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Abbreviations

ACF: Accumulated Cash Flow
ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers
AEA: Alaska Energy Authority
AFUE: Annual Fuel Utilization Efficiency
B/C: Benefit / Cost Ratio
BTU: British Thermal Unit
BTU/hr: BTU per hour
COP: Coefficient of Performance
CFM: Cubic Feet per Minute
Eff: Efficiency
F: Fahrenheit
ft: Feet
GPM: Gallons Per Minute
HP: Horsepower
HVAC: Heating, Ventilating, and Air-Conditioning
in: Inch(es)
kW: Kilowatt(s)
kWh: Kilowatt-Hour
lb(s): Pound(s)
MBH: Thousand BTUs per Hour
O&M: Operations and Maintenance
MMBTU: One Million BTUs
PC: Project Cost
R: R-Value
SF: Square Feet, Supply Fan
TEMP: Temperature
TPY: Tons per Year
V: Volts
VRF: Variable Refrigerant Flow
W: Watts
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1. Executive Summary

Coffman performed a preliminary biomass feasibility assessment for the Holy Name Catholic Church and School in Ketchikan, Alaska, to determine the technical and economic viability of a biomass heating system. The proposed biomass heating system is a wood pellet boiler located in a detached building with a buried heat piping loop to the church. As part of the project, the hydronic systems of the church and school would be connected so that the pellet boiler could serve both buildings. A local wood pellet supplier would deliver pellets to an adjacent wood pellet silo.

Due to the low price of heating oil at $2.90/gal and high cost of wood pellets at $327/ton, the benefit to cost ratios for the project is less than 1.0, and thus would not typically be considered economically justified at this time. However, the price of heating oil has varied greatly over time and as heating oil prices rise the project does become more economically viable. For example, when heating oil reaches $3.47/gal the wood pellet boiler project becomes economically justified.

Heat Pumps could be another solution to reduce energy costs and fossil fuel consumption, as the cost of electricity in Ketchikan is quite low due to hydropower. Evaluating the full economics of a heat pump system is outside the scope of this study, however, preliminary calculations show that a heat pump system (COP of 2.5) with a project cost of $200,000 is economically justified with a benefit to cost ratio of 1.35. It is recommended that a heat pump system be further studied to develop a detailed estimate of probable costs for the project.

A summary of the economic analysis is shown in the following table.

<table>
<thead>
<tr>
<th>Item</th>
<th>Wood Pellet Boiler System</th>
<th>Heat Pump System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capital Cost</td>
<td>($235,000)</td>
<td>($200,000)</td>
</tr>
<tr>
<td>Present Value of Project Benefits (20-year life)</td>
<td>$401,286</td>
<td>$401,286</td>
</tr>
<tr>
<td>Present Value of Operating Costs (20-year life)</td>
<td>($241,511)</td>
<td>($131,349)</td>
</tr>
<tr>
<td>Benefit / Cost Ratio of Project (20-year life)</td>
<td>0.68</td>
<td>1.35</td>
</tr>
<tr>
<td>Net Present Value (20-year life)</td>
<td>($75,225)</td>
<td>$69,937</td>
</tr>
<tr>
<td>Year Cash Flow is Net Positive</td>
<td>First Year</td>
<td>First Year</td>
</tr>
<tr>
<td>Payback Period (Year Accumulated Cash Flow &gt; Project Capital Cost)</td>
<td>&gt;20 years</td>
<td>16 years</td>
</tr>
</tbody>
</table>

The current energy prices in Ketchikan are shown in the following table. Using Heat Pumps and burning wood pellets are less expensive than heating oil on an energy basis.

<table>
<thead>
<tr>
<th>Community</th>
<th>Fuel Type</th>
<th>Units</th>
<th>Gross BTU/unit</th>
<th>System Efficiency</th>
<th>$/unit</th>
<th>Delivered $/MMBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketchikan</td>
<td>Heat Pump (COP of 2.5)</td>
<td>kWh of Elec Input</td>
<td>10,236</td>
<td>COP of 2.5</td>
<td>$0.10</td>
<td>$11.72</td>
</tr>
<tr>
<td></td>
<td>Wood Pellets</td>
<td>ton</td>
<td>16,600,000</td>
<td>80%</td>
<td>$327</td>
<td>$24.62</td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>kWh</td>
<td>3,412</td>
<td>99%</td>
<td>$0.10</td>
<td>$29.60</td>
</tr>
<tr>
<td></td>
<td>Heating Oil</td>
<td>gal</td>
<td>134,000</td>
<td>65%</td>
<td>$2.90</td>
<td>$33.30</td>
</tr>
</tbody>
</table>
2. Introduction

A preliminary feasibility assessment was completed to determine the technical and economic viability of biomass heating systems at the Holy Name Catholic Church and School, located in Ketchikan, Alaska. The Holy Name Church operates and maintains both the church building and school building. The church was awarded a biomass pre-feasibility study from the Fairbanks Economic Development Corporation (FEDC). In this report the buildings will be referred to as the “church” or “school”.

Figure 1 – Church Building

Figure 2 – School Building
3. Preliminary Site Investigation

A site visit was completed at the church and school by Coffman Engineers on June 29th, 2018. The inspector was Walter Heins P.E., a senior mechanical engineer who has been involved in many biomass projects over the years.

Building Descriptions

The church and school buildings are both two story buildings that are connected by an enclosed breezeway. Both the church and the school are occupied daily. There have been no energy audits completed for the buildings. For each building, the square footage, date of construction, occupant characteristics and type of construction is shown in the following table.

<table>
<thead>
<tr>
<th>Building</th>
<th>Square Footage</th>
<th>Year Built</th>
<th>Occupants</th>
<th>Type of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church</td>
<td>16,000</td>
<td>1985</td>
<td>200 on Sunday, 10 on other days</td>
<td>CMU block and metal stud walls (R-19 to R-30) and built-up flat roof with rigid insulation (R-60)</td>
</tr>
<tr>
<td>School</td>
<td>21,600</td>
<td>1965</td>
<td>75 students</td>
<td>The lower level has masonry walls (R-10) and the upper level is stick frame (R-16). The roof is wood truss with fiberglass batt insulation (R-24).</td>
</tr>
</tbody>
</table>

Existing Heating System

Each building is heated with a cast-iron sectional oil-fired boilers that feed perimeter baseboard units, cabinet unit heaters and heating coils using water as the hydronic fluid. There is no centralized DDC control system for the heating systems. The church uses thermostats to control the heating system. The only control system in the church is an interlock on the Kitchen AHU and Kitchen Hood. The school utilizes thermostats to control the heating system as well. The school also has a pneumatic control system to actuate pneumatic thermostats in the classrooms and pneumatic controlled valves for the AHU.

The church domestic hot water (DHW) is provided by an indirect hot water heater off of the boiler loop. There are electric water heaters in the kitchen and janitor closet by restrooms, which allows DHW to be supplied without using the oil boiler. The school DHW is provided by an indirect hot water heater off of the boiler loop.

The school boiler is the original boiler, installed in 1965. Maintenance personnel reported that the school boiler is operational, but it is past its expected lifespan. Parts for the boiler are currently difficult to obtain. Replacement of the boiler will likely occur in the near future. The church boiler was installed in 1985 and is in good operational order. The church boiler is a different make than school boiler and parts are more readily available. There are no plans to replace this boiler in the near future.
The following table shows the heating capacities of the boiler plants.

<table>
<thead>
<tr>
<th></th>
<th>Boiler Plant</th>
<th>DHW Plant</th>
<th>Fuel Tankage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>School</strong></td>
<td>Cleaver-Brooks, Progress Oil Boiler, 1,000,000 BTU/hr Gross Output</td>
<td>Bock Hot Water Heater, Direct-Fired, 85 gal</td>
<td>Two 300-gal above ground fuel tanks located indoors adjacent to boiler room</td>
</tr>
</tbody>
</table>

The boilers and central pumps are located in mechanical rooms. The combustion efficiency of the boilers is unknown, as no combustion test reports were available. For this study, the Annual Fuel Utilization Efficiency of the boiler system is estimated at 65% to account for typical oil boiler inefficiencies, including short cycling, due to the age of the boilers.

**Available Space, Street Access, Fuel Storage and Site Constraints**

The church and school have good site access around both buildings. There is an asphalt access drive that traverses the west and south sides of the buildings, which allows easy access around the buildings. There is a playground on the south side of the school.

There is no practical space inside the buildings for a biomass system that includes fuel storage. There may be space in the school boiler room if the existing boiler is removed. However, there is no good spot for a pellet storage box (inside the building) or pellet silo outside the building that is close enough to transfer pellets to the biomass system. Therefore, for this analysis the biomass boiler system will be located in a detached biomass building with an outdoor silo adjacent to it.

The preferred location of a detached biomass building and silo, is on the west side of the church and school in the asphalt access drive. The silo could be easily accessed by delivery trucks and the biomass building can be easily accessed for maintenance and operation.

A site layout of the major site constraints at the church and school is shown on the following page.
Figure 3 – Holy Name Church and School Layout
4. Biomass System

Biomass System Options

The biomass boiler system selected as the basis of design for the church and school is a wood pellet boiler. Wood pellets are the best fit for the buildings because they are fully automated boilers that require limited labor for operation and fuel handling. Cord wood boiler systems were not considered because they require manual loading and firing of cord wood, which requires significant labor. Currently the church does not have available staff to handle cord wood and adding the cost of paying for this additional labor would further decrease the economics of the option.

Wood chip systems were considered, but were not selected because of the availability of local wood pellets. The handling of pellets is much easier than wood chips or cord wood and the fuel feeder systems typically run with less maintenance than chip systems.

For this study, a Twin Heat ME80i wood pellet boiler was selected. The high efficiency boiler can modulate down to 30% load and still maintain efficiencies of 85% or higher, according to manufacturer documentation. The ME80i unit can produce 80kW of thermal output (or 273,000 BTU/hr).

During final design more research should go into final boiler determination based on Alaska reliability, size, operation, fuel handling, etc. The Alaska Energy Authority can provide further information on systems that have been used successfully in Alaska.

Figure 4 – Twin Heat ME80i Pellet Boiler

The biomass boiler would be installed in an 8ft wide x 16ft long insulated building. The building could be built onsite or fabricated offsite and shipped to the site as a module. The biomass building would include a thermal storage tank, pellet augers, pump, piping and wiring for a fully complete system. The module would be installed on a concrete pad with a pellet silo adjacent to it. A Twin Heat outdoor galvanized steel pellet silo, that can hold 12 tons of pellets, was selected as the basis of design. A flexible pellet auger connects from the bottom of the silo to the Twin Heat pellet boiler. A manufacturer provided
general arrangement drawing of the pellet boiler, flexible auger and pellet silo is shown in the following figure.

![Diagram of 12 Ton Pellet Silo and ME80i Boiler](image)

**Figure 5 – Example of Outdoor Pellet Silo Connected to Twin Heat ME80i Boiler**

The combustion efficiency of the pellet boiler can reach higher than 85%. Using thermal storage will also help the unit run at higher efficiencies during normal operation. For this study, an Annual Fuel Utilization Efficiency of 80% was used, to account for normal operations throughout the year.

**Biomass System Integration**

The detached biomass boiler building will house the pellet boiler and thermal storage tank. The pellet boiler and thermal storage tank will operate with glycol. A buried, insulated piping loop will transfer heat using glycol from the boiler building to the church’s mechanical room. In the mechanical room, a new heat exchanger will transfer heat from the pellet boiler loop to the church’s heating system. The heat exchanger is used to separate the church’s hydronic system (using water) from the pellet boiler’s glycol loop, so that the buried line can be freeze protected. A new pump will be required to pump glycol from the pellet boiler building to the church heat exchanger. The new pellet boiler building will require an electrical connection to power the pellet boiler and associated facility lighting and equipment.

A new supply and return line will be run inside the church and school buildings through the breezeway to connect both the church and school hydronic systems together. This will allow the pellet boiler to heat both buildings. The existing oil boilers in both buildings could be used to add heat if the pellet boiler could not carry the load or was down for regular maintenance activities.

**Heat Pump Alternative**

Due to the relatively low cost of electricity in Ketchikan, it was observed that heat pumps are another option for offsetting heating oil at the buildings. Heat pumps use electricity to drive a refrigeration cycle that can be used to heat a building or domestic hot water.

There are many styles of heat pump units available. Air-to-Air heat pumps and variable refrigerant flow (VRF) units take heat out of the outside air and use cassettes inside the buildings to heat interior spaces. These systems would work relatively efficiently at the church and school, but would require a new heat
distribution system. The existing hydronic system, radiators and heating coils could not be used to deliver heat to the spaces using this type of heat pump system. Air-to-Air and VRF units are readily available on the market and manufactures include Daikin, Mitsubishi and others.

Air-to-Water heat pumps are also becoming more prevalent. These units take heat out of the outside air and can heat water. An air-to-water heat pump could be installed on the return line of the existing boiler system in both the church and school. It would utilize the existing hydronic system to transfer heat to the spaces in the buildings. The benefit of the air-to-water heat pump is that the existing hydronic system can be used, and a new heat distribution system is not needed. However, air-to-water heat pumps that can output high temperature water are typically only available in Europe and Japan, with limited support in the U.S. As these units come to the U.S. market in the future, the air-to-water heat pumps may be a viable option. For example, Sanden and Mitsubishi both make a CO2 heat pump that is not available in the U.S. yet.

Ground source heat pumps that use a buried piping in the ground, will likely not be a feasible system for the church and school due to the small size of the building heat load. Ground source heat pumps are better suited for large loads because the ground source heat pumps are expensive, and a lot of energy needs to be offset in order for the systems to be economical. Ground source heat pumps are not recommended for the church and school due to these reasons.

The downside of the heat pumps is that they do not operate well when temperatures get colder outside. A hybrid system may be needed where the heating oil boiler is still used to heat the buildings during the coldest days when the heat pumps cannot carry the load.

A site visit by a heat pump contractor may be a good start for further evaluating the options and costs of a heat pump system.
5. Energy Consumption and Costs

Energy Costs

The table below shows the energy comparison of different fuel types in the community. The system efficiency is used to calculate the delivered MMBTU’s of energy to the building. The delivered cost of energy to the building, in $/MMBTU, is the most accurate way to compare costs of different energy types.

Heating oil is the most expensive heating fuel on the list at $33.30/MMBTU. Wood Pellets and heating with electric resistance heaters are the next cheapest at $24.62/MMBTU and $29.60/MMBTU, respectively. Wood pellets are not that much cheaper than heating oil or electric, due to the relatively high cost of pellet delivery to Ketchikan.

The lowest cost form of energy is heat pumps, which range from $11.72/MMBTU to $14.65/MMBTU based on COP’s of 2.5 to 2.0. The COP (or Coefficient of Performance) is the ratio of the useful heating provided compared to the amount of energy consumed by the heat pump. Higher COPs mean lower operating costs.

Based on the energy comparison of fuels at Ketchikan, it can be seen that heat pumps do offer the most affordable heating opportunity. This is due to the relatively low cost of electricity in the area, which is used to power heat pumps.

<table>
<thead>
<tr>
<th>Community</th>
<th>Fuel Type</th>
<th>Units</th>
<th>Gross BTU/unit</th>
<th>System Efficiency</th>
<th>$/unit</th>
<th>Delivered $/MMBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketchikan</td>
<td>Heat Pump</td>
<td>kWh of Elec Input</td>
<td>10,236</td>
<td>COP of 2.5</td>
<td>$0.10</td>
<td>$11.72</td>
</tr>
<tr>
<td></td>
<td>(COP of 2.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heat Pump</td>
<td>kWh of Elec Input</td>
<td>6,824</td>
<td>COP of 2.0</td>
<td>$0.10</td>
<td>$14.65</td>
</tr>
<tr>
<td></td>
<td>(COP of 2.0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood Pellets</td>
<td>ton</td>
<td>16,600,000</td>
<td>80%</td>
<td>$327</td>
<td>$24.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td>kWh</td>
<td>3,412</td>
<td>99%</td>
<td>$0.10</td>
<td>$29.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heating Oil</td>
<td>gal</td>
<td>134,000</td>
<td>65%</td>
<td>$2.90</td>
<td>$33.30</td>
</tr>
</tbody>
</table>

Cord Wood

Cord wood was evaluated as a biomass fuel, but was not considered viable due to the additional handling requirements. In order to burn cord wood, a person is required to stack, move and load the cord wood boiler daily, if not multiple times per day. Cord wood was not considered viable because the Church wishes to have a more automated biomass system that does not require additional labor. Plus, there is limited space onsite to store large volumes of cord wood.

Wood Pellets

There is currently no local wood pellet manufacturer in Ketchikan, AK. There was a pellet mill in Ketchikan, but is no longer in service. Marble Construction is the local wood pellet distributor using pellets out of
British Columbia. Wood pellets are shipped to Ketchikan in containers and are stored at the distributor’s pellet storage. A pellet augur truck is used to transport the wood pellets to client’s silos, such as the Ketchikan Airport. The delivered price of wood pellets to a client is $350/ton. The pellets are approximately 5% moisture content and have an energy content of 8,300 BTU/lb (16,600,000 BTU/ton).

True Value Hardware in Ketchikan also sells wood pellets. They only sell 40lb bags of pellets, not bulk delivery. Pellets can be purchased by pallet, which contain 50 of the 40lb bags, or one ton of pellets. The pellet cost is $327/ton, which was used for this study.

If a local supplier of pellets becomes available in the future at a lower cost, the pellet system could become much more viable.

**Heating Oil**

The high price of fuel oil is the main economic driver for the use of lower cost biomass heating. Fuel oil is currently purchased at $2.90/gal, based on heating oil records. The price of fuel oil has fluctuated greatly over time, and currently appears to be at a lower price than in the recent past. The wide variation of fuel oil prices is a disadvantage compared to more stably priced wood pellets. For this study, the energy content of fuel oil is based on 134,000 BTU/gal, according to “Heating Values of Fuels” by the UAF Cooperative Extension, 2009.

**Electricity**

Electricity for the church is provided by the Ketchikan Public Utilities (KPU). According to the utility data the effective electricity rate at the church is $0.10/kWh. The effective electricity rate is the cost of all electric costs (demand, energy, customer charges) per kWh for a billing period. Due to the relatively low cost of electricity, it is a cheaper heating source than heating oil on a BTU basis. There are 3,412 BTU per kWh.
Existing Fuel Oil Consumption

The existing heating oil consumption at the church and school is shown below, based on available heating oil purchase records. The total combined cost of heating oil usage at both facilities is $17,110 per year.

<table>
<thead>
<tr>
<th>Building</th>
<th>Fuel Type</th>
<th>Annual Consumption</th>
<th>Net MMBTU/yr</th>
<th>Avg. Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church</td>
<td>Heating Oil</td>
<td>2,600 gal</td>
<td>226.5</td>
<td>$7,540</td>
</tr>
<tr>
<td>School</td>
<td>Heating Oil</td>
<td>3,300 gal</td>
<td>287.4</td>
<td>$9,570</td>
</tr>
<tr>
<td>Total</td>
<td>Heating Oil</td>
<td>5,900 gal</td>
<td>513.9</td>
<td>$17,110</td>
</tr>
</tbody>
</table>

Biomass System Consumption

It is estimated that the proposed biomass system offset approximately 98% of the heating energy for the church and school buildings. The remaining 2% of the heating energy will be provided by the existing oil boilers. This result is based on an analysis of the building’s annual heating oil consumption, the heat output of the pellet boiler and BIN weather data for the area.

<table>
<thead>
<tr>
<th>Building</th>
<th>Fuel Type</th>
<th>% Heating Source</th>
<th>Net MMBTU/yr</th>
<th>Annual Consumption</th>
<th>Energy Cost</th>
<th>Total Energy Cost</th>
<th>Annual Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church and School</td>
<td>Wood Pellets</td>
<td>98%</td>
<td>503.6</td>
<td>38 tons</td>
<td>$12,401</td>
<td>$12,823</td>
<td>$4,287</td>
</tr>
<tr>
<td></td>
<td>Fuel Oil</td>
<td>2%</td>
<td>10.3</td>
<td>118 gal</td>
<td>$342</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additional</td>
<td>N/A</td>
<td>N/A</td>
<td>800 kWh</td>
<td>$80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note – Based on wood pellets at $327/ton, heating oil at $2.90/gal and electricity at $0.10/kWh.

Heat Pump Consumption

If heat pumps were used instead, it is estimated that the heat pumps would offset 95% of the heating energy for the church and school buildings. The remaining 5% of the heating energy will be provided by the existing oil boilers. The following table is an estimate of the electrical and heating oil consumption of the building using heat pumps with a COP of 2.5. As can be seen, at current energy prices, the heat pump saves over double what the pellet system does in energy costs (note this does not address construction costs).

<table>
<thead>
<tr>
<th>Building</th>
<th>Fuel Type</th>
<th>% Heating Source</th>
<th>Net MMBTU/yr</th>
<th>Annual Consumption</th>
<th>Energy Cost</th>
<th>Total Energy Cost</th>
<th>Annual Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church and School</td>
<td>Heat Pump</td>
<td>95%</td>
<td>488.2</td>
<td>57,233</td>
<td>$5,723</td>
<td>$6,579</td>
<td>$10,531</td>
</tr>
<tr>
<td></td>
<td>(COP=2.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fuel Oil</td>
<td>5%</td>
<td>25.7</td>
<td>295 gal</td>
<td>$856</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Preliminary Cost Estimating

An estimate of probable costs was completed for installing the wood pellet boiler systems at each school. The estimate is based on equipment quotes and from previous projects in Alaska. A remote factor of 5% was used to account for shipping costs. Project and Construction Management was estimated at 5%. Engineering design and permitting was estimated at 20%. A 25% contingency is used as no specific design engineering effort has been completed, specific quotes for all materials have not been prepared, and all the integration components have not been determined. Thus, there are unknowns related to the extent of Mechanical, Electrical, and Civil work required for the proposed project.
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Work</td>
<td>Building Foundation</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td>Buried Utilities</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$10,000</strong></td>
</tr>
<tr>
<td>Electrical Utilities</td>
<td>Service Entrance</td>
<td>$3,000</td>
</tr>
<tr>
<td></td>
<td>Conduit and Wiring</td>
<td>$3,000</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$6,000</strong></td>
</tr>
<tr>
<td>Biomass Boiler</td>
<td>Building</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Detached Boiler Building (8'x16') @ $200/SF</td>
<td>$25,600</td>
</tr>
<tr>
<td></td>
<td>Twin Heat ME80i Pellet Boiler</td>
<td>$20,000</td>
</tr>
<tr>
<td></td>
<td>Insulated SS Chimney</td>
<td>$3,000</td>
</tr>
<tr>
<td></td>
<td>Flexible pellet auger</td>
<td>$1,200</td>
</tr>
<tr>
<td></td>
<td>Outdoor Galvanized Steel Pellet Silo (12 tons)</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td>Thermal Storage Tank 200 gal</td>
<td>$3,000</td>
</tr>
<tr>
<td></td>
<td>Mechanical, Piping and pump allowance</td>
<td>$15,000</td>
</tr>
<tr>
<td></td>
<td>Electrical allowance</td>
<td>$25,000</td>
</tr>
<tr>
<td></td>
<td>Shipping to Ketchikan</td>
<td>$5,000</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$102,800</strong></td>
</tr>
<tr>
<td>Building</td>
<td>Connections</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Insulated Pipe to Church</td>
<td>$7,000</td>
</tr>
<tr>
<td></td>
<td>Heat Exchanger</td>
<td>$3,000</td>
</tr>
<tr>
<td></td>
<td>Piping tie-in of Church and School</td>
<td>$20,000</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$30,000</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal Material and Installation Cost</strong></td>
<td><strong>$148,800</strong></td>
</tr>
<tr>
<td>Remote Factor</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$156,240</strong></td>
</tr>
<tr>
<td>Project and Construction Management</td>
<td>5%</td>
<td>$7,812</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$156,612</strong></td>
</tr>
<tr>
<td>Design Fees and Permitting</td>
<td>20%</td>
<td>$31,323</td>
</tr>
<tr>
<td></td>
<td><strong>Subtotal</strong></td>
<td><strong>$187,935</strong></td>
</tr>
<tr>
<td>Contingency</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Project Cost</strong></td>
<td><strong>$234,919</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Total Budgetary Cost</strong></td>
<td><strong>$235,000</strong></td>
</tr>
</tbody>
</table>
7. Economic Analysis

The following assumptions were used to complete the economic analysis for this study.

<table>
<thead>
<tr>
<th>Table 10 – Discount and Escalation rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Discount Rate for Net Present Value Analysis</td>
</tr>
<tr>
<td>Wood Fuel Escalation Rate</td>
</tr>
<tr>
<td>Fossil Fuel Escalation Rate</td>
</tr>
<tr>
<td>Electricity Escalation Rate</td>
</tr>
<tr>
<td>O&amp;M Escalation Rate</td>
</tr>
</tbody>
</table>

The real discount rate, or minimum attractive rate of return, is 3.0% and is the current rate used for all Life Cycle Cost Analysis by the Alaska Department of Education and Early Development. This is a typical rate used for completing economic analysis for entities that have not established their own internal minimum attractive rate of return. The escalation rates used for the wood, heating oil, electricity and O&M rates are based on rates used in previous Alaska Energy Authority funded biomass pre-feasibility studies. The wood fuel escalation rate was set at 2%. The electricity escalation rate was set at 2%, because the majority of the power in the community is from stably priced hydropower.

A net present value analysis was completed using real dollars (constant dollars) and the real discount rate, as required per the Alaska Department of Education and Early Development Life Cycle Cost Analysis Handbook.

**O&M Costs**

Non-fuel related operations and maintenance costs (O&M) were estimated at $600 per year. The estimate is based on annual maintenance time for similar pellet boilers. For only the first two years of service, the maintenance cost is doubled to account for maintenance staff getting used to operating the new system.

**Definitions**

There are many different economic terms used in this study. A listing of all the terms with their definition is provided below for reference.
## Table 11 – Economic Definitions

<table>
<thead>
<tr>
<th>Economic Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capital Cost</td>
<td>This is the opinion of probable cost for designing and constructing the project.</td>
</tr>
<tr>
<td>Present Value of Project Benefits (20-year life)</td>
<td>The present value of all of the heating oil that would have been consumed by the existing heating oil-fired heating system, over a 20-year period.</td>
</tr>
<tr>
<td>Present Value of Operating Costs (20-year life)</td>
<td>The present value of all of the proposed biomass systems operating costs over a 20-year period. This includes wood fuel, additional electricity, and O&amp;M costs for the proposed biomass system and the heating oil required by the existing equipment to supply the remaining amount of heat to the building.</td>
</tr>
<tr>
<td>Benefit / Cost Ratio of Project (20-year life)</td>
<td>This is the benefit to cost ratio over the 20-year period. A project that has a benefit to cost ratio greater than 1.0 is economically justified. It is defined as follows: $\frac{PV(\text{Project Benefits}) - PV(\text{Operating Costs})}{\text{Project Capital Cost}}$</td>
</tr>
<tr>
<td>Net Present Value (20-year life)</td>
<td>This is the net present value of the project over a 20-year period. If the project has a net present value greater than zero, the project is economically justified. This quantity accounts for the project capital cost, project benefits and operating costs.</td>
</tr>
<tr>
<td>Payback Period (Year Accumulated Cash Flow &gt; Project Capital Cost)</td>
<td>The Payback Period is the number of years it takes for the accumulated cash flow of the project to be greater than or equal to the project capital cost. This quantity includes escalating energy prices and O&amp;M rates. This quantity is calculated as follows: $\sum_{k=0}^{J} R_k$</td>
</tr>
</tbody>
</table>

Where:

- $PV = \text{The present value over the 20-year period}$
Results

An economic analysis was completed to determine the simple payback, benefit to cost ratio, and net present value of the proposed wood pellet boiler system at the Holy Name Church and School. A wood pellet boiler would be located in a detached biomass building and a buried heat loop would connect to the new heat exchanger in the church’s mechanical room. The church and school hydronic systems would be tied together so that the pellet boiler could serve both buildings. The wood pellet boiler would supplement heat for the existing oil boilers. A pellet silo would be located next to the pellet boiler building and filled by a local pellet supplier.

Due to the low price of heating oil at $2.90/gal and high cost of wood pellets at $327/ton, the benefit to cost ratios for the project is less than 1.0. Any project with a benefit to cost ratio less than 1.0 is typically not considered economically justified, and therefore the wood pellet system is not economically justified at this time.

However, historically the price of heating oil has varied greatly over time and as heating oil prices rise the project does become more economically viable. For example, when heating oil reaches $3.47/gal the wood pellet boiler project becomes economically justified. This can be seen in the sensitivity analysis on the next page.

During the analysis, it was observed that heat pumps could be another viable solution to reduce energy costs and fossil fuel consumption, due to the low cost of electricity in Ketchikan. Evaluating the full economics of a heat pump system is outside the scope of this study, however, preliminary calculations show that a heat pump system (COP of 2.5) with a total project cost of $200,000 is economically justified with a benefit to cost ratio of 1.35. It is recommended that a heat pump system be further studied to develop a detailed estimate of probable costs for the project.

The results are shown in the table below. Refer to Appendix B for the economic analysis spreadsheets for greater detail. (Note: values shown in red and parenthesis are negative numbers)

<table>
<thead>
<tr>
<th>Item</th>
<th>Wood Pellet Boiler System</th>
<th>Heat Pump System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capital Cost</td>
<td>($235,000)</td>
<td>($200,000)</td>
</tr>
<tr>
<td>Present Value of Project Benefits (20-year life)</td>
<td>$401,286</td>
<td>$401,286</td>
</tr>
<tr>
<td>Present Value of Operating Costs (20-year life)</td>
<td>($241,511)</td>
<td>($131,349)</td>
</tr>
<tr>
<td>Benefit / Cost Ratio of Project (20-year life)</td>
<td>0.68</td>
<td>1.35</td>
</tr>
<tr>
<td>Net Present Value (20-year life)</td>
<td>($75,225)</td>
<td>$69,937</td>
</tr>
<tr>
<td>Year Cash Flow is Net Positive</td>
<td>First Year</td>
<td>First Year</td>
</tr>
<tr>
<td>Payback Period (Year Accumulated Cash Flow &gt; Project Capital Cost)</td>
<td>&gt;20 years</td>
<td>16 years</td>
</tr>
</tbody>
</table>

* ROM (rough order of magnitude) estimate.

Another opportunity to make the heat pump system more economical would be to negotiate a lower rate with KPU electric utility by giving them demand response control. This would allow utility to shut down heat pumps when electric demand is high in the area. In this case the existing oil boiler would provide heat while the heat pumps are turned off during a utility demand control. Even though additional heating
oil will be used to fire the boilers, the low cost of demand control electricity will more than offset this cost.

Sensitivity Analysis

A sensitivity analysis was completed to show how changing heating oil prices, wood pellet prices, and project costs affect the benefit to cost (B/C) ratios of the project. As heating oil costs increase and wood costs decrease, the project becomes more economically viable. The B/C ratios greater than 1.0 are economically justified and are highlighted in green. B/C ratios less than 1.0 are not economically justified and are highlighted in orange.

| Table 13 – Sensitivity Analysis – Heating Oil Price vs Wood Pellet Price |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| B/C Ratios                                      | Wood Pellet Price |
|                                                | $250/ton | $300/ton | $350/ton | $400/ton | $450/ton |
| Heating Oil Price                               |           |           |           |           |           |
| $2.75/gal                                       | 0.81      | 0.67      | 0.53      | 0.38      | 0.24      |
| $3.00/gal                                       | 0.96      | 0.81      | 0.67      | 0.53      | 0.39      |
| $3.25/gal                                       | 1.10      | 0.96      | 0.82      | 0.67      | 0.53      |
| $3.50/gal                                       | 1.25      | 1.10      | 0.96      | 0.82      | 0.67      |
| $3.75/gal                                       | 1.39      | 1.25      | 1.10      | 0.96      | 0.82      |
| $4.00/gal                                       | 1.54      | 1.39      | 1.25      | 1.11      | 0.96      |
| $4.25/gal                                       | 1.68      | 1.54      | 1.39      | 1.25      | 1.11      |
| $4.50/gal                                       | 1.82      | 1.68      | 1.54      | 1.39      | 1.25      |
| $4.75/gal                                       | 1.97      | 1.82      | 1.68      | 1.54      | 1.39      |
| $5.00/gal                                       | 2.11      | 1.97      | 1.83      | 1.68      | 1.54      |
| $5.25/gal                                       | 2.26      | 2.11      | 1.97      | 1.83      | 1.68      |

Note: Based on a project cost of $235,000.

| Table 14 – Sensitivity Analysis – Wood Pellet Price vs Project Cost |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| B/C Ratios                                      | Project Cost    |
|                                                | ($150,000) | ($200,000) | ($250,000) | ($300,000) | ($350,000) |
| Wood Pellet Price                               |              |              |              |              |              |
| $150/ton                                        | 1.86      | 1.40      | 1.12      | 0.93      | 0.80      |
| $200/ton                                        | 1.64      | 1.23      | 0.98      | 0.82      | 0.70      |
| $250/ton                                        | 1.41      | 1.06      | 0.85      | 0.71      | 0.60      |
| $300/ton                                        | 1.19      | 0.89      | 0.71      | 0.59      | 0.51      |
| $350/ton                                        | 0.96      | 0.72      | 0.58      | 0.48      | 0.41      |
| $400/ton                                        | 0.74      | 0.55      | 0.44      | 0.37      | 0.32      |
| $450/ton                                        | 0.51      | 0.38      | 0.31      | 0.26      | 0.22      |
| $500/ton                                        | 0.29      | 0.22      | 0.17      | 0.14      | 0.12      |

Note: Based on heating oil price of $2.90/gal.
Heat Pump Sensitivity Analysis

A sensitivity analysis was completed for the heat pump alternative. The project cost and the price of electricity are the two main variables for the heat pump economics. A heat pump system with a COP of 2.5 was used.

<table>
<thead>
<tr>
<th>Electricity Rate</th>
<th>B/C Ratios</th>
<th>Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>($150,000)</td>
<td>($200,000)</td>
</tr>
<tr>
<td>$0.08/kWh</td>
<td>1.93</td>
<td>1.45</td>
</tr>
<tr>
<td>$0.09/kWh</td>
<td>1.87</td>
<td>1.40</td>
</tr>
<tr>
<td>$0.09/kWh</td>
<td>1.84</td>
<td>1.38</td>
</tr>
<tr>
<td>$0.10/kWh</td>
<td>1.80</td>
<td>1.35</td>
</tr>
<tr>
<td>$0.11/kWh</td>
<td>1.73</td>
<td>1.30</td>
</tr>
<tr>
<td>$0.12/kWh</td>
<td>1.66</td>
<td>1.25</td>
</tr>
<tr>
<td>$0.13/kWh</td>
<td>1.60</td>
<td>1.20</td>
</tr>
<tr>
<td>$0.14/kWh</td>
<td>1.53</td>
<td>1.15</td>
</tr>
<tr>
<td>$0.15/kWh</td>
<td>1.46</td>
<td>1.10</td>
</tr>
<tr>
<td>$0.16/kWh</td>
<td>1.39</td>
<td>1.05</td>
</tr>
<tr>
<td>$0.17/kWh</td>
<td>1.33</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Note: Based on heating oil price of $2.90/gal and heat pump with COP of 2.5.
8. Forest Resource and Fuel Availability Assessments

Fuel Availability

There are two local wood pellet suppliers in Ketchikan: Marble Construction and True Value Hardware. Marble Construction distributes pellets out of British Columbia. Wood pellets are shipped to Ketchikan in containers and are stored in bulk at the distributor’s pellet storage.

True Value Hardware in Ketchikan also sells wood pellets. They only sell 40lb bags of pellets, not bulk delivery. Pellets can be purchased by pallet, which contains 50 of the 40lb bags, or one ton of pellets.

There appears to be adequate pellet availability from both distributors. No further forest resource assessments were obtained.

Air Quality Permitting

Currently, air quality permitting is regulated according to the Alaska Department of Environmental Conservation Section 18 AAC 50 Air Quality Control regulations. Per these regulations, a minor air quality permit is required if a new wood boiler or wood stove produces one of the following conditions per Section 18 AAC 50.502 (C)(1): 40 tons per year (TPY) of carbon dioxide (CO2), 15 TPY of particulate matter greater than 10 microns (PM-10), 40 TPY of sulfur dioxide, 0.6 TPY of lead, 100 TPY of carbon monoxide within 10 kilometers of a carbon monoxide nonattainment area, or 10 TPY of direct PM-2.5 emissions. These regulations assume that the device will operate 24 hours per day, 365 days per year and that no fuel burning equipment is used. If a new wood boiler or wood stove is installed in addition to a fuel burning heating device, the increase in air pollutants cannot exceed the following per AAC 50.502 (C)(3): 10 TPY of PM-10, 10 TPY of sulfur dioxide, 10 TPY of nitrogen oxides, 100 TPY of carbon monoxide within 10 kilometers of a carbon monoxide nonattainment area, or 10 TPY of direct PM-2.5 emissions. Per the Wood-fired Heating Device Visible Emission Standards (Section 18 AAC 50.075), a person may not operate a wood-fired heating device in a manner that causes black smoke or visible emissions that exceed 50 percent opacity for more than 15 minutes in any hour in an area where an air quality advisory is in effect.

From Coffman’s discussions with Patrick Dunn at the Alaska Department of Environmental Conservation, these regulations are focused on permitting industrial applications of wood burning equipment. In his opinion, it would be unlikely that an individual wood boiler would require an air quality permit unless several boilers were to be installed and operated at the same site. If several boilers were installed and operated together, the emissions produced could be greater than 40 tons of CO2 per year. This would require permitting per AAC 50.502 (C)(1) or (C)(3). Permitting would not be required on the residential wood fired stoves unless they violated the Wood-fired Heating Device Visible Emission Standards (Section 18 AAC 50.075). Recent similarly sized Garn wood fired boiler systems installed in Alaska have not required air quality permits.
9. General Biomass Technology Information

Heating with Wood Fuel

Wood fuels are among the most cost-effective and reliable sources of heating fuel for communities adjacent to forestland when the wood fuels are processed, handled, and combusted appropriately. Compared to other heating energy fuels, such as oil and propane, wood fuels typically have lower energy density and higher associated transportation and handling costs. Due to this low bulk density, wood fuels have a shorter viable haul distance when compared to fossil fuels. This short haul distance also creates an advantage for local communities to utilize locally-sourced wood fuels, while simultaneously retaining local energy dollars.

Most communities in rural Alaska are particularly vulnerable to high energy prices due to the large number of heating degree days and expensive shipping costs. For many communities, wood-fueled heating can lower fuel costs. For example, cordwood sourced at $250 per cord is just 25% of the cost per MMBTU as #1 fuel oil sourced at $7 per gallon. In addition to the financial savings, the local communities also benefit from the multiplier effect of circulating energy dollars within the community longer, more stable energy prices, job creation, and more active forest management.

The local cordwood market is influenced by land ownership, existing forest management and ecological conditions, local demand and supply, and the State of Alaska Energy Assistance program.

Types of Wood Fuel

Wood fuels are specified by energy density, moisture content, ash content, and granulometry. Each of these characteristics affects the wood fuel’s handling characteristics, storage requirements, and combustion process. Higher quality fuels have lower moisture, ash, dirt, and rock contents, consistent granulometry, and higher energy density. Different types of fuel quality can be used in wood heating projects as long as the infrastructure specifications match the fuel content characteristics. Typically, lower quality fuel will be the lowest cost fuel, but it will require more expensive storage, handling, and combustion infrastructure, as well as additional maintenance.

Projects in rural Alaska must be designed around the availability of wood fuels. Some fuels can be harvested and manufactured on site, such as cordwood, woodchips, and briquettes. Wood pellets can also be used, but typically require a larger scale pellet manufacturer to make them. The economic feasibility of manufacturing on site is determined by a financial assessment of the project. Typically, larger projects offer more flexibility in terms of owning and operating the wood harvesting and manufacturing equipment, such as a wood chipper, splitter, or equipment to haul wood out of forest, than smaller projects.
High Efficiency Wood Pellet Boilers

High efficiency pellet boilers are designed to burn wood pellets cleanly and efficiently. These boilers utilize pellet storage bins or silos that hold a large percentage of the building’s annual pellet supply. Augers or vacuums transfer pellets from the silos to a pellet hopper adjacent to the pellet boiler, where pellets can be fed into the boiler for burning. Pellets are automatically loaded into the pellet boiler and do not require manual loading such as in a Garn cordwood boiler. The pellet boilers typically have a 3 to 1 turn down ratio, which allows the firing rate to modulate from 100% down to 33% fire. This allows the boiler to properly match building heat demand, increasing boiler efficiency. The efficiencies of these boilers can range from 85% to 92% efficiency depending on firing rate.

High Efficiency Cordwood Boilers

High Efficiency Low Emission (HELE) cordwood boilers are designed to burn cordwood fuel cleanly and efficiently. The boilers use cordwood that is typically seasoned to 25% moisture content (MC) or less and meet the dimensions required for loading and firing. The amount of cordwood burned by the boiler will depend on the heat load profile of the building and the utilization of the fuel oil system as back up. Two HELE cordwood boiler suppliers include Garn (www.garn.com) and TarmUSA (www.woodboilers.com). Both of these suppliers have units operating in Alaska. TarmUSA has a number of residential units operating in Alaska and has models that range between 100,000 to 300,000 BTU/hr. Garn boilers, manufactured by Dectra Corporation, are used in Tanana, Kasilof, Dot Lake, Thorne Bay, Coffman Cove and other locations to heat homes, washaterias, schools, and community buildings.

The Garn boiler has a unique construction, which is basically a wood boiler housed in a large water tank. Garn boilers come in several sizes and are appropriate for facilities using 100,000 to 1,000,000 BTUs per hour. The jacket of water surrounding the fire box absorbs heat and is piped into buildings via a heat exchanger, and then transferred to an existing building heating system, in-floor radiant tubing, unit heaters, or baseboard heaters. In installations where the Garn boiler is in a detached building, there are additional heat exchangers, pumps and a glycol circulation loop that are necessary to transfer heat to the building while allowing for freeze protection. Radiant floor heating is the most efficient heating method when using wood boilers such as Garns, because they can operate using lower supply water temperatures compared to baseboards.

Garn boilers are approximately 87% efficient and store a large quantity of water. For example, the Garn WHS-2000 holds approximately 1,825 gallons of heated water. Garns also produce virtually no smoke when at full burn, because of a primary and secondary gasification (2,000 °F) burning process. Garns are manually stocked with cordwood and can be loaded multiple times a day during periods of high heating demand. Garns are simple to operate with only three moving parts: a handle, door and blower. Garns produce very little ash and require minimal maintenance. Removing ash and inspecting fans are typical maintenance requirements. Fans are used to produce a draft that increases combustion temperatures and boiler efficiency. In cold climates, Garns can be equipped with exterior insulated storage tanks for extra hot water circulating capacity. Most facilities using cordwood boilers keep existing oil-fired systems operational to provide heating backup during biomass boiler downtimes and to provide additional heat for peak heating demand periods.

Low Efficiency Cordwood Boilers

Outdoor boilers are categorized as low-efficiency, high emission (LEHE) systems. These boiler systems are not recommended as they produce significant emission issues and do not combust wood fuels efficiently.
or completely, resulting in significant energy waste and pollution. These systems require significantly more wood to be purchased, handled and combusted to heat a facility as compared to a HELE system. Additionally, several states have placed a moratorium on installing LEHE boilers because of air quality issues (Washington). These LEHE systems can have combustion efficiencies as low as 25% percent and produce more than nine times the emission rate of standard industrial boilers. In comparison, HELEs can operate around 87% efficiency.

**High Efficiency Wood Stoves**

Newer high efficiency wood stoves are available on the market that produce minimal smoke, minimal ash and require less firewood. New EPA-certified wood stoves produce significantly less smoke than older uncertified wood stoves. High efficiency wood stoves are easy to operate with minimal maintenance compared to other biomass systems. The Blaze King Classic high efficiency wood stove ([www.blazeking.com](http://www.blazeking.com)) is a recommended model, due to its built-in thermostats that monitor the heat output of the stove. This stove automatically adjusts the air required for combustion. This unique technology, combined with the efficiencies of a catalytic combustor with a built-in thermostat, provides the longest burn times of any wood stove. The Blaze King stove allows for optimal combustion and less frequent loading and firing times.

**Bulk Fuel Boilers**

Bulk fuel boilers usually burn wood chips, sawdust, bark or pellets and are designed around the wood resources that are available from the local forests or local industry. Several large facilities in Tok, Craig, and Delta Junction (Delta Greely High School) are using bulk fuel biomass systems. Tok uses a commercial grinder to process woodchips. The chips are then dumped into a bin and are carried by a conveyor belt to the boiler. The wood fuel comes from timber scraps, local sawmills and forest thinning projects. The Delta Greely High School has a woodchip bulk fuel boiler that heats the 77,000 square foot facility. The Delta Greely system, designed by Coffman engineers, includes a completely separate boiler building which includes a chip storage bunker and space for storage of tractor trailers full of chips (so handling of frozen chips could be avoided). Woodchips are stored in the concrete bunker and augers move the material on a conveyor belt to the boilers.

**Heat Pumps**

Heat pumps can be an energy-efficient alternative for heating buildings located in moderate heating climates. Electricity is used to drive a refrigeration cycle in the heat pump, which transfers heat from the outside air to the inside of the building. The Department of Energy is a great source for more information on heat pumps.


**Grants**

There are state, federal, and local grant opportunities for biomass work for feasibility studies, design and construction. If a project is pursued, a thorough search of websites and discussions with the AEA Biomass group is recommended to make sure no possible funding opportunities are missed. Below are some funding opportunities and existing past grants that have been awarded.
The U.S. Department of Agriculture Rural Development has over fifty financial assistance programs for a variety of rural applications. This includes energy efficiency and renewable energy programs.

http://www.rd.usda.gov/programs-services

The city of Nulato was awarded a $40,420 grant for engineering services for a wood energy project by the United States Department of Agriculture (USDA) and the United States Forest Service. Links regarding the award of the Woody Biomass Utilization Project recipients are shown below:


Delta Junction was awarded a grant for engineering from the Alaska Energy Authority from the Renewable Energy Fund for $831,203. This fund provides assistance to utilities, independent power producers, local governments, and tribal governments for feasibility studies, reconnaissance studies, energy resource monitoring, and work related to the design and construction of eligible facilities.

http://www.akenergyauthority.org/Programs/RenewableEnergyFund

The Alaska Wood Energy Development Task Group (AWEDTG) consists of a coalition of federal and state agencies and not-for-profit organizations that have signed a Memorandum of Understanding (MOU) to explore opportunities to increase the utilization of wood for energy and biofuels production in Alaska. A pre-feasibility study for Aleknagik was conducted in 2012 for the AWEDTG. The preliminary costs for the biomass system(s) are $346,257 for the city hall and health center system and $439,096 for the city hall, health center, and future washateria system.

http://www.akenergyauthority.org/Programs/AEEE/Biomass

The Emerging Energy Technology Fund grand program provides funds to eligible applicants for demonstrations projects of technologies that have a reasonable expectation to be commercially viable within five years and that are designed to: test emerging energy technologies or methods of conserving energy, improve an existing energy technology, or deploy an existing technology that has not previously been demonstrated in Alaska.

http://www.akenergyauthority.org/Programs/EETF1

The U.S. Forest Service also has grants available, such as the Wood Innovation Program. In 2018, there was $8 million of grant money available to communities to expand and accelerate wood products and wood energy markets.


Department of Energy (DOE) funding options can be accessed at these links:

https://www.energy.gov/energy-economy/funding-financing

https://www.energy.gov/eere/wipo/energy-efficiency-and-conservation-block-grant-program

https://www.energy.gov/eere/funding/apply-eere-funding-opportunities

https://archive.epa.gov/greenbuilding/web/html/funding.html#general
Also, the Alaska Housing Finance Corporation (AHFC) and DOE have revolving loan funds that can be used for energy improvements.


https://www.energy.gov/savings/energy-efficiency-revolving-loan-fund-program
Appendix A
Site Photos
Church Photos

1. North Elevation of Church
2. South Elevation of Church
3. East Elevation of Church
4. Church Fuel Storage
Church Photos

5. Church Boiler

6. Church Water Heater

Coffman Engineers, Inc.
<table>
<thead>
<tr>
<th></th>
<th>Church Photos</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>Church AHU-1</td>
</tr>
<tr>
<td>8.</td>
<td>AHU-1 Control</td>
</tr>
<tr>
<td>9.</td>
<td>Exhaust Fan</td>
</tr>
<tr>
<td>10.</td>
<td>Church Hydronic Pumps</td>
</tr>
<tr>
<td>11.</td>
<td>Church Heating Main</td>
</tr>
<tr>
<td>12.</td>
<td>Church Electrical Panels</td>
</tr>
</tbody>
</table>
### Church Photos

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Image of Church Electrical Panels" /></td>
<td>13. Church Electrical Panels</td>
</tr>
<tr>
<td><img src="image2.jpg" alt="Image of Church Electrical Service" /></td>
<td>14. Church Electrical Service</td>
</tr>
</tbody>
</table>
### School Photos

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="North Elevation of School" /></td>
<td><img src="image2.png" alt="South Elevation of School" /></td>
</tr>
<tr>
<td><img src="image3.png" alt="East Elevation of School" /></td>
<td><img src="image4.png" alt="West Elevation of Church and School" /></td>
</tr>
</tbody>
</table>
School Photos

19. School Boiler

20. School Water Heater

21. School AHU-1

22. School Air Compressor
<table>
<thead>
<tr>
<th>School Photos</th>
</tr>
</thead>
</table>

Coffman Engineers, Inc.
<table>
<thead>
<tr>
<th>School Photos</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="School Electrical Service" /></td>
</tr>
<tr>
<td>27. School Electrical Panels</td>
</tr>
</tbody>
</table>
Appendix B
Economic Analysis Spreadsheets
## Holy Name Health and School

### Project Capital Cost
- **($235,000)**

### Present Value of Project Benefits (20-year life)
- **$401,286**

### Present Value of Operating Costs (20-year life)
- **($241,511)**

### Benefit / Cost Ratio of Project (20-year life)
- **0.68**

### Net Present Value (20-year life)
- **($75,225)**

### Payback Period (Year Accumulated Cash Flow > Project Capital Cost)
- **>20 years**

### Discount Rate for Net Present Value Analysis
- **3%**

### Escalation Rates
- **Wood Fuel Escalation Rate**: 2%
- **Fossil Fuel Escalation Rate**: 5%
- **Electricity Escalation Rate**: 2%
- **O&M Escalation Rate**: 2%

### Existing Heating System Operating Costs
- **Existing Heating Oil Consumption**: 5,900 gal, $17,110
- **Fossil Fuel**: $2.90, 2%
- **Additional Electricity**: $0.10, 800 kWh
- **Operation and Maintenance Costs**: ($600)
- **Additional O&M Costs for first 2 years**: $0

### Biomass System Operating Costs
- **Wood Pellet Cost (Delivered)**: 38.0 tons, ($12,426)
- **Fossil Fuel**: $2.90, 2%
- **Additional Electricity**: $0.10, 800 kWh
- **Operation and Maintenance Costs**: ($600)
- **Additional O&M Costs for first 2 years**: $0

| Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year | Year |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| Existing Heating System Operating Costs | $17,110 | $17,966 | $18,864 | $19,807 | $20,797 | $21,837 | $22,929 | $24,075 | $25,279 | $26,543 | $27,870 | $29,264 | $30,727 | $32,263 | $33,877 | $35,570 | $37,349 | $39,216 | $41,177 | $43,236 | $45,422 | $47,743 | $50,197 |
| Biomass System Operating Costs | $12,426 | $12,675 | $12,928 | $13,187 | $13,450 | $13,719 | $13,994 | $14,274 | $14,559 | $14,850 | $15,147 | $15,450 | $15,759 | $16,074 | $16,396 | $16,724 | $17,058 | $17,399 | $17,747 | $18,102 | $18,462 | $18,832 | $19,214 |
| Annual Operating Cost Savings | $3,062 | $3,626 | $4,851 | $5,503 | $6,195 | $6,930 | $7,711 | $8,539 | $9,418 | $10,349 | $11,337 | $12,383 | $13,491 | $14,664 | $15,906 | $17,220 | $18,610 | $20,081 | $21,635 | $23,278 | $25,000 | $26,800 | $28,671 |
| Accumulated Cash Flow | $3,062 | $6,688 | $11,539 | $17,042 | $23,237 | $30,167 | $37,878 | $46,417 | $55,835 | $66,185 | $77,521 | $89,904 | $103,395 | $118,060 | $133,966 | $151,186 | $169,796 | $189,876 | $211,512 | $234,790 | $260,024 | $286,324 | $314,716 |

### Economic Analysis Results

| Description | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | Year 9 | Year 10 | Year 11 | Year 12 | Year 13 | Year 14 | Year 15 | Year 16 | Year 17 | Year 18 | Year 19 | Year 20 | Year 21 | Year 22 | Year 23 | Year 24 |
|-------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Total Heating Oil Consumption | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Existing Heating Oil Consumption | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biomass System Oil Consumption | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Heating Source Proportion | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Annual Energy Units | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Heating Source | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Gas | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Oil | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
Appendix C
AWEDTG Field Data Sheets
## APPLICANT:

<table>
<thead>
<tr>
<th>Eligibility:</th>
<th>□ Local government</th>
<th>□ State agency</th>
<th>□ Federal agency</th>
<th>□ School/School District</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ Federally Recognized Tribe</td>
<td>□ Regional ANCSA Corp.</td>
<td>□ Village ANCSA Corp.</td>
<td>□ Private Entity that can demonstrate a Public Benefit</td>
</tr>
<tr>
<td></td>
<td>□ Not-for-profit organization</td>
<td>□ Other (describe): Church</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contact Name:</th>
<th>Larry Jackson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mailing Address:</td>
<td>Holy Name Church</td>
</tr>
<tr>
<td></td>
<td>433 Jackson St.</td>
</tr>
<tr>
<td>City:</td>
<td>Ketchikan</td>
</tr>
<tr>
<td>State:</td>
<td>AK</td>
</tr>
<tr>
<td>Zip Code:</td>
<td>99901</td>
</tr>
<tr>
<td>Office phone:</td>
<td>(907) 907-225-2400</td>
</tr>
<tr>
<td>Cell phone:</td>
<td>( )</td>
</tr>
<tr>
<td>Fax:</td>
<td>(907) 247-0041</td>
</tr>
<tr>
<td>Email:</td>
<td>see below</td>
</tr>
</tbody>
</table>

### Facility Identification/Name:

**Holy Name School and Church**

<table>
<thead>
<tr>
<th>Facility Contact Person:</th>
<th>Larry Jackson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility Contact Telephone:</td>
<td>(907) 907-225-2400, (907) 617-4542</td>
</tr>
<tr>
<td>Facility Contact Email:</td>
<td><a href="mailto:Info@akforestenterprises.com">Info@akforestenterprises.com</a></td>
</tr>
</tbody>
</table>

### SCHOOL/FACILITY INFORMATION (complete separate Field Data Sheet for each building)

**SCHOOL FACILITY** (Name: ____________________________________________________________________________________ )

<table>
<thead>
<tr>
<th>School Type:</th>
<th>[ ] Pre-School</th>
<th>[ ] Elementary</th>
<th>[ ] Middle School</th>
<th>[ ] Junior High</th>
<th>[ ] High School</th>
<th>[ ] Campus</th>
<th>[ ] Student Housing</th>
<th>[ ] Pool</th>
<th>[ ] Gymnasium</th>
<th>[ ] Other (describe):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of facility (sq. ft. heated):</td>
<td>21,600</td>
<td>Year built/age:</td>
<td>1965</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of floors:</td>
<td>2</td>
<td>Year(s) renovated:</td>
<td>na</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bldgs.:</td>
<td>1</td>
<td>Next renovation:</td>
<td>unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># of Students:</td>
<td>75</td>
<td>Has an energy audit been conducted?:</td>
<td>no</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OTHER FACILITY** (Name: ____________________________________________________________________________________ )

<table>
<thead>
<tr>
<th>Type:</th>
<th>[ ] Health Clinic</th>
<th>[ ] Public Safety Bldg.</th>
<th>[ ] Water Plant</th>
<th>[ ] Washeteria</th>
<th>[ ] Multi-Purpose Bldg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[ ] Community Center</td>
<td>[ ] Public Housing</td>
<td>[ ] District Energy System</td>
<td>[ ] Church</td>
<td>[ ] Other (list):</td>
</tr>
<tr>
<td>Size of Facility (sq. ft. heated):</td>
<td>16,000 SF</td>
<td>Year built/age:</td>
<td>1985</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of floors:</td>
<td>2</td>
<td>Year(s) renovated:</td>
<td>na</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of bldgs.:</td>
<td>1</td>
<td>Next renovation:</td>
<td>unknown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of Usage:</td>
<td>Daily</td>
<td># of Occupants</td>
<td>200 Sunday, 10 weekdays</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has an energy audit been conducted?:</td>
<td>No</td>
<td>If Yes, when? *</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* If an Energy Audit has been conducted, please provide a copy.
### School

**HEATING SYSTEM INFORMATION**

#### CONFIGURATION (check all that apply)
- [ ] Heat plant in one location: [ ] on ground level  [ ] below ground level  [ ] mezzanine  [ ] roof  [ ] at least 1 exterior wall
- [ ] Different heating plants in different locations: How many? _______________ What level(s)? _________________________
- [ ] Individual room-by-room heating systems (space heaters)
- [ ] Is boiler room accessible to delivery trucks?  [ ] Yes  [ ] No

#### HEAT DELIVERY (check all that apply)
- [ ] Hot water:  [ ] baseboard  [ ] radiant heat floor  [ ] cabinet heaters  [ ] air handlers  [ ] radiators  [ ] other: _______________
- [ ] Steam: ____________________________________________________________________________________________________
- [ ] Forced/ducted air  Classroom Ventilation only
- [ ] Electric heat:  [ ] resistance  [ ] boiler  [ ] heat pump(s)
- [ ] Space heaters  Mostly baseboard, Unit heaters in Gym, convectors in Halls, AHU for Classroom ventilation

#### HEAT GENERATION (check all that apply)

<table>
<thead>
<tr>
<th>Heating System</th>
<th>Heating Capacity (Btuh / kWh)</th>
<th>Annual Fuel Consumption</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot water boiler:</td>
<td>1,000,000</td>
<td>4,800 gal/yr</td>
<td>$2.50/gal</td>
</tr>
<tr>
<td>Steam boiler:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm air furnace:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric resistance:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat pumps:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space heaters:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### TEMPERATURE CONTROLS (type of system; check all that apply)
- [ ] Thermostats on individual devices/appliances; no central control system
- [ ] Pneumatic control system  Manufacturer: __________________________  Approx. Age: 54
- [ ] Direct digital control system  Manufacturer: __________________________  Approx. Age: __________

**Pneumatic t-stats for classroom BB**

Record Name Plate data for boilers (use separate sheet if necessary):  See Photo

Progress Oil Boiler: 1,000,000 BTU/hr output. Manufactured in 1964.

Describe locations of different parts of the heating system and what building areas are served:

Boiler room on lower level, exterior wall. Piping is looped through three circuits to individual terminal units. AHU is for classroom ventilation only

Describe age and general condition of existing equipment:

Older equipment is operational but past its expected lifespan. Parts are hard to obtain for repairs

Who performs boiler maintenance?  Volunteer for routine work, local  P&H contractor for larger issues

Where is piping or ducting routed through the building?  (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):

Above false ceiling and though walls

Describe on-site fuel storage:  Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

Two 300-gallon tanks indoors, no spill containment, no nameplate. Good condition

If this fuel is also used for other purposes, please describe:  Fuel only used for oil boiler.
School

DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER

Check all that apply:

☐ Lavatories
☐ Kitchen
☐ Showers
☐ Laundry
☐ Water treatment
☐ Other: ________________________________

TYPE OF SYSTEM

Check all that apply:

☐ Direct-fired, single tank
☐ Direct fired, multiple tanks
☐ Indirect, using heating boiler with separate storage tank
☐ Hot water generator with separate storage tank
☐ Other: ________________________________

What fuels are used to generate hot water? (Check all that apply):

☐ natural gas  ☐ propane  ☐ electric  ☐ #1 fuel oil  ☐ #2 fuel oil

Describe location of water heater(s):

Located in boiler room

Amtrol indirect hot water heater. 41 gal.

Describe on-site fuel storage: number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

BUILDING ENVELOPE

Upper level stick frame, Lower level masonry where underground

Wall type (stick frame, masonry, SIP, etc.): Stick R-16

Insulation Value: Masonry R-10

Insulation Value:

Roof type: Wood truss with Batt Insulation

Insulation Value: R-24

Windows: ☐ single  ☐ double pane  ☐ other: ________________________________

Arc

Outside Air/Air Exchange: ☐ HRV  ☐ CO2 Sensor

ELECTRICAL

Utility company that serves the building or community: Ketchikan Public Utilities (KPU)

Type of grid: ☐ building stand-alone  ☐ village/community power  ☐ railbelt grid

Energy source: ☐ hydropower  ☐ diesel generator(s)  ☐ Other: ________________________________

Electricity rate per kWh: $0.0942  Demand charge: __________________

Electrical energy phase(s) available: ☐ single phase  ☐ 3-phase  3-phase is available but school is currently supplied with single phase 120/240v power

Back-up generator on site: ☐ Yes  ☐ No  If Yes, provide output capacity: __________________

Are there spare circuits in MDP and/or electrical panel?: ☐ Yes  ☐ No  Very limited

Record MDP and electrical panel name plate information: See photos

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $350/ton  Viable fuel source? Yes  No
- Wood chip cost delivered to facility $NA/ton  Viable fuel source? Yes  No
- Cord wood cost delivered to facility $NA/cord  Viable fuel source? Yes  No
- Distance to nearest wood pellet and wood chip suppliers? Prince Rupert, BC, Canada (same source as KTN Airport)
- Can logs or wood fuel be stockpiled on site or at a nearby facility? A pellet bin could be installed on site

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other:
FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)? Yes

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc.)? No

What are local soil conditions? Permafrost issues? Rocky

Is the building in proximity to other buildings with biomass potential? If so, Which ones and How close? School and church abut each other

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary? Where would addition go? There is room on site for a new boiler building. No room inside the facility for biomass boiler.

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from? KPU and city water/sewer are available in the adjacent street if the existing utility tie-ins don’t work for the new boiler building

If necessary, can piping be run underground from a central plant to the building? Where would piping enter boiler room? Piping could be trenched from a central boiler to the school. Piping would enter the boiler room at the exterior wall

OTHER INFORMATION

Provide any other information that will help describe the space heating and domestic hot water systems, such as

Is heat distribution system looping or branching? Two parallel loops with individual branches on each loop.

For baseboard hydronic heat, what is the diameter of the copper tubing? Size of fins? Number of fins per lineal foot?

Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source?

Any systems that could be added to the boiler system?

Are heating fuel records available?

Baseboards are 3/4” tube, 60 Fin/Ft with varying fin size. Most are 4”x4”

School has a small food warming kitchen with electric stove/range.

There are no other systems to add to the boiler, unless you can figure out how to get light from hot water......

Fuel records have been requested. (Anna Marie Mestas, Holy Parish Business Manager (907) 617-6212

PICTURE / VIDEO CHECKLIST

Exterior
Main entry
Building elevations
Several near boiler room and where potential addition/wood storage and/or exterior piping may enter the building
Access road to building and to boiler room
Power poles serving building
Electrical service entry
Emergency generator

Interior
Boilers, pumps, domestic water heaters, heat exchangers – all mechanical equipment in boiler room and in other parts of the building.
Boiler room piping at boiler and around boiler room
Piping around domestic water heater
MDP and/or electrical panels in or around boiler room
Pictures of available circuits in MDP or electrical panel (open door).
Picture of circuit card of electrical panel
Picture of equipment used to heat room in the building (i.e. baseboard fin tube, unit heaters, unit ventilators, air handler, fan coil)
Pictures of any other major mechanical equipment
Pictures of equipment using fuel not part of heating or domestic hot water system (kitchen equip., lab equip., pool, etc.)
Pictures of building plans (site plan, architectural floor plan, mechanical plan, boiler room plan, electrical power plan)
Church

HEATING SYSTEM INFORMATION

CONFIGURATION (check all that apply)
- ☑ Heat plant in one location: ☑ on ground level ☑ below ground level ☑ mezzanine ☑ roof ☑ at least 1 exterior wall
- ☐ Different heating plants in different locations: How many? _______________ What level(s)? _______________
- ☑ Individual room-by-room heating systems (space heaters)
- ☑ Is boiler room accessible to delivery trucks? ☑ Yes ☐ No

HEAT DELIVERY (check all that apply)
- ☑ Hot water: ☑ baseboard ☐ radiant heat floor ☐ cabinet heaters ☑ air handlers ☐ radiators ☐ other: _______________
- ☐ Steam: _______________________________________________________________________________________
- ☑ Forced/ducted air Kitchen Make up only
- ☐ Electric heat: ☐ resistance ☐ boiler ☐ heat pump(s)
- ☑ Space heaters Mostly Baseboard, convectors in halls, AHU for Kitchen Make up only

HEAT GENERATION (check all that apply)

<table>
<thead>
<tr>
<th></th>
<th>Heating capacity</th>
<th>Annual Fuel Consumption</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑ Hot water boiler:</td>
<td>☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☑ #2 fuel oil</td>
<td>625,000</td>
<td>3,700 gal</td>
</tr>
<tr>
<td>☐ Steam boiler:</td>
<td>☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☐ #2 fuel oil</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>☐ Warm air furnace:</td>
<td>☐ natural gas ☐ propane ☐ electric ☐ #1 fuel oil ☐ #2 fuel oil</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>☐ Electric resistance:</td>
<td>☐ baseboard ☐ duct coils</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>☐ Heat pumps:</td>
<td>☐ air source ☐ ground source ☐ sea water</td>
<td>__________</td>
<td>__________</td>
</tr>
<tr>
<td>☐ Space heaters:</td>
<td>☐ woodstove ☐ Toyo/Monitor ☐ other: _______________</td>
<td>__________</td>
<td>__________</td>
</tr>
</tbody>
</table>

TEMPERATURE CONTROLS (type of system; check all that apply)

- ☑ Thermostats on individual devices/appliances; no central control system except interlock on Kitchen AHU and Kitchen hood
- ☐ Pneumatic control system Manufacturer: __________________________ Approx. Age: __________
- ☐ Direct digital control system Manufacturer: __________________________ Approx. Age: __________

Record Name Plate data for boilers (use separate sheet if necessary): Weil Mclain Model BL-976-S-W, 624,000 BTU/hr

Describe locations of different parts of the heating system and what building areas are served:

Boiler room on lower level, exterior wall. Piping is looped through three circuits to individual terminal units. AHU is for Kitchen Make up only

Describe age and general condition of existing equipment:

Older equipment is operational but at its expected lifespan.

Who performs boiler maintenance? ☐ Volunteer for routine work, P&H __________ contractor for larger issues

Describe any current maintenance issues:

Where is piping or ducting routed through the building? (tunnels, utilidors, crawlspace, above false ceiling, attic, etc.):

Above false ceiling and through walls

Describe on-site fuel storage: Number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:

500 gallon tank outside boiler room, no spill containment, good condition

If this fuel is also used for other purposes, please describe: Fuel is only used for oil boiler.
DOMESTIC HOT WATER

USES OF DOMESTIC HOT WATER
Check all that apply:

☐ Lavatories
☐ Kitchen
☐ Showers
☐ Laundry
☐ Water treatment
☐ Other: ________________________________

TYPE OF SYSTEM
Check all that apply:

☐ Direct-fired, single tank
☐ Direct fired, multiple tanks
☐ Indirect, using heating boiler with separate storage tank
☐ Hot water generator with separate storage tank
☐ Other: ____________________________________________

What fuels are used to generate hot water? (Check all that apply):
☐ natural gas
☐ propane
☐ electric
☐ #1 fuel oil
☐ #2 fuel oil

Describe location of water heater(s):
WH-1 in boiler room, electric WH in store room by Kitchen, Electric WH in Jan closet by Rest rooms

Describe on-site fuel storage:
number of tanks, size of tanks, location(s) of tanks, condition, spill containment, etc.:
See boiler info

BUILDING ENVELOPE

Wall type (stick frame, masonry, SIP, etc.): ________________________________ Insulation Value: _______

Roof type: ________________________________ Insulation Value: _______

Windows:
☐ single pane
☐ double pane
☐ other: ________________________________

Arctic entry(s):
☐ none
☐ at main entrance only
☐ at multiple entrances
☐ at all entrances

Drawings available:
☐ architectural
☐ mechanical
☐ electrical

Outside Air/Air Exchange:
☐ HRV
☐ CO2 Sensor

ELECTRICAL

Utility company that serves the building or community: Ketchikan Public Utility (KPU)

Type of grid: ☐ building stand-alone ☐ village/community power ☐ railbelt grid

Energy source:
☐ hydropower
☐ diesel generator(s)
☐ Other: ________________________________

Electricity rate per kWh: $0.0942 Demand charge: ______________

Electrical energy phase(s) available:
☐ single phase
☐ 3-phase
3-phase is available but school is currently supplied with single phase 120/240v power

Back-up generator on site:
☐ Yes ☐ No If Yes, provide output capacity: ________________________________

Are there spare circuits in MDP and/or electrical panel?: ☐ Yes ☐ No Very Limited

Record MDP and electrical panel name plate information: See Photos

WOOD FUEL INFORMATION

- Wood pellet cost delivered to facility $350/ton Viable fuel source? Yes No
- Wood chip cost delivered to facility $NA/ton Viable fuel source? Yes No
- Cord wood cost delivered to facility $NA/cord Viable fuel source? Yes No
- Distance to nearest wood pellet and wood chip suppliers: Prince Rupert, BC, Canada, same as KTN airport
- Can logs or wood fuel be stockpiled on site or at a nearby facility? A pellet bin could be installed on site

Who manages local forests? Village Native Corp, Regional Native Corp, State of Alaska, Forest Service, BLM, USF&WS, Other:
FACILITY SITE CONSIDERATIONS

Is there good access to site for delivery vehicles (trucks, chip vans, etc)?  Yes

Are there any significant site constraints? (Playgrounds, other buildings, wetlands, underground utilities, etc)?  No

What are local soil conditions?  Permafrost issues?  Rocky

Is the building in proximity to other buildings with biomass potential?  If so, Which ones and How close?  School and church abut each other

Can building accommodate a biomass boiler inside, or would an addition for a new boiler be necessary?  Where would addition go?  There is room onsite for a new boiler building.  No room inside the facility for biomass boiler

Where would potential boiler plant or addition utilities (water/sewer/power/etc.) come from?  KPU and city water are available in the adjacent street if the existing utility tie-ins don't work for the new boiler building

If necessary, can piping be run underground from a central plant to the building?  Where would piping enter boiler room?  Piping could be trenched from a central boiler to the church.  Piping would enter the boiler room at the exterior wall.

OTHER INFORMATION

Provide any other information that will help describe the space heating and domestic hot water systems, such as

Is heat distribution system looping or branching?  Three parallel loops with individual branches on each loop

For baseboard hydronic heat, what is the diameter of the copper tubing?  Size of fins? Number of fins per lineal foot?  Any other energy using systems (kitchen equipment, lab equipment, pool etc)? Fuel or energy source?

Any systems that could be added to the boiler system?

Are heating fuel records available?  Baseboards are 3/4” tube, 60 Fin/Ft with varying fin size. Most are 4”x4”

Church has small commercial-style kitchen with propane stove/range. The commercial exhaust hoods are interlocked to a make up air AHU with HW preheat coils

There are no other systems that could be added to the boiler except converting the two small electric water heaters to indirect-fired HW generators

Fuel records have been requested, Anna Marie Mestas, Holy Name Parish Business Manager (907) 617-6212

PICTURE / VIDEO CHECKLIST

Exterior
Main entry
Building elevations
Several near boiler room and where potential addition/wood storage and/or exterior piping may enter the building
Access road to building and to boiler room
Power poles serving building
Electrical service entry
Emergency generator

Interior
Boilers, pumps, domestic water heaters, heat exchangers – all mechanical equipment in boiler room and in other parts of the building.
Boiler room piping at boiler and around boiler room
Piping around domestic water heater
MDP and/or electrical panels in or around boiler room
Pictures of available circuits in MDP or electrical panel (open door).
Picture of circuit card of electrical panel
Picture of equipment used to heat room in the building (i.e. baseboard fin tube, unit heaters, unit ventilators, air handler, fan coil)
Pictures of any other major mechanical equipment
Pictures of equipment using fuel not part of heating or domestic hot water system (kitchen equip., lab equip., pool, etc.)
Pictures of building plans (site plan, architectural floor plan, mechanical plan, boiler room plan, electrical power plan)