# Comprehensive Energy Audit
# For

# Angoon Water Treatment Plant

Prepared For
**City of Angoon**

**August 9, 2016**

**Prepared By:**

**ANTHC-DEHE**
**4500 Diplomacy Dr.**
**Anchorage, AK 99508**

# Table of Contents

# PREFACE

This energy audit was conducted using funds from the United States Department of Agriculture Rural Utilities Service 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 Angoon, Alaska. The author of this report is Kevin Ulrich, Energy Manager-in-Training (EMIT).

The purpose of this report is to provide a comprehensive document of the findings and analysis that resulted from an energy audit conducted in May 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 Water Treatment Plant Operator Danny Frederickson, Water Treatment Plant Operator Paul Thomas, Mayor Albert Howard, and City Clerk Lawrence George.

# 1. EXECUTIVE SUMMARY

This report was prepared for the City of Angoon. The scope of the audit focused on the Angoon Water Treatment Plant and the associated water and wastewater 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.

In the near future, a representative of ANTHC will be contacting the City of Angoon 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 Angoon Water Treatment Plant is $26,292. Electricity represents the largest portion with an annual cost of approximately $24,511. Fuel oil represents the remaining portion with an annual cost of approximately $1,781.

The Angoon Water Treatment Plant does not receive assistance from the Power Cost Equalization (PCE) program through the State of Alaska, according to the city office. The residents of the community receive assistance from the program but the Angoon Water Treatment Plant pays the full price for electricity. The cost of electricity with PCE is $0.22 per kWh and the cost of electricity without PCE is $0.61 per kWh. The Angoon Water Treatment Plant is eligible for the PCE program and participation in the program would reduce the estimated electricity cost by $15,671 annually. ANTHC will work with the community to extend their PCE program coverage to the Angoon Water Treatment Plant.

Table 1.1 lists the total usage of electricity and #1 heating oil 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 | 40,182 kWh | 28,025 kWh |
| #2 Oil | 533 gallons | 416 gallons |

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

**Table 1.2: Building Benchmarks for the Angoon Water Treatment Plant**

| Building Benchmarks | | | |
|---|---|---|---|
| **Description** | **EUI (kBtu/Sq.Ft.)** | **EUI/HDD (Btu/Sq.Ft./HDD)** | **ECI ($/Sq.Ft.)** |
| **Existing Building** | 106.2 | 12.57 | $13.25 |
| **With Proposed Retrofits** | 77.1 | 9.13 | $9.32 |
| EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.<br>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 Angoon Water Treatment Plant. 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 Recomendations for the Angoon Water Treatment Plant**

| 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: Intake Gallery | Replace with direct-wire LED replacement bulbs. | $113 | $50 | 26.54 | 0.4 | 314.9 |
| 2 | Lighting: Process Room | Replace with direct-wire LED replacement bulbs. | $738 | $800 | 10.67 | 1.1 | 1,786.7 |
| 3 | Lighting: Office | Replace with direct-wire LED replacement bulbs. | $239 | $320 | 8.63 | 1.3 | 574.3 |
| 4 | Setback Thermostat: Water Treatment Plant and Office | Program the Toyo stove with an unoccupied setback to 50.0 deg F for the water treatment plant and office spaces. | $493 | $1,000 | 6.69 | 2.0 | 3,261.1 |
| 5 | Other Electrical: Lift Station Pump | Clean the pumps out of debris for more efficient operation and to keep the pumps from breaking. | $321 + $250 Maintenance Savings | $1,000 | 4.83 | 1.8 | 894.1 |
| 6 | Other Electrical: Chlorine Room Electric Heater | Lower thermostat setting to 50 deg. F. | $125 | $500 | 2.89 | 4.0 | 305.8 |
| 7 | Lighting: Hallway | Replace with direct-wire LED replacement bulbs. | $55 | $240 | 2.68 | 4.3 | 134.8 |
| 8 | Other Electrical: Generator Room Electric Heater | Shut off electric heater and use only in extreme winter conditions. | $165 | $1,000 | 1.91 | 6.1 | 402.8 |

| 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 |
| 9 | Other Electrical: Water Intake Pumps | Conduct a leak detection study, repair minor leaks in the distribution system, replace VFD controllers, lower the water usage to appropriate community levels, and install a cooling device inside the VFD electric panel at the intake gallery. | $5,478 + $500 Maintenance Savings | $40,000 | 1.76 | 6.7 | 15,267.3 |
| 10 | Lighting: Chemical Room | Replace with direct-wire LED replacement bulbs. | $28 | $240 | 1.33 | 8.7 | 66.5 |
| 11 | Lighting: Generator Room | Replace with direct-wire LED replacement bulbs. | $15 | $240 | 0.74 | 15.6 | 36.8 |
| 12 | Lighting: Chlorine Room | Replace with direct-wire LED replacement bulbs. | $9 | $160 | 0.66 | 17.6 | 21.8 |
| 13 | Air Tightening | Add weatherization around door edges. | $23 | $500 | 0.43 | 21.7 | 152.0 |
| 14 | Exterior Door: Generator Room | Replace existing door with a new door that includes functioning doorknobs and latches. | $7 | $1,064 | 0.15 | 162.2 | 43.4 |
| | **TOTAL, all measures** | | **$7,808 + $750 Maintenance Savings** | **$47,114** | **2.11** | **5.5** | **23,262.2** |

### *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 $7,808 per year, or 29.7% of the buildings' total energy costs. These measures are estimated to cost $47,114, for an overall simple payback period of 5.5 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** | **Lighting** | **Other Electrical** | **Total Cost** |
| **Existing Building** | $1,781 | $328 | $2,196 | $21,987 | **$26,292** |
| **With Proposed Retrofits** | $1,388 | $328 | $895 | $15,872 | **$18,484** |
| **Savings** | $393 | $0 | $1,301 | $6,114 | **$7,808** |

# 2. AUDIT AND ANALYSIS BACKGROUND

## *2.1 Program Description*

This audit included services to identify, develop, and evaluate energy efficiency measures at the Angoon Water Treatment Plant. 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 Angoon Water Treatment Plant 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.

The Angoon Water Treatment Plant is made up of the following activity areas:

1) Water Treatment Plant and Office: 1,243 square feet
2) New Expansion: 741 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 re-evaluated 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. Angoon Water Treatment Plant

## *3.1. Building Description*

The 1,984 square foot Angoon Water Treatment Plant was constructed in 1976, with a normal occupancy of one person for approximately 3-4 hours per day. An expansion was added to the water treatment plant in 2011 to include additional space for chemical storage and processes.

The Angoon Water Treatment Plant serves as the central facility for the water intake, treatment, and distribution processes. The plant has four large sand filters that process the water that is fed from the Auk'tah Lake. Raw water is pumped from the lake by two 10 HP VFD smart pumps and injected with polymer and chlorine before going through the filters and getting transported to the 500,000 gallon water storage tank. Auk'tah Lake is approximately 750 ft. from the water treatment plant. After the water has been given enough contact time with the chemicals, it is gravity-fed down the four-mile long road to the main part of town. A water tower present in the main part of town with a booster pump to help supply water to the upper townsite.

**Figure 3.1: 500,000 gallon water storage tank in Angoon**

There are two lift stations in town that are used to collect sewage and pump it away from town to the ocean away from shore. One lift station is in the downtown region on Aanya Street and has two 5HP pumps that consume 3,156 kWh annually. These pumps will occasionally get clogged with trash and other foreign objects that will impede the operations of the lift station. Proper maintenance and cleaning are necessary to maintain the station. A second lift station is located near the store in the northwest section of town and is completely inoperable. A project to replace this lift station is currently in development and this will increase the energy usage of the wastewater treatment processes.

**Figure 3.2: Downtown lift station on Aanya Street**

**Figure 3.3: Kootznahoo lift station. This lift station is not in operation. Pictured is operator Danny Frederickson**

There are two old water towers that are used for water storage for the upper regions of town. A boost pump is used to fill the tall standpipe for the upper townsite from the main distribution. Water is then gravity-fed from the water towers to the residents. The other metal tank is specifically for the school. A third tank made entirely of wood is present but it has not been in use for many years.

**Figure 3.4 (left): Water tower for the school in Angoon.**

**Figure 3.5 (above): Water towers for the upper region of town in Angoon**

## Description of Building Shell

The walls are built with single stud standard lumber construction with 2 x 6 framing and approximately 5.5 inches of R-21 batt insulation. The average wall height is approximately 15 ft. high with the north and south walls averaging around 12 ft. tall and the east and west walls peaking at approximately 15 ft. high.

The building has a cathedral ceiling with standard 2 x 6 framing and 16-inch spacing. The roof has approximately 5.5 inches of R-21 batt insulation and there is approximately 2,030 square feet of roof space.

The building foundation is on grade with a concrete slab directly on top of the ground with no gravel pad or insulation necessary. There is approximately 1,984 square feet of floor space in the building.

The office has two double-pane windows that are approximately 69.75” x 38.5” each. The chemical room has two double-pane windows that are approximately 38” x 34.75” each. The hallway by the process room has one double-pane window that is approximately 46.5” x 34.5”.

There are five entrances in the building. The main entrance has two double-doors that are weatherized and insulated. The chemical room has one metal door that has had foam insulation installed around the edges, effectively rendering the door non-useable. The hallway by the process room has a single metal door. The chlorine room has a single metal door with a quarter-lite window. The generator room has a metal door with no doorknob or locking mechanism present, presenting a large hole in the door and allowing the door to swing open freely.


**Figure 3.6: Generator Room door with no doorknob.**

**Figure 3.7: Chemical Room door with foam insulation sealing the spaces around the door frame.**

## Description of Heating Plants

The heating plants used in the building are:

**Toyo Laser 56**

| | |
|---|---|
| Fuel Type: | #2 Oil |
| Input Rating: | 22,000 BTU/hr |
| Steady State Efficiency: | 95 % |
| Idle Loss: | 0.5 % |
| Heat Distribution Type: | Air |

There are two Toyotomi stoves that are used to provide space heat to the building. One is a Toyotomi Laser 56 located in the chemical room. This heater was set at 49 deg. F during the site visit with an actual room temperature of 52 deg. F. The heater is set for 50-60 deg. F during the winter months. There is a Toyotomi Laser 73 stove in the process room that is not used because of a fuel leak.

**Figure 3.8: Toyotomi Laser 56 in the chemical room of the water treatment plant.**

**Figure 3.9: Toyotomi Laser 73 in the process room of the water treatment plant. This unit is not used.**

### Hot Water Heater

Nameplate Information: Promax EJCS 20 200
Fuel Type: Electricity
Input Rating: 0 BTU/hr
Steady State Efficiency: 100 %
Idle Loss: 0.5 %
Heat Distribution Type: Water

Boiler Operation: All Year
Notes: Used for hot water purposes

There is an electric hot water heater that is used to provide hot water for the sinks in the building. The heater is rated for 2500 Watts and is constantly heated to 120 deg. F.

**Figure 3.10: Electric hot water heater in the water treatment plant.**

## Lighting

The building lighting is comprised entirely of T8 and T12 4-ft. fluorescent light bulbs on the interior of the building. There is no exterior lighting present at the facility. The water treatment plant has a total of 28 T8 light bulbs and 52 T12 light bulbs. All T12 light bulbs are super-saver 34 Watt models rather than the standard 40 Watt version.

There is a 60 Watt incandescent light bulb at the water intake site.
There is a high pressure sodium light bulb at the water intake site.

## Plug Loads

The water treatment plant 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 are two water intake pumps that are used to pump water from the Auk'tah Lake into the facility for water treatment.  Each pump is a 10 HP variable frequency drive (VFD) smart pump.  During the site visit, both pumps were running together, though one pump was not operating in good condition.  In a later trip, this pump was not in operation.  This was due to the VFD controller not functioning, causing the pump to stop running.  Additionally, the panel with the controls was unusually warm, possibly causing errors with the controller operation.  These pumps combine to consume approximately 26,513 kWh annually.

**Figure 3.11:  Water intake gallery near the Auk'tah Lake.**

**Figure 3.12:  Water intake pumps in the gallery near Auk'tah Lake.**

There are electric heaters in the chlorine room and the generator room.  The chlorine room has a Trane electric heater rated for 3.3 kW.  The unit also has a 1/20 HP motor attached.  The space had a set point of 70 deg. F during the site visit.  This heater consumes approximately 669 kWh annually.  The generator room has a small electric heater that keeps the space warm.  This is used more than necessary because of the air leakage through the generator door.  The heater is estimated to consume approximately 320 kWh annually.

**Figure 3.13:  Electric heater in the chlorine room.**

**Figure 3.14:  Electric heater in the generator room.**

There is an air scour that is used to aerate the filters during the backwash process. The backwash occurs once per week for approximately 20 minutes. The air scour is rated for 10 HP and consumes approximately 391 kWh annually.

There are three pumps and a mixer used in the chemical processing of the plant. Two pumps and a mixer are used for polymer and one pump is used for chlorine. The pumps details are shown in Table 3.1.

**Table 3.1: Chemical Pump Information**

| Pump | Rating (Watts) | Annual Consumption (kWh) |
|---|---|---|
| Dilute Polymer er | 185 | 34 |
| Dilute Polymer Injection Pump | 375 | 3,287 |
| Neat Polymer Injection Pump | 23 | 202 |
| Chlorine Pump | 168 | 1,473 |

The chlorine pump had major operational problems during the site visit where the pump could not overcome air pressure in the line to inject chlorine into the water. This was repaired temporarily onsite, but this pump needs replacement as well as additional spare parts for sanitation purposes.

## *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 Inside Passage Electric Cooperative (IPEC) provides electricity to the residents of Angoon 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 Angoon**

| Average Energy Cost | |
|---|---|
| **Description** | **Average Energy Cost** |
| Electricity | $ 0.61/kWh |
| #2 Oil | $ 3.34/gallons |

### 3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Angoon pays approximately $26,292 annually for electricity and other fuel costs for the Angoon Water Treatment Plant.

Figure 3.15 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.

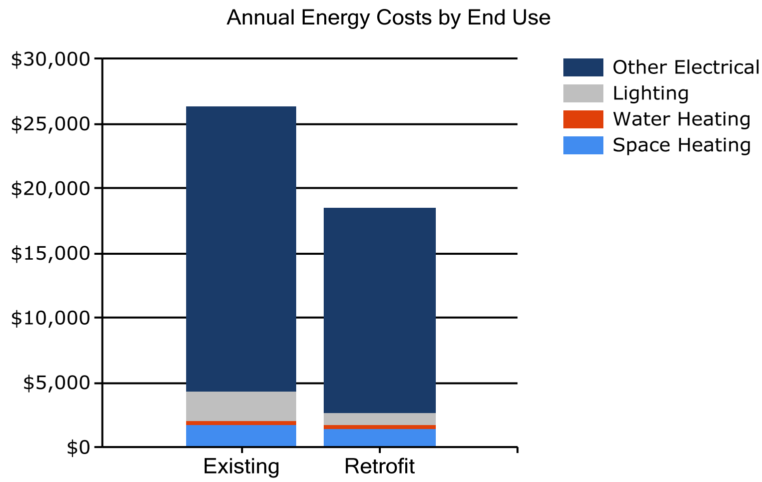



**Figure 3.15: Annual Energy Costs by End Use**

Figure 3.16 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.

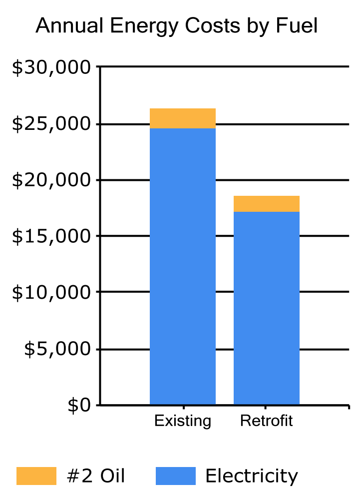



**Figure 3.16: Annual Energy Costs by Fuel Type**

Figure 3.17 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.

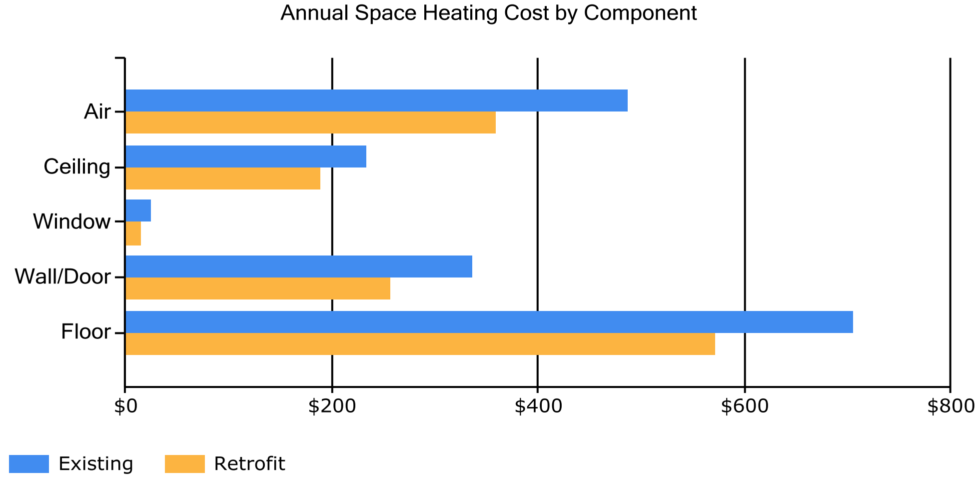



**Figure 3.17: Annual Space Heating Cost by Component**

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 Concumption by Category**

| Electrical Consumption (kWh) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Domestic Hot Water | 46 | 42 | 46 | 44 | 46 | 44 | 46 | 46 | 44 | 46 | 44 | 46 |
| Lighting | 306 | 278 | 306 | 296 | 306 | 296 | 306 | 306 | 296 | 306 | 296 | 306 |
| Other Electrical | 3059 | 2788 | 3059 | 2960 | 3059 | 2960 | 3059 | 3059 | 2960 | 3059 | 2960 | 3059 |

**Table 3.3: Fuel Oil Consumption by Category**

| Fuel Oil #2 Consumption (Gallons) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Space Heating | 122 | 84 | 74 | 36 | 9 | 1 | 1 | 1 | 5 | 32 | 69 | 101 |

### 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 3.4 for details):

*Building Site EUI = (Electric Usage in kBtu + Fuel Oil Usage in kBtu) / Building Square Footage*

*Building Source EUI = (Electric Usage in kBtu X SS Ratio + Fuel Oil Usage in kBtu) / Building Square Footage*

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

**Table 3.4: Angoon Water Treatment Plant 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 | 40,182 kWh | 137,141 | 3.340 | 458,050 |
| #2 Oil | 533 gallons | 73,582 | 1.010 | 74,318 |
| **Total** | | **210,723** | | **532,368** |
| | | | | |
| BUILDING AREA | | 1,984 | Square Feet | |
| BUILDING SITE EUI | | 106 | kBTU/Ft²/Yr | |
| **BUILDING SOURCE EUI** | | 268 | **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 3.5: Angoon Water Treatment Plant Building Benchmarks**

| Building Benchmarks | | | |
|---|---|---|---|
| **Description** | **EUI (kBtu/Sq.Ft.)** | **EUI/HDD (Btu/Sq.Ft./HDD)** | **ECI ($/Sq.Ft.)** |
| **Existing Building** | **106.2** | **12.57** | **$13.25** |
| **With Proposed Retrofits** | **77.1** | **9.13** | **$9.32** |
| **EUI: Energy Use Intensity - The annual site energy consumption divided by the structure's conditioned area.<br>EUI/HDD: Energy Use Intensity per Heating Degree Day.<br>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 systems 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 Angoon Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating energy usage. Climate data from Angoon 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 Angoon. 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.

**Table 4.1: List of Energy Efficiency Recommendations by Economic Priority**

| PRIORITY LIST – ENERGY EFFICIENCY MEASURES | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Rank** | **Feature** | **Improvement Description** | **Annual Energy Savings** | **Installed Cost** | **Savings to Investment Ratio, SIR** | **Simple Payback (Years)** | **$CO_2$ Savings** |
| 1 | Lighting: Intake Gallery | Replace with direct-wire LED replacement bulbs. | $113 | $50 | 26.54 | 0.4 | 314.9 |
| 2 | Lighting: Process Room | Replace with direct-wire LED replacement bulbs. | $738 | $800 | 10.67 | 1.1 | 1,786.7 |

| PRIORITY LIST – ENERGY EFFICIENCY MEASURES | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rank | Feature | Improvement Description | Annual Energy Savings | Installed Cost | Savings to Investment Ratio, SIR | Simple Payback (Years) | $CO_2$ Savings |
| 3 | Lighting: Office | Replace with direct-wire LED replacement bulbs. | $239 | $320 | 8.63 | 1.3 | 574.3 |
| 4 | Setback Thermostat: Water Treatment Plant and Office | Program the Toyo stove with an unoccupied setback to 50.0 deg. F for the water treatment plant and office spaces. | $493 | $1,000 | 6.69 | 2.0 | 3,261.1 |
| 5 | Other Electrical: Lift Station Pump | Clean the pumps out of debris for more efficient operation and to keep the pumps from breaking. | $321 + $250 Maintenance Savings | $1,000 | 4.83 | 1.8 | 894.1 |
| 6 | Other Electrical: Chlorine Room Electric Heater | Lower thermostat setting to 50 deg. F. | $125 | $500 | 2.89 | 4.0 | 305.8 |
| 7 | Lighting: Hallway | Replace with direct-wire LED replacement bulbs. | $55 | $240 | 2.68 | 4.3 | 134.8 |
| 8 | Other Electrical: Generator Room Electric Heater | Shut off electric heater and use only in extreme winter conditions. | $165 | $1,000 | 1.91 | 6.1 | 402.8 |
| 9 | Other Electrical: Water Intake Pumps | Conduct a leak detection study, repair minor leaks in the distribution system, replace VFD controllers, lower the water usage to appropriate community levels, and install a cooling device inside the VFD electric panel at the intake gallery. | $5,478 + $500 Maintenance Savings | $40,000 | 1.76 | 6.7 | 15,267.3 |
| 10 | Lighting: Chemical Room | Replace with direct-wire LED replacement bulbs. | $28 | $240 | 1.33 | 8.7 | 66.5 |
| 11 | Lighting: Generator Room | Replace with direct-wire LED replacement bulbs. | $15 | $240 | 0.74 | 15.6 | 36.8 |

| PRIORITY LIST – ENERGY EFFICIENCY MEASURES | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Rank** | **Feature** | **Improvement Description** | **Annual Energy Savings** | **Installed Cost** | **Savings to Investment Ratio, SIR** | **Simple Payback (Years)** | **$CO_2$ Savings** |
| 12 | Lighting: Chlorine Room | Replace with direct-wire LED replacement bulbs. | $9 | $160 | 0.66 | 17.6 | 21.8 |
| 13 | Air Tightening | Add weatherization around door edges. | $23 | $500 | 0.43 | 21.7 | 152.0 |
| 14 | Exterior Door: Generator Room | Replace existing door with a new door that includes functioning doorknobs and latches. | $7 | $1,064 | 0.15 | 162.2 | 43.4 |
| | **TOTAL, all measures** | | **$7,808 + $750 Maintenance Savings** | **$47,114** | **2.11** | **5.5** | **23,262.2** |

## *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 Door Measures*

| **Rank** | **Location** | | **Size/Type, Condition** | | **Recommendation** | |
|---|---|---|---|---|---|---|
| 14 | Exterior Door: Generator Room | | Door Type: Entrance, Metal, EPS core, metal edge, no glass<br>Modeled R-Value: 2.7 | | Replace existing door with a new door that includes functioning doorknobs and latches.. | |
| **Installation Cost** | | $1,064 | **Estimated Life of Measure (yrs)** | 30 | **Energy Savings (/yr)** | $7 |
| **Breakeven Cost** | | $156 | **Savings-to-Investment Ratio** | 0.1 | **Simple Payback yrs** | 162 |
| Auditors Notes: The existing door is missing a doorknob and locking mechanism, causing the door to have holes in it and allowing air to penetrate into the room. Replace with a functioning door to allow the space to close. | | | | | | |

### *4.3.2 Air Sealing Measures*

| Rank | Location | | Existing Air Leakage Level (cfm@50/75 Pa) | | Recommended Air Leakage Reduction (cfm@50/75 Pa) | |
|---|---|---|---|---|---|---|
| 13 | | | Air Tightness estimated as: 3000 cfm at 50 Pascals | | Add weatherization around door edges. | |
| **Installation Cost** | $500 | **Estimated Life of Measure (yrs)** | 10 | **Energy Savings (/yr)** | $23 | |
| **Breakeven Cost** | $214 | **Savings-to-Investment Ratio** | 0.4 | **Simple Payback yrs** | 22 | |
| Auditors Notes: Add weather stripping around door edges. This also includes the reduction in air leakage from the generator room door replacement. | | | | | | |

## *4.4 Mechanical Equipment Measures*

### *4.4.1 Night Setback Thermostat Measures*

| Rank | Building Space | | | Recommendation | |
|---|---|---|---|---|---|
| 4 | Water Treatment Plant and Office | | | Program the Toyo stove with an unoccupied setback to 50.0 deg F for the water treatment plant and office spaces. | |
| **Installation Cost** | $1,000 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $493 |
| **Breakeven Cost** | $6,693 | **Savings-to-Investment Ratio** | 6.7 | **Simple Payback yrs** | 2 |
| Auditors Notes: The Toyotomi Laser 56 was set at 49 deg. F during the site visit. The operator stated that the set point is around 50-60 deg. F in the winter. Program the stove to allow the space to be heated to 50 degrees all year since the plant is only occupied three hours per day. | | | | | |

## *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 | Intake Gallery | | Incandescent 60 Watt StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $50 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $113 | |
| **Breakeven Cost** | $1,327 | **Savings-to-Investment Ratio** | 26.5 | **Simple Payback yrs** | 0 | |
| Auditors Notes: There is a single fixture with one light bulb to be replaced. | | | | | | |

| Rank | Location | | Existing Condition | | Recommendation | |
|---|---|---|---|---|---|---|
| 2 | Process Room | | 10 FLUOR (4) T12 4' F40T12 34W Energy-Saver StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $800 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $738 | |
| **Breakeven Cost** | $8,536 | **Savings-to-Investment Ratio** | 10.7 | **Simple Payback yrs** | 1 | |
| Auditors Notes: There are ten fixtures with four light bulbs in each fixture to be replaced with two new LED light bulbs for a total of 20 lights to be replaced by LED equivalent lighting. | | | | | | |

| Rank | Location | Existing Condition | | Recommendation | |
|---|---|---|---|---|---|
| 3 | Office | 4 FLUOR (4) T8 4' F32T8 30W Energy-Saver Instant StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $320 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $239 |
| **Breakeven Cost** | $2,760 | **Savings-to-Investment Ratio** | 8.6 | **Simple Payback yrs** | 1 |
| Auditors Notes: There are four fixtures with four light bulbs in each fixture to be replaced with two new LED light bulbs for a total of eight lights to be replaced by LED equivalent lighting. | | | | | |

| Rank | Location | Existing Condition | | Recommendation | |
|---|---|---|---|---|---|
| 7 | Hallway | 3 FLUOR (2) T12 4' F40T12 34W Energy-Saver StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $240 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $55 |
| **Breakeven Cost** | $642 | **Savings-to-Investment Ratio** | 2.7 | **Simple Payback yrs** | 4 |
| Auditors Notes: There are three fixtures with two light bulbs in each fixture for a total of six lights to be replaced by LED equivalent lighting. | | | | | |

| Rank | Location | Existing Condition | | Recommendation | |
|---|---|---|---|---|---|
| 10 | Chemical Room | 3 FLUOR (2) T8 4' F32T8 30W Energy-Saver Instant StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $240 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $28 |
| **Breakeven Cost** | $319 | **Savings-to-Investment Ratio** | 1.3 | **Simple Payback yrs** | 9 |
| Auditors Notes: There are three fixtures with two light bulbs in each fixture for a total of six lights to be replaced by LED equivalent lighting | | | | | |

| Rank | Location | Existing Condition | | Recommendation | |
|---|---|---|---|---|---|
| 11 | Generator Room | 3 FLUOR (2) T12 4' F40T12 34W Energy-Saver StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $240 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $15 |
| **Breakeven Cost** | $178 | **Savings-to-Investment Ratio** | 0.7 | **Simple Payback yrs** | 16 |
| Auditors Notes: There are three fixtures with two light bulbs in each fixture for a total of six lights to be replaced by LED equivalent lighting. | | | | | |

| Rank | Location | Existing Condition | | Recommendation | |
|---|---|---|---|---|---|
| 12 | Chlorine Room | 2 FLUOR (2) T8 4' F32T8 30W Energy-Saver Instant StdElectronic | | Replace with direct-wire LED replacement bulbs. | |
| **Installation Cost** | $160 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $9 |
| **Breakeven Cost** | $105 | **Savings-to-Investment Ratio** | 0.7 | **Simple Payback yrs** | 18 |
| Auditors Notes: There are two fixtures with two light bulbs in each fixture for a total of four lights to be replaced by LED equivalent lighting. | | | | | |

## *4.5.2 Other Electrical Measures*

| **Rank** | **Location** | **Description of Existing** | | **Efficiency Recommendation** | |
|---|---|---|---|---|---|
| 5 | Lift Station Pump | Lift Station Pump | | Clean the pumps out of debris for more efficient operation and to keep the pumps from breaking | |
| **Installation Cost** | $1,000 | **Estimated Life of Measure (yrs)** | 10 | **Energy Savings (/yr)** | $321 |
| | | | | **Maintenance Savings (/yr)** | $250 |
| **Breakeven Cost** | $4,834 | **Savings-to-Investment Ratio** | 4.8 | **Simple Payback yrs** | 2 |
| Auditors Notes: The pumps were clogged with garbage and foreign objects that damage the motor and make the lift station operations less efficient. Regular cleaning will reduce maintenance costs and preserve the life of the pumps. | | | | | |

| **Rank** | **Location** | **Description of Existing** | | **Efficiency Recommendation** | |
|---|---|---|---|---|---|
| 6 | Chlorine Room Electric Heater | Electric Heater | | Lower thermostat settings to 50 deg. F. | |
| **Installation Cost** | $500 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $125 |
| **Breakeven Cost** | $1,447 | **Savings-to-Investment Ratio** | 2.9 | **Simple Payback yrs** | 4 |
| Auditors Notes: The heater was set to 70 deg. F and would have to turn on when the operator occupied the space because the door would be open. This only needs to be set to 50 deg. F for freeze protection purposes. | | | | | |

| **Rank** | **Location** | **Description of Existing** | | **Efficiency Recommendation** | |
|---|---|---|---|---|---|
| 8 | Generator Room Electric Heater | Electric Heater | | Shut off electric heater and use only in extreme winter conditions. | |
| **Installation Cost** | $1,000 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $165 |
| **Breakeven Cost** | $1,908 | **Savings-to-Investment Ratio** | 1.9 | **Simple Payback yrs** | 6 |
| Auditors Notes: This heater runs more than necessary in part because of the extra air penetration through the holes in the door. The door replacement as well as better controls of the heater will reduce excess energy use in this room. | | | | | |

| **Rank** | **Location** | **Description of Existing** | | **Efficiency Recommendation** | |
|---|---|---|---|---|---|
| 9 | Water Intake Pumps | 2 Water Intake Pumps | | Conduct a leak detection study, repair minor leaks in the distribution system, replace VFD controllers, lower the water usage to appropriate community levels, and install a cooling device inside the VFD electric panel at the intake gallery | |
| **Installation Cost** | $40,000 | **Estimated Life of Measure (yrs)** | 15 | **Energy Savings (/yr)** | $5,478 |
| | | | | **Maintenance Savings (/yr)** | $500 |
| **Breakeven Cost** | $70,319 | **Savings-to-Investment Ratio** | 1.8 | **Simple Payback yrs** | 7 |
| Auditors Notes:<br><br>The community uses approximately 244 gallons/person/day with an average intake of 80 gpm. This is partly because the pumps are controlled improperly and partly because of leaks and excess usage by the community. Conduct a leak detection study and repair leaks where found. This assumes approximately 10% of the leaks will be repaired. At the time of the site visit, both pumps were in operation together with pump 1 operating inefficiently because of motor problems within the pump and problems with the VFD controller. This operation is reflected in the electricity usage values. Since the site visit, the VFD controller for pump 1 is not functioning and the pump is inoperable. Replace the VFD controller so that the pumps can be operated with better controls and not in constant operation. This assumes a reduction of 33% of electricity usage due to the VFD controls. Also, the panel by the intake gallery has been over heating and a radiant cooling device can be installed to prevent overheating. $30,000 for the leak detection and repair, $8000 for the VFD controllers, and $2000 for the cooling device. | | | | | |

# 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 Angoon 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.

# APPENDICES

## Appendix A – Energy Audit Report – Project Summary

| ENERGY AUDIT REPORT – PROJECT SUMMARY | |
|---|---|
| **General Project Information** | |
| **PROJECT INFORMATION** | **AUDITOR INFORMATION** |
| **Building:** Angoon Water Treatment Plant | **Auditor Company:** ANTHC-DEHE |
| **Address:** Water Treatment Plant | **Auditor Name:** Kevin Ulrich |
| **City:** Angoon<br>**Client Name:** Danny Frederickson and Paul Thomas | **Auditor Address:** 4500 Diplomacy Dr.<br>Anchorage, AK 99508 |
| **Client Address:** PO Box 189<br><br>Angoon, AK 99820 | **Auditor Phone:** (907) 729-3237<br>**Auditor FAX:** |
| **Client Phone:** (907) 788-3653<br>**Client FAX:** | **Auditor Comment:** |
| **Design Data** | |
| **Building Area:** 1,984 square feet | **Design Space Heating Load:** Design Loss at Space: 36,869 Btu/hour<br>with Distribution Losses: 36,869 Btu/hour<br>Plant Input Rating assuming 82.0% Plant Efficiency and 25% Safety Margin: 56,203 Btu/hour<br>Note: Additional Capacity should be added for DHW and other plant loads, if served. |
| **Typical Occupancy:** 0 people | **Design Indoor Temperature:** 55.9 deg F (building average) |
| **Actual City:** Angoon | **Design Outdoor Temperature:** 1 deg F |
| **Weather/Fuel City:** Angoon | **Heating Degree Days:** 8,450 deg F-days |
| **Utility Information** | |
| **Electric Utility:** Inside Passage Electric Cooperative | **Average Annual Cost/kWh:** $0.61/kWh |

| Annual Energy Cost Estimate | | | | | |
|---|---|---|---|---|---|
| **Description** | **Space Heating** | **Water Heating** | **Lighting** | **Other Electrical** | **Total Cost** |
| **Existing Building** | $1,781 | $328 | $2,196 | $21,987 | **$26,292** |
| **With Proposed Retrofits** | $1,388 | $328 | $895 | $15,872 | **$18,484** |
| **Savings** | $393 | $0 | $1,301 | $6,114 | **$7,808** |

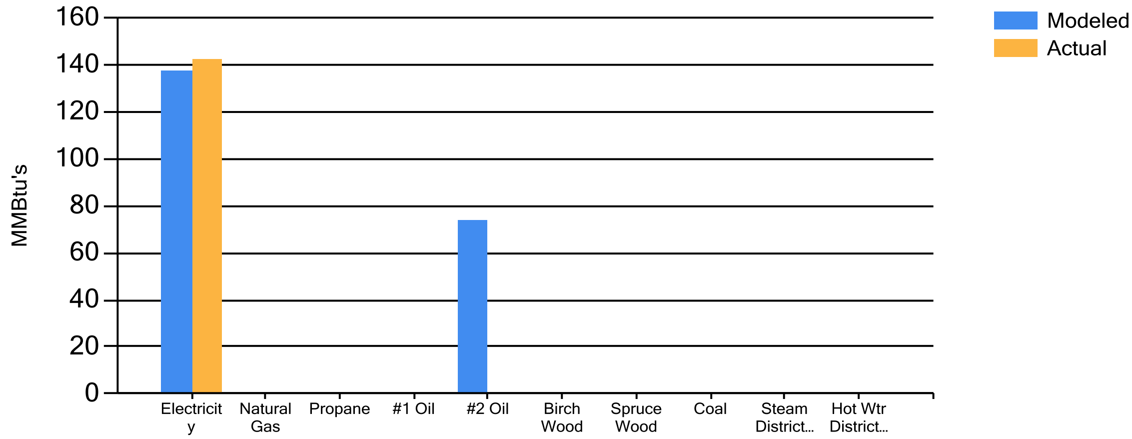
| Building Benchmarks | | | |
|---|---|---|---|
| **Description** | **EUI (kBtu/Sq.Ft.)** | **EUI/HDD (Btu/Sq.Ft./HDD)** | **ECI ($/Sq.Ft.)** |
| **Existing Building** | 106.2 | 12.57 | $13.25 |
| **With Proposed Retrofits** | 77.1 | 9.13 | $9.32 |

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.

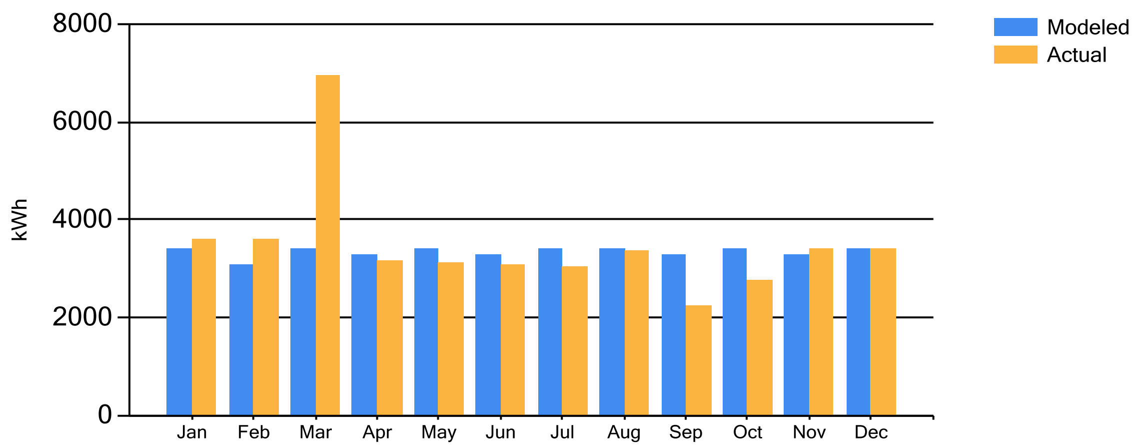
# Appendix B – Actual Fuel Use versus Modeled Fuel Use

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.

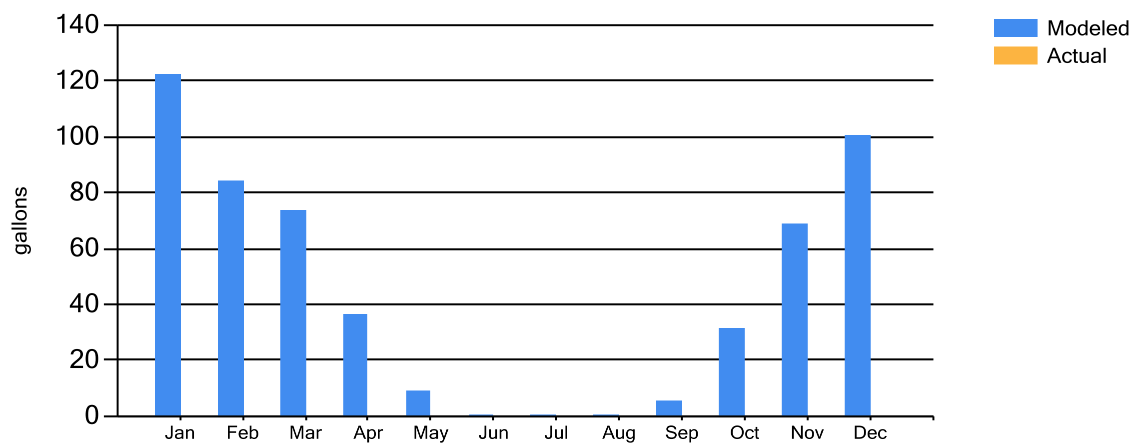
**Annual Fuel Use**




**Electricity Fuel Use**




**#2 Fuel Oil Fuel Use**



# Appendix C - Electrical Demands

| Estimated Peak Electrical Demand (kW) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Current | 8.8 | 8.7 | 8.7 | 8.6 | 8.5 | 8.4 | 8.3 | 8.3 | 8.2 | 8.1 | 8.0 | 7.9 |
| As Proposed | 7.7 | 7.6 | 7.5 | 7.4 | 7.3 | 7.2 | 7.2 | 7.1 | 7.0 | 6.9 | 6.8 | 6.8 |

------------------------------------------

AkWarmCalc Ver 2.5.3.0, Energy Lib 3/7/2016