

The 1,706 square foot Golovin Washeteria was constructed in 2006, with a normal occupancy of 1 person. The number of hours of operation for this building average 10 hours per day, considering all seven days of the week. The washeteria is open from 9:00AM – 9:00pm and the operator is present for approximately three hours per day in the mechanical space.

The Golovin Washeteria serves as the central location for laundromat and shower services for the community. Additionally, the building houses components of the water distribution system that fill the lower water storage tank and distribute water to the lower part of the community. The Golovin Washeteria receives treated water from the Golovin Water Treatment Plant through the water distribution main. The community water system is a fill-and-draw system, where the community storage tanks are filled over a 3-4 week period and the community then operates for the remainder of the year using the water in storage. When the lower tank is being filled, water pressure is lost to the washeteria because the treated water must pass through the entire plumbing network in the washeteria mechanical space before it is pumped through the transfer line into the water storage tank. During the rest of the year, water is pumped from the lower water storage tank to the water distribution main, and the distribution main is kept heated by the washeteria boilers and heat recovery system. Wastewater is sent out of the building to a lift station where it is then pumped to a sewage tank and an ocean outfall. There is also a watering point located at the washeteria that is used by the residents to get water for personal use.

Figure 3.1: The lower 1.2MM water storage tank in Golovin

Description of Building Shell

The exterior walls are constructed with 2 x 8 single stud lumber construction with 16-inch spacing and approximately 6 inches of polyurethane foam insulation. The lower wall height is 10 ft. while the upper wall height is 15 ft. tall. There is approximately 1,840 square feet of wall space in the building.

The building has a cathedral ceiling with a partial attic for storage space. The roof is constructed with 2 x 8 lumber with standard framing and 16-inch spacing. There is approximately 7.5 inches of polyurethane foam insulation in the roof and there is approximately 1,798 square feet of roof space in the building.

The building is built on pilings with a gap beneath the floor of approximately four feet. The floor is constructed with 2x12 standard lumber and approximately 11.75 inches of polyurethane foam insulation. There is approximately 1,707 square feet of wall space in the building.

There are six windows in the building. Each window is 3’6” x 4’ in dimension with double-pane glass and wood framing. Three windows are on the south-facing wall, two windows are on the north-facing wall, and one window is on the west-facing wall.

There are two entrances in the building. One entrance is a single metal door with an arctic entryway as the main entrance. The other entrance is a single metal door from the mechanical room. Both doors are insulated metal with no windows.

Description of Heating Plants

The heating plants used in the building are:

Boiler 1

Fuel Type:	#1 Oil
Input Rating:	346,000 BTU/hr
Steady State Efficiency:	77 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Figure 3.2: Boiler 1 in the Golovin Washeteria

Boiler 2

Fuel Type:	#1 Oil
Input Rating:	346,000 BTU/hr
Steady State Efficiency:	77 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Figure 3.3: Boiler 2 in the Golovin Washeteria

Boiler 3

Fuel Type:	#1 Oil
Input Rating:	346,000 BTU/hr
Steady State Efficiency:	77 %
Idle Loss:	1.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year
Notes:	This boiler is operated on demand whenever the dryers are in operation.

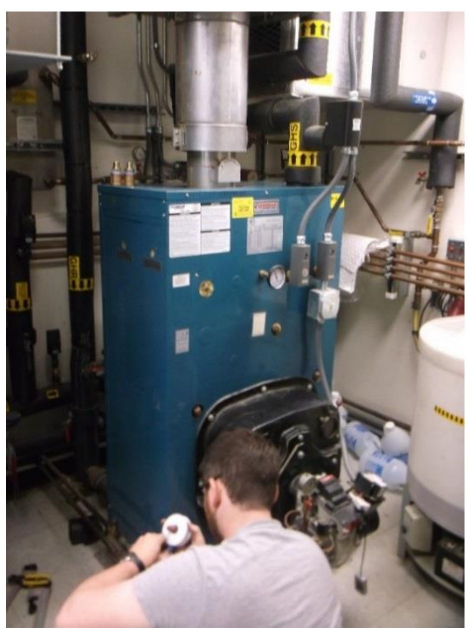


Figure 3.4: Boiler 3 in the Golovin Washeteria

Heat Recovery

Fuel Type:	Heat Recovery
Input Rating:	225,000 BTU/hr
Steady State Efficiency:	95 %
Idle Loss:	0 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Direct Fire Hot Water Heater

Fuel Type:	#1 Oil
Input Rating:	300,000 BTU/hr
Steady State Efficiency:	77 %
Idle Loss:	0.5 %
Heat Distribution Type:	Glycol
Boiler Operation:	All Year

Figure 3.5: Hot water heater in the Golovin Washeteria

Boilers 1 and 2 are used primarily for all space heating needs. They are also used for heating the lower water storage tank, sewer force main, and the community water supply that passes through the building. Boiler 3 is used specifically on demand for the dryers. During the site visit, the heat recovery high temperature was 144 deg. F and the dryer settings were at 140 deg. F. It was noted by the washeteria attendant that the dryers were not hot enough for a standard load to be completed within an hour. Ideal dryer settings for the customers would be at 180 deg. F. The heat recovery system is used for space heat, domestic hot water needs, and for the outside circulating water loop from the main line to the washeteria. The heat recovery system is used first before Boiler 1 and Boiler 2 are engaged, which significantly lowers the overall runtimes of the boilers. A direct-fired hot water heater is used in tandem with the heat recovery system to heat the sinks, showers, and washers. Boiler 3 is the only heating plant for the dryers and is hydronically plumbed in a separate loop.

Space Heating Distribution Systems

There is one unit heater in the building that is located in the boiler room. The unit heater is rated for 19,000 BTU/hr and has a 1/20 HP motor. In addition to the unit heater, there are three baseboard units that are used for space heating purposes.

Domestic Hot Water System

The washeteria uses approximately 165 gallons of hot water per day. There are two large washers that use approximately 15 gallons of hot water per load and operate for an average of 6-8 loads per day. There are two small washers that use approximately ten gallons of hot water per load and operate for an average of 3-5 loads per day. There are four shower stalls that use approximately five gallons of hot water per shower for an average of four showers per day.

Heat Recovery Information

There is a heat recovery system that transports heat from the generator cooling loops from the power plant to the glycol circulating loop in the boiler room. The power plant is owned and operated by the City of Golovin and is located approximately 100 ft. from the Golovin Washeteria. During the site visit, the high temperature for the heat recovery at the washeteria was 144 deg. F and the low temperature was 138 deg. F. The radiators at the operating were actively running during the day despite heat being transferred to the washeteria, indicating that there is still heat available for further use. At the power plant, the heat recovery loop was circulating at approximately 60 gpm and the display indicated that 101,000 Btu/hr was being actively transferred to the washeteria. The design rating for the heat recovery system is approximately 225,000 Btu/hr.

Figure 6: Heat Recovery System in the Golovin Power Plant

Description of Building Ventilation System

There is an air handling unit that supplies a constant volume of air to the entire washeteria. This is located in the boiler room to make sure that the closely-confined space is properly supplied with fresh air. The unit is rated for 650 CFM at 250 Watts and is used when the washeteria space is occupied.

There is an exhaust fan in the boiler room that ventilates the space when the boilers are in operation. The unit is rated for 650 CFM at 250 Watts and is used when the washeteria space is occupied.

There is a ventilation fan in the boiler that is set on a thermostat to keep the room temperature below 85 deg. F. This is rated for 300 CFM at 40 Watts and is used for an estimated 15 minutes per day.

There is a dryer plenum air handling unit that supplies make-up air to the plenum during dryer operations. The unit is rated for 650 CFM at 250 Watts and is used when the dryers are in operation.

Lighting

The washeteria room has eight fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on for 12 hours per day when the washeteria is open and they consume approximately 4,147 kWh annually.

The boiler room has five fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on approximately six hours per day when the washeteria is open and consume approximately 1,234 kWh annually.

The office has two fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on for 12 hours per day when the washeteria is open and they consume approximately 1,037 kWh annually.

The three restrooms each have one fixture with two T8 4ft. fluorescent light bulbs in each fixture and one fixture with a single T8 2ft. fluorescent light bulb. These lights combine to consume approximately 460 kWh annually.

The storage room where the water tank components are located has two fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on approximately three hours per day and consume approximately 247 kWh annually.

The plumbing chase has three fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are rarely used and consume approximately 13 kWh annually.

The dryer plenum has two fixtures with four T8 4ft. fluorescent light bulbs in each fixture. The lights are on for approximately an hour per day and consume approximately 62 kWh annually.

The arctic entry has a single incandescent 60 Watt light bulb that operates when the washeteria is open and consumes approximately 263 kWh annually.

The exterior of the building has three fixtures with a single metal halide 150 Watt light in each fixture. The lights are on during the winter months and consume approximately 2,761 kWh annually.

Plug Loads

The Golovin Washeteria has a variety of power tools, a telephone, and some other miscellaneous loads that require a plug into an electrical outlet. The use of these items is infrequent and consumes a small portion of the total energy demand of the building.

Major Equipment

There is a Water Heater Pump that is used to supply water from the hot water heater to the showers when they are in use. The pump is rated for 280 Watts and operates approximately 50% of the time that the washeteria is open. It consumes approximately 675 kWh annually.

There is a Washeteria Waste Heat Pump that acts as a circulating pump for the glycol loop that moves glycol throughout the building where each load pulls from the loop for their heating needs. The pump is rated for 220 Watts and operates constantly throughout the year. It consumes approximately 1,929 kWh annually.

There is a Waste Heat Water Heater Supply Pump that supplies heat from the heat recovery system to the hot water heater to heat the domestic hot water. The pump is rated for 120 Watts and operates constantly throughout the year. It consumes approximately 1,052 kWh annually.

There is a Water Supply Waste Heat Pump that supplies heated glycol from the circulating glycol loop to a heat exchanger to heat the water supply for the washeteria. There is also a Water Supply Heat Add Pump that pumps water from the water supply line to a heat exchanger to heat the water supply for the washeteria. The "Water Supply" in the labeling refers to the water from the Golovin Water Treatment Plant to the washeteria for laundry and shower needs. These pumps work together and operate constantly throughout the year. They are rated for 87 Watts and 85 Watts, respectively, and combine to consume approximately 1,508 kWh annually.

There are two Building Heat Circulation Pumps that are used to supply heated glycol from the circulating glycol loop to the unit heater and baseboards in the building. One of the pumps is on constantly during the winter heating months and as needed in the summer time. They are rated for 430 Watts and consume approximately 2,630 kWh annually.

There is a Water System Pressure Pump located in the storage room. This is used to maintain the pressure of the lower part of the distribution system. This allows the lower water storage tank to be the first tank used by the lower part of the community without being negatively affected by the upper water storage tank pressure. When the tank is filled in the summer there are pumps in the water treatment plant that supply water to the tank and push the water to the rest of the town. This pump operates constantly during the winter heating months and as needed in the summer time. It is rated for 1,125 Watts and consumes approximately 3,813 kWh annually.

There are two large washers that operate for an average of 6-8 loads per day. They are rated for 1,152 Watts and consume approximately 3,056 kWh annually. There are also two small washers that operate for an average of 4-5 loads per day. They are rated for 984 Watts and consume approximately 1,617 kWh annually.

Figure 3.7: Two large washers and two small washers in the Golovin Washeteria

There are four hydronic dryers that are in operation in the main room. Each of the dryers has four motors for the drum and belts related to the dryer function that combine to be rated for 1,440 Watts. The dryers also use 380 Watts of electricity for the controls. The washeteria has an average of 4-8 dryer loads per day.

The heat recovery system has three pumps associated with its operation. There is a Power Plant Heat Recovery Pump in the washeteria that pumps glycol from the power plant glycol loop to the heat recovery heat exchanger. The pump is constantly operating and consumes approximately 2,139 kWh annually. There is a Water Plant Heat Recovery Pump in the power plant that pumps glycol through a circulating loop between the power plant and water plant for the heat recovery system. The pump is constantly operating and consumes approximately 5,435 kWh annually. There is a Small Water Plant Side Heat Recovery Pump in the power plant that is used to pump heated glycol from the generator cooling loop to the building for local heat. This pump is constantly operating and consumes approximately 745 kWh annually. All three pumps are billed under the washeteria.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour. One KW of electric demand is equivalent to 1,000 watts running at a particular moment. The basic usage charges are shown as generation service and delivery charges along with several non-utility generation charges.

The fuel oil usage profile shows the fuel oil usage for the building. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The City of Golovin owns and operates Golovin Power Utilities, which provides electricity to the residents of the community as well as all commercial and public facilities.

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges, subsidies, and utility customer charges:

Table 3.1: Energy Rates for Each Fuel Source in Golovin

Average Energy Cost	
Description	**Average Energy Cost**
Electricity	$ 0.5600/kWh
#1 Oil	$ 5.00/gallons
Heat Recovery	$ 0.01/million Btu

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Golovin pays approximately $44,511 annually for electricity and other fuel costs for the Golovin Washeteria.

Figure 3.8 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 energy efficiency measures shown in this report.

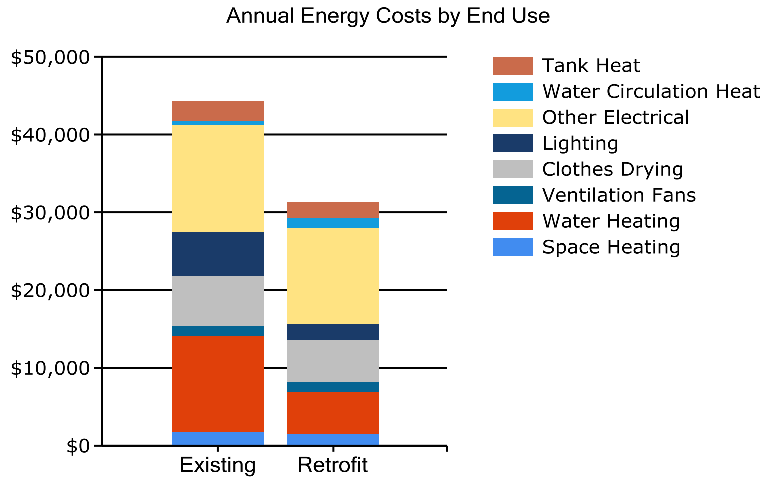


Figure 3.8: Annual Energy Costs by End Use

Figure 3.9 below shows how the annual energy cost of the building splits between the different fuels used by the building. The "Existing" bar shows the breakdown for the building as it is now; the "Retrofit" bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.9: Annual Energy Costs by Fuel Type

Figure 3.10 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

Annual Space Heating Cost by Component

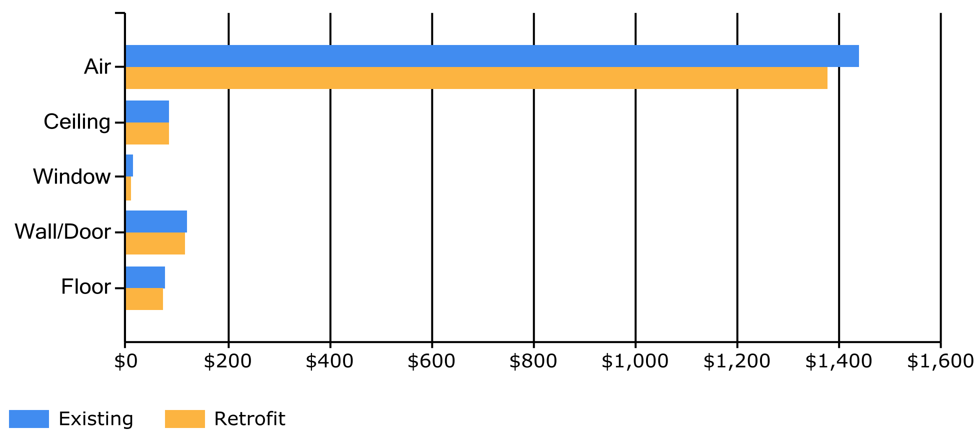


Figure 3.10: Annual Space Heating by Component

The tables below show AkWarm's estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below "DHW" refers to Domestic Hot Water heating.

Table 3.2: Electrical Consumption by Category

Electrical Consumption (kWh)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	152	152	150	102	49	27	19	22	36	67	106	154
DHW	472	432	472	452	360	258	267	267	258	463	453	473
Ventilation Fans	186	170	186	180	186	180	186	186	180	186	180	186
Clothes Drying	347	211	231	224	231	280	347	463	448	521	448	376
Lighting	1010	920	1010	977	816	613	633	633	613	1010	977	1010
Other Electrical	2306	2036	2234	2162	2044	1741	1799	1799	1706	2270	2197	2306
Water Circulation Heat	133	121	133	127	62	0	0	0	0	130	127	133
Tank Heat	181	165	180	170	170	162	167	167	162	172	171	181

Table 3.3: Fuel Oil Consumption by Category

Fuel Oil #1 Consumption (Gallons)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	0	0	0	0	0	57	59	59	57	0	0	0
DHW	270	254	268	224	126	30	31	31	30	200	229	275
Clothes Drying	70	51	56	54	56	61	70	83	81	90	81	73
Tank Heat	49	47	48	33	14	0	0	0	0	21	35	50

Table 3.4: Heat Recovery Consumption by Category

Heat Recovery Consumption (Million Btu)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Space Heating	35	35	35	24	11	6	4	5	8	15	24	35
DHW	10	9	10	9	6	5	6	6	5	8	9	10
Water Circulation Heat	9	9	9	6	1	0	0	0	0	3	6	9
Tank Heat	17	16	16	11	3	0	0	0	0	6	12	18

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building's annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building's energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building's energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building's energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.
The site and source EUIs for this building are calculated as follows. (See Table 3.5 for details):

$$\text{Building Site EUI} = \frac{(\text{Electric Usage in kBtu} + \text{Fuel Oil Usage in kBtu})}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{(\text{Electric Usage in kBtu X SS Ratio} + \text{Fuel Oil Usage in kBtu})}{\text{Building Square Footage}}$$

where "SS Ratio" is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.5: Golovin Washeteria EUI Calculations

Energy Type	Building Fuel Use per Year	Site Energy Use per Year, kBTU	Source/Site Ratio	Source Energy Use per Year, kBTU
Electricity	49,825 kWh	170,051	3.340	567,971
#1 Oil	3,321 gallons	438,367	1.010	442,751
Hot Wtr District Ht	483.18 million Btu	483,175	1.280	618,465
Total		**1,091,594**		**1,629,187**
BUILDING AREA		1,706	Square Feet	
BUILDING SITE EUI		640	kBTU/Ft²/Yr	
BUILDING SOURCE EUI		955	**kBTU/Ft²/Yr**	
* Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011.				

Table 3.6: Golovin Washeteria Building Benchmarks

Building Benchmarks			
Description	**EUI (kBtu/Sq.Ft.)**	**EUI/HDD (Btu/Sq.Ft./HDD)**	**ECI ($/Sq.Ft.)**
Existing Building	639.9	45.89	$26.09
With Proposed Retrofits	486.4	34.88	$18.33
EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area. EUI/HDD: Energy Use Intensity per Heating Degree Day. ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.			

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The HVAC system and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Golovin Washeteria was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Golovin was used for analysis. From this, the model was be calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated.

Limitations of AkWarm© Models

• The model is based on typical mean year weather data for Golovin. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing

information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
• The heating load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in heating loads across different parts of the building.

The energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures are summarized in Table 4.1. Please refer to the individual measure descriptions later in this report for more detail.

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
1	Lighting: Office Lights	Replace with new energy-efficient LED lighting.	$367	$160	26.96	0.4	1,355.5
2	Lighting: Washeteria Room Lights	Replace with new energy-efficient LED lighting.	$1,468	$640	26.95	0.4	5,410.4
3	Lighting: Arctic Entry	Replace with new energy-efficient LED lighting.	$108	$50	25.40	0.5	398.2
4	Lighting: Exterior Lights	Replace with new energy-efficient LED lighting.	$1,110	$1,500	8.70	1.4	4,362.6
5	Force Main Heat Add	Expand the size of the pipe from the existing 1/2" to a 1" line to maximize heat recovery capability. Shut off heating controls in the summer time. Lower temperature set points to 40 deg. F.	$3,464	$6,000	7.82	1.7	14,618.3
6	Lighting: Boiler Room	Replace with new energy-efficient LED lighting and add new occupancy sensor	$561	$900	7.32	1.6	2,063.9
7	Lighting: Storage Room	Replace with new energy-efficient LED lighting.	$87	$160	6.42	1.8	321.6

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
8	Other – Water Storage Tank Heat-Add	Replace heat-add pumps for the water storage tank so that the tank does not freeze when the head of the tank is less than 5 ft in relation to the pumps. This causes the tank to heat almost twice as much water as needed. Replace the pumps with more efficient models to account for the pressure drops within the water storage tank. The existing pumps cannot suck the water through the line and need 5ft of water pressure to function properly (level of 17ft. total). (This will be fixed by construction)	$843	$2,000	5.26	2.4	5,094.3
9	Other Electrical: Water Plant Heat Recovery Pump (Power Plant Bldg)	Adjust heat recovery controls in the power plant to reduce the pump run time when washeteria demand is not calling for heat.	$1,004	$3,000	3.93	3.0	3,945.8
10	Other Electrical: Water Supply Waste Heat Pump	Shut off pump in summer.	$160	$500	3.76	3.1	599.5
11	Other Electrical: Water Supply Heat Add Pump	Shut off pump in summer.	$156	$500	3.67	3.2	585.3

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
12	Lighting: Restrooms - 2ft. Lights	Replace with new energy-efficient LED lighting.	$26	$120	2.50	4.7	92.7
13	HVAC And DHW	Install Tigerloop deaerators on each boiler for cleaner-burning fuel. Install Honeywell T775 boiler controls to replace the analog thermostats and allow the heat recovery system to fully operate within the building. This is in addition to other retrofits including the expansion of heat-add pipes for the transfer line and force main line, controls work for the heat-add systems, and rerouting of piping.	$3,523	$25,000	2.45	7.1	11,390.6
14	Lighting: Restrooms - 4ft. Lights	Replace with new energy-efficient LED lighting.	$49	$240	2.40	4.9	178.0
15	Lighting: Dryer Plenum	Replace with new energy-efficient LED lighting.	$22	$160	1.61	7.3	81.5
16	Setback Thermostat: Washeteria	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	$72	$1,000	0.85	13.8	1,997.0
17	Setback Thermostat: Mechanical Room	Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Mechanical Room space.	$33	$1,000	0.39	30.4	910.0
18	Clothes Dryers	Clean and replace filters regularly.	$19	$100	0.36	5.4	72.6

PRIORITY LIST – ENERGY EFFICIENCY MEASURES							
Rank	Feature	Improvement Description	Annual Energy Savings	Installed Cost	Savings to Investment Ratio, SIR[1]	Simple Payback (Years)[2]	CO_2 Savings
19	Lighting: Plumbing Chase	Replace with new energy-efficient LED lighting.	$5	$240	0.23	51.1	17.7
20	Water Supply Heat Add	Allow transfer line to bypass washeteria. Increase from 1/2" diameter to 1" diameter to increase flow through washeteria heat exchanger.	$77	$8,500	0.12	110.7	1,183.4
21	Transfer Line Heat Add	Replace Transfer Line with 2-inch buried pipe to expand heat recovery capabilities. This line will bypass the main plumbing of the washeteria and feed directly into the water storage tank transfer line to maximize efficiency. Lower temperature set points. Because much of this work is associated with the heating system retrofits, some of the cost is represented in that retrofit.	$76	$8,500	0.12	112.0	1,169.8
22	Air Tightening	Add weather stripping around the exterior doors and insulate around the window seams.	$5	$1,000	0.04	208.2	132.6
	TOTAL, all measures		**$13,235**	**$61,270**	**2.97**	**4.6**	**55,981.1**

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure in the list 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, plug loads, facility equipment, and occupants generate heat within the building. Lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties were included in the lighting project analysis.

4.3 Building Shell Measures

4.3.1 Air Sealing Measures

Rank	Location		Existing Air Leakage Level (cfm@50/75 Pa)		Recommended Air Leakage Reduction (cfm@50/75 Pa)	
22			Air Tightness estimated as: 2600 cfm at 50 Pascals		Add weather stripping around the exterior doors and insulate around the window seams.	
Installation Cost	$1,000		**Estimated Life of Measure (yrs)**	10	**Energy Savings (/yr)**	$5
Breakeven Cost	$40		**Savings-to-Investment Ratio**	0.0	**Simple Payback yrs**	208
Auditors Notes: The two entrance doors have air penetrating around the edges into the building. Weatherize the doors to lower the heating demand of the building.						

4.4 Mechanical Equipment Measures

4.4.1 Heating/ Domestic Hot Water Measure

Rank	Recommendation					
13	Install Tigerloop deaerators on each boiler for cleaner-burning fuel. Install Honeywell T775 boiler controls to replace the analog thermostats and allow the heat recovery system to fully operate within the building. This is in addition to other retrofits including the expansion of heat-add pipes for the transfer line and force main line, controls work for the heat-add systems, and rerouting of piping.					
Installation Cost	$25,000	**Estimated Life of Measure (yrs)**	20	**Energy Savings (/yr)**	$3,523	
Breakeven Cost	$61,257	**Savings-to-Investment Ratio**	2.5	**Simple Payback yrs**	7	
Auditors Notes:						

4.4.2 Night Setback Thermostat Measures

Rank	Building Space			Recommendation	
16	Washeteria			Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Washeteria space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$72
Breakeven Cost	$850	**Savings-to-Investment Ratio**	0.8	**Simple Payback yrs**	14
Auditors Notes: Lower the building temperature to 60 deg. F in the evenings to reduce the heating demand.					

Rank	Building Space				Recommendation	
17	Mechanical Room				Implement a Heating Temperature Unoccupied Setback to 60.0 deg F for the Mechanical Room space.	
Installation Cost	$1,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**		$33
Breakeven Cost	$387	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**		30
Auditors Notes: Lower the building temperature to 60 deg. F in the evenings to reduce the heating demand.						

4.5 Electrical & Appliance Measures

4.5.1 Lighting Measures

The goal of this section is to present any lighting energy conservation measures that may also be cost beneficial. It should be noted that replacing current bulbs with more energy-efficient equivalents will have a small effect on the building heating and cooling loads. The building cooling load will see a small decrease from an upgrade to more efficient bulbs and the heating load will see a small increase, as the more energy efficient bulbs give off less heat.

4.5.1a Lighting Measures – Replace Existing Fixtures/Bulbs

Rank	Location	Existing Condition		Recommendation	
1	Office Lights	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with direct-wire LED replacement bulbs.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$367
Breakeven Cost	$4,313	**Savings-to-Investment Ratio**	27.0	**Simple Payback yrs**	0
Auditors Notes: There are two fixtures with four bulbs to be replaced with two new light bulbs for a total of four light bulbs to be replaced					

Rank	Location	Existing Condition		Recommendation	
2	Washeteria Room Lights	8 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with direct-wire LED replacement bulbs.	
Installation Cost	$640	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,468
Breakeven Cost	$17,249	**Savings-to-Investment Ratio**	27.0	**Simple Payback yrs**	0
Auditors Notes: There are eight fixtures with four bulbs to be replaced with two new light bulbs for a total of 16 light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
3	Arctic Entry	INCAN A Lamp, Std 60W		Replace with direct-wire LED replacement bulbs.	
Installation Cost	$50	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$108
Breakeven Cost	$1,270	**Savings-to-Investment Ratio**	25.4	**Simple Payback yrs**	0
Auditors Notes: There is a single fixture with a single incandescent light bulb to be replaced.					

Rank	Location	Existing Condition	Recommendation
4	Exterior Lights	3 MH 150 Watt StdElectronic	Replace with direct-wire LED replacement bulbs.

Installation Cost	$1,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,110
Breakeven Cost	$13,044	**Savings-to-Investment Ratio**	8.7	**Simple Payback yrs**	1

Auditors Notes: There are three fixtures with a single light bulb in each fixture for a total of three light bulbs to be replaced.

Rank	Location	Existing Condition	Recommendation
6	Boiler Room	5 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic	Replace with direct-wire LED replacement bulbs and add an occupancy sensor.

Installation Cost	$900	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$561
Breakeven Cost	$6,584	**Savings-to-Investment Ratio**	7.3	**Simple Payback yrs**	2

Auditors Notes: There are five fixtures with four bulbs to be replaced with two new light bulbs for a total of ten light bulbs to be replaced. The occupancy sensor can be used to shut down the lights when the operator is not present in the boiler room.

Rank	Location	Existing Condition	Recommendation
7	Storage Room	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic	Replace with direct-wire LED replacement bulbs.

Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$87
Breakeven Cost	$1,027	**Savings-to-Investment Ratio**	6.4	**Simple Payback yrs**	2

Auditors Notes: There are two fixtures with four bulbs to be replaced with two new light bulbs for a total of four light bulbs to be replaced.

Rank	Location	Existing Condition	Recommendation
12	Restrooms - 2ft. Lights	3 FLUOR T8 4' F32T8 32W Standard Instant StdElectronic	Replace with direct-wire LED replacement bulbs.

Installation Cost	$120	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$26
Breakeven Cost	$300	**Savings-to-Investment Ratio**	2.5	**Simple Payback yrs**	5

Auditors Notes: There are three fixtures with four bulbs to be replaced with two new light bulbs for a total of 12 light bulbs to be replaced.

Rank	Location	Existing Condition	Recommendation
14	Restrooms - 4ft. Lights	3 FLUOR (2) T8 4' F32T8 32W Standard Instant StdElectronic	Replace with direct-wire LED replacement bulbs.

Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$49
Breakeven Cost	$576	**Savings-to-Investment Ratio**	2.4	**Simple Payback yrs**	5

Auditors Notes: There are three fixtures with two bulbs in each fixture for a total of four light bulbs to be replaced.

Rank	Location	Existing Condition		Recommendation	
15	Dryer Plenum	2 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic with Manual Switching		Replace with direct-wire LED replacement bulbs.	
Installation Cost	$160	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$22
Breakeven Cost	$257	**Savings-to-Investment Ratio**	1.6	**Simple Payback yrs**	7
Auditors Notes: There are two fixtures with four bulbs to be replaced with two new light bulbs for a total of four light bulbs to be replaced.					

Rank	Location	Existing Condition		Recommendation	
19	Plumbing Chase	3 FLUOR (4) T8 4' F32T8 32W Standard Instant StdElectronic		Replace with direct-wire LED replacement bulbs.	
Installation Cost	$240	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$5
Breakeven Cost	$55	**Savings-to-Investment Ratio**	0.2	**Simple Payback yrs**	51
Auditors Notes: There are three fixtures with four bulbs to be replaced with two new light bulbs for a total of 12 light bulbs to be replaced.					

4.5.2 Other Electrical Measures

Rank	Location	Description of Existing		Efficiency Recommendation	
9	Water Plant Heat Recovery Pump (Power Plant Bldg)	Heat Recovery Pump		Adjust heat recovery controls in the power plant to reduce the pump run time when washeteria demand is not calling for heat.	
Installation Cost	$3,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$1,004
Breakeven Cost	$11,798	**Savings-to-Investment Ratio**	3.9	**Simple Payback yrs**	3
Auditors Notes: The washeteria often has times in the warmer months where there is no call for space heat or water heat but the heat recovery system is still active. Adjusting the heat recovery controls can save on heat losses and on the operation of the circulation pump.					

Rank	Location	Description of Existing		Efficiency Recommendation	
10	Water Supply Waste Heat Pump	Water Supply Waste Heat Pump		Shut off pump in summer.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$160
Breakeven Cost	$1,881	**Savings-to-Investment Ratio**	3.8	**Simple Payback yrs**	3
Auditors Notes: The pumps are in constant operation but the water does not need heated in the summer months. Shut off the pump to reduce water usage and electricity usage.					

Rank	Location	Description of Existing		Efficiency Recommendation	
11	Water Supply Heat Add Pump	Water Supply Heat Add Pump with Manual Switching		Shut off pump in summer.	
Installation Cost	$500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$156
Breakeven Cost	$1,837	**Savings-to-Investment Ratio**	3.7	**Simple Payback yrs**	3
Auditors Notes: The pumps are in constant operation but the water does not need heated in the summer months. Shut off the pump to reduce water usage and electricity usage.					

4.5.3 Other Measures

Rank	Location	Description of Existing	Efficiency Recommendation
5		Force Main Heat Add	Expand the size of the pipe from the existing 1/2" to a 1" line to maximize heat recovery capability. Shut off heating controls in the summer time. Lower temperature set points to 40 deg. F.

Installation Cost	$6,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$3,464
Breakeven Cost	$46,922	**Savings-to-Investment Ratio**	7.8	**Simple Payback yrs**	2
Auditors Notes:					

Rank	Location	Description of Existing	Efficiency Recommendation
8		Water Storage Tank Heat Load	Replace heat-add pumps for the water storage tank so that the tank does not freeze when the head of the tank is less than 5 ft in relation to the pumps. This causes the tank to heat almost twice as much water as needed. Replace the pumps with more efficient models to account for the pressure drops within the water storage tank. The existing pumps cannot suck the water through the line and need 5ft of water pressure to function properly (level of 17ft. total). (This will be fixed by construction)

Installation Cost	$2,000	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$843
Breakeven Cost	$10,513	**Savings-to-Investment Ratio**	5.3	**Simple Payback yrs**	2
Auditors Notes:					

Rank	Location	Description of Existing	Efficiency Recommendation
18		Clothes Dryers	Clean and replace filters regularly.

Installation Cost	$100	**Estimated Life of Measure (yrs)**	2	**Energy Savings (/yr)**	$19
Breakeven Cost	$36	**Savings-to-Investment Ratio**	0.4	**Simple Payback yrs**	5
Auditors Notes:					

Rank	Location	Description of Existing	Efficiency Recommendation
20		Water Supply Heat Add Load	Allow transfer line to bypass washeteria. Increase from 1/2" diameter to 1" diameter to increase flow through washeteria heat exchanger.

Installation Cost	$8,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$77
Breakeven Cost	$1,032	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	111
Auditors Notes:					

Rank	Location	Description of Existing		Efficiency Recommendation	
21		Transfer Line Heat Add		Replace Transfer Line with 2-inch buried pipe to expand heat recovery capabilities. This line will bypass the main plumbing of the washeteria and feed directly into the water storage tank transfer line to maximize efficiency. Lower temperature set points. Because much of this work is associated with the heating system retrofits, some of the cost is represented in that retrofit.	
Installation Cost	$8,500	**Estimated Life of Measure (yrs)**	15	**Energy Savings (/yr)**	$76
Breakeven Cost	$1,020	**Savings-to-Investment Ratio**	0.1	**Simple Payback yrs**	112
Auditors Notes:					

5. ENERGY EFFICIENCY ACTION PLAN

Through inspection of the energy-using equipment on-site and discussions with site facilities personnel, this energy audit has identified several energy-saving measures. The measures will reduce the amount of fuel burned and electricity used at the site. The projects will not degrade the performance of the building and, in some cases, will improve it.

Several types of EEMs can be implemented immediately by building staff, and others will require various amounts of lead time for engineering and equipment acquisition. In some cases, there are logical advantages to implementing EEMs concurrently. For example, if the same electrical contractor is used to install both lighting equipment and motors, implementation of these measures should be scheduled to occur simultaneously.

In the near future, a representative of ANTHC will be contacting the City of Golovin to follow up on the recommendations made in this report. Funding has been provided to ANTHC through a Rural Alaska Village Grant and the Denali Commission to provide the community with assistance in understanding the report and implementing the recommendations. ANTHC will work to complete the recommendations within the 2016 calendar year.

APPENDICES

Appendix A – Energy Audit Report – Project Summary

ENERGY AUDIT REPORT – PROJECT SUMMARY	
General Project Information	
PROJECT INFORMATION	**AUDITOR INFORMATION**
Building: Golovin Washeteria	**Auditor Company:** ANTHC-DEHE
Address: PO Box 62059	**Auditor Name:** Kevin Ulrich and Steve Sutton
City: Golovin	**Auditor Address:** 4500 Diplomacy Dr. Anchorage, AK 99508
Client Name: Wayne Henry Sr. and Wayne Henry Jr.	
Client Address:	**Auditor Phone:** (907) 729-3237
	Auditor FAX:
Client Phone: (907) 779-2371	**Auditor Comment:**
Client FAX:	
Design Data	
Building Area: 1,706 square feet	**Design Space Heating Load:** Design Loss at Space: 122,214 Btu/hour with Distribution Losses: 128,647 Btu/hour Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 196,107 Btu/hour Note: Additional Capacity should be added for DHW and other plant loads, if served.
Typical Occupancy: 0 people	**Design Indoor Temperature:** 70 deg F (building average)
Actual City: Golovin	**Design Outdoor Temperature:** -24.3 deg F
Weather/Fuel City: Golovin	**Heating Degree Days:** 13,943 deg F-days
Utility Information	
Electric Utility: Golovin Power Utilities	**Average Annual Cost/kWh:** $0.56/kWh

Annual Energy Cost Estimate

Description	Space Heating	Water Heating	Ventilation Fans	Clothes Drying	Lighting	Other Electrical	Water Circulation Heat	Tank Heat	Total Cost
Existing Building	$1,734	$12,425	$1,229	$6,445	$5,725	$13,775	$542	$2,636	**$44,511**
With Proposed Retrofits	$1,656	$5,279	$1,229	$5,583	$1,894	$12,452	$1,128	$2,056	**$31,277**
Savings	$79	$7,146	$0	$861	$3,831	$1,323	-$586	$580	**$13,235**

Building Benchmarks

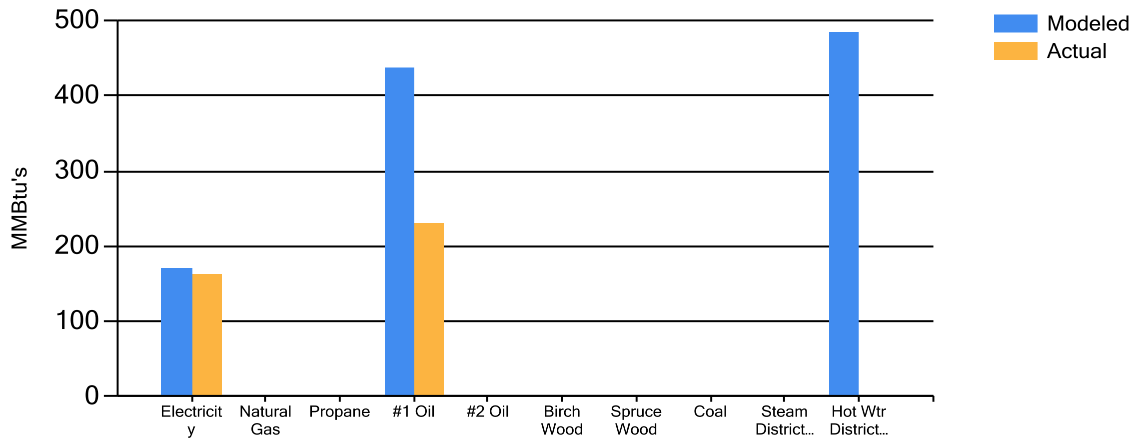
Description	EUI (kBtu/Sq.Ft.)	EUI/HDD (Btu/Sq.Ft./HDD)	ECI ($/Sq.Ft.)
Existing Building	639.9	45.89	$26.09
With Proposed Retrofits	486.4	34.88	$18.33

EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.
EUI/HDD: Energy Use Intensity per Heating Degree Day.
ECI: Energy Cost Index - The total annual cost of energy divided by the square footage of the conditioned space in the building.

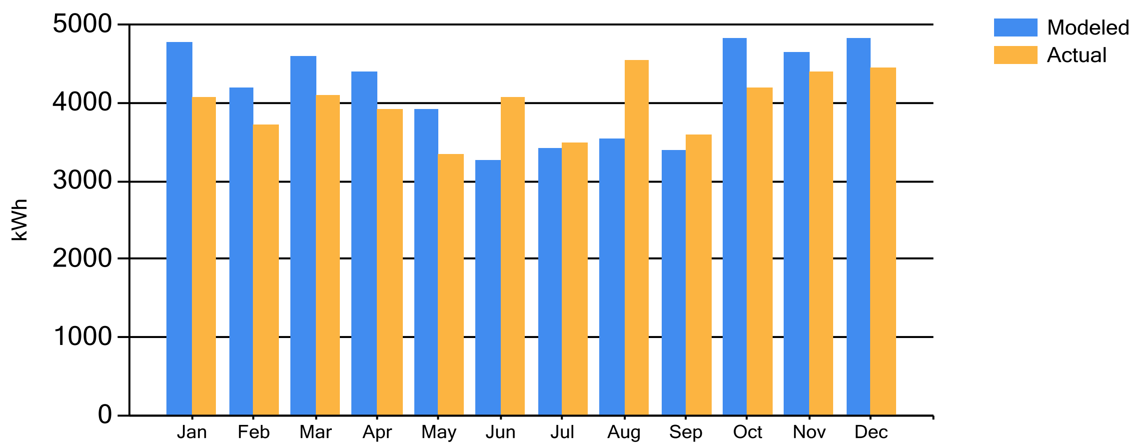
Appendix B – Actual Fuel Use versus Modeled Fuel Use

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.

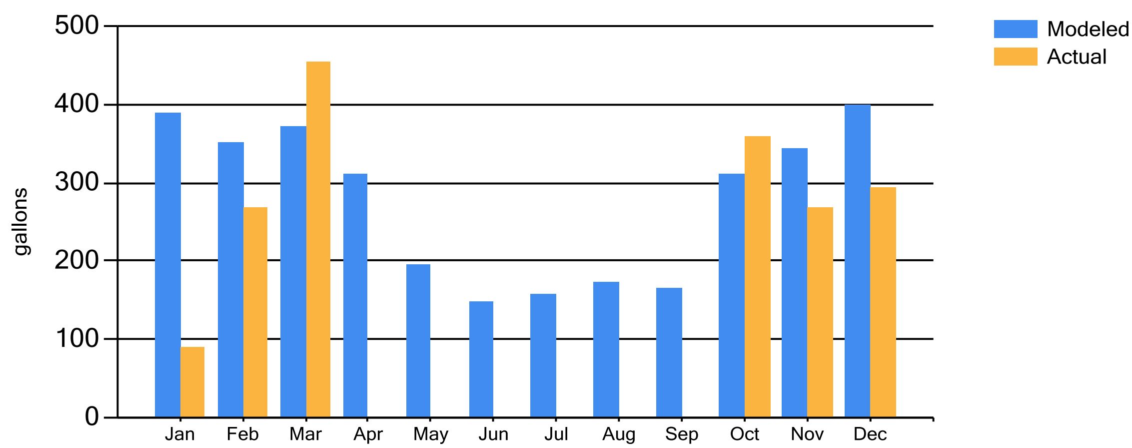
Annual Energy Use



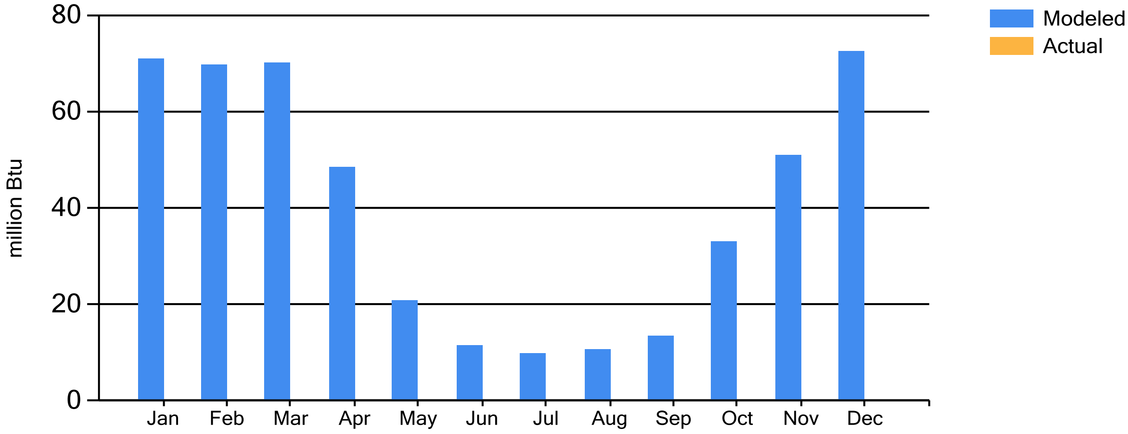
Electricity Use



#1 Fuel Oil Use



Heat Recovery Use



Appendix C - Electrical Demands

Estimated Peak Electrical Demand (kW)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Current	12.2	12.2	12.2	12.1	11.2	10.4	10.4	10.4	10.4	12.1	12.1	12.2
As Proposed	10.4	10.5	10.4	10.4	9.4	8.6	8.6	8.6	8.6	10.3	10.4	10.4

AkWarmCalc Ver 2.5.3.0, Energy Lib 3/7/2016