Emerging Energy Technology Grant

Emerging energy technology is a critical phase in the development process of energy technology, linking research and development to the commercialization of energy solutions. Although the Arctic possesses bountiful energy resources, the Arctic also faces unique conditions in terms of climate, environment, population density, energy costs, logistics, and the isolated nature of electrical generation and transmission systems. These conditions, challenging under the best of circumstances, making the Arctic an ideal test bed for energy technology. Emerging energy technology provides a unique opportunity to meet Arctic energy needs, develop energy resources, and create global expertise.

In 2009 the Denali Commission, an independent federal agency in Alaska, released a public solicitation entitled the Emerging Energy Technology Grant (EETG). The EETG targeted (1) research, development, or demonstration projects designed to (a) test new energy technologies or methods of conserving energy or (b) improve an existing energy technology; and (2) applied research projects that employ energy technology with a reasonable expectation that the technology will be commercially viable in Alaska in not more than five years.

The following are the 9 projects funded under this solicitation:

- Alaska SeaLife Center, Seawater Heat Pump Demonstration Project
- Cordova Electric Cooperative, Psychrophiles for Generating Heating Gas
- Kotzebue Electric Association, Feasibility of Solar Hot Water Systems
- ORPC Alaska, Nenana Hydrokinetic Turbine
- Sealaska Corporation, Commercial Scale Wood Pellet Boiler
- Kotzebue Electric Association, Flow Battery Energy Storage Systems
- Tanana Chiefs Conference, Organic Rankine Cycle Heat Recovery System
- University of Alaska, Fairbanks, High Penetration Hybrid Power System
- Kotzebue Electric Association, Wales Diesel-Off High Penetration Wind System

For further information, please visit the EETG program website:

http://energy-alaska.wikidot.com/emerging-energy-technology-grant

Sealaska Corporation

Sealaska Corporation is an Alaska Native corporation formed under the Alaska Native Claims Settlement Act (ANCSA) of 1971, a settlement of all aboriginal claims within the state of Alaska between Alaska Natives and the federal government. The aboriginal homelands of Sealaska’s shareholders are the forests and coastline of the Alaska panhandle, which extend from Yakutat on the north to the Queen Charlotte Islands of British Columbia on the south. Sealaska is the Regional Native Corporation for Southeast Alaska and has more than 17,600 shareholders, primarily of Tlingit, Haida and Tsimshian descent. Through its business ventures and investments, Sealaska provides economic, cultural and social benefits to current and future generations of shareholders.

About the Author

The Alaska Center for Energy and Power (ACEP) is an applied energy research group housed under the Institute of Northern Engineering at the University of Alaska Fairbanks. ACEP is serving as the program manager of the EETG program on behalf of the Denali Commission.

A key deliverable for each EETG project is a lessons learned report by ACEP. As the projects deal with emerging energy technology, providing lessons learned and recommendations is critical for understanding the future of the technology in Alaska, and the next steps needed in developing energy solutions for Alaska.

ACEP’s technical knowledge and objective academic management of the projects, specifically for data collection, analysis, and reporting, are vital components to the intent of the solicitation.
A Review of Commercial-Scale Wood Pellet Boilers in Southeast Alaska

A Project by the Sealaska Corporation

Report Overview

In 2010, the Sealaska Corporation (Sealaska), the regional native corporation for Southeast Alaska, converted the heating system of its headquarters in Juneau from an oil-fired boiler to a wood pellet-fired boiler. Wood pellet-fired boilers have been used effectively for over 30 years in many different countries and environments but have had limited application in Alaska, and no commercial-scale project had been installed yet. Sealaska’s overall project goal was to demonstrate that biomass heat can be feasible and is a cost-effective option for larger commercial, industrial and municipal buildings. This project also has the potential to influence the demand for a densified wood product made of Southeast Alaska’s waste wood fiber.

This demonstration was funded by the Denali Commission Emerging Energy Technology Grant (EETG) program and implemented by Sealaska. This report presents lessons learned based on the demonstration experience and presents broader recommendations for other commercial-scale biomass projects in Southeast Alaska as well as general research. This report will cover the following aspects of the Sealaska pellet boiler project:

• A technical review of the boiler, including its installation, operation, and performance
• A review of the Southeast Alaska pellet market
• The relevance of this project to other wood pellet projects and markets in Alaska

For comprehensive project information, data, and report appendices, please visit the EETG program website at:

http://energy-alaska.wikidot.com/emerging-energy-technology-grant

Technology Overview

In a conventional boiler system used for space heating, a fuel (e.g., heating oil) is combusted to heat up a heat transfer fluid (e.g., water) by means of a heat exchanger. The hot fluid is then plumbed throughout the conditioned space of the building, providing heat. A wood pellet-fired boiler works on the same principles as a conventional oil boiler, except the fuel being used to heat the fluid is wood pellets instead of heating oil.

Wood Pellets

Wood pellets are a densified wood product. Typically, to create a wood pellet, wood chips or sawdust is passed through a pulverizing system, dried, milled, and extruded. This results in a product that has a uniform size and low moisture content and when compared to cordwood, contains more energy per weight and provides a more efficient combustion (Figure 1). Pellets primarily come in three quality grades: utility, standard, and premium. The grade differences relate to the qual-
ity of the feedstock used and the resulting moisture and ash content. Premium pellets, for example, consist of less than 1% ash by weight, whereas utility grade pellets can consist of as much as 6% ash.

The uniform size of wood pellets is a critical aspect of the fuel's functionality. A uniform size allows for easier transportation and storage as well as automation of the boiler fuel supply system. This is of particular importance for commercial-scale pellet systems because a consistent pellet quality enables wood pellet boilers to provide the same competitive supply, operations, and maintenance characteristics as conventional oil boilers.

Pellets, because of the manufacturing process, generally have lower emissions per MMBtu$^{iv}$ than heating oil when advanced emissions control systems are installed.$^{v}$ Pellets, however, like heating oil, are subject to supply chain and logistical considerations (e.g., supply interruption and transportation costs). Moisture control must also be included in storage planning and design. The following is a summary of key fuel considerations with wood-pellet boilers compared to both traditional cordwood and heating oil boilers:

<table>
<thead>
<tr>
<th>Fuel Consideration</th>
<th>Wood Pellet Boiler</th>
<th>Cord Wood Boiler</th>
<th>Heating Oil Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Uniform pellet size allows for compact storage; pellets must be kept dry; containment and spill prevention not an issue</td>
<td>Needs a large storage area with simple moisture control, such as a roof, to keep wood dry; containment and spill prevention not an issue</td>
<td>Containment and spill prevention needed for storage; moisture control is needed although typically accounted for in fuel storage system</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>Low moisture content (&lt;10%), depending on pellet grade</td>
<td>Typically 6 months to 1 year to dry to &lt;25% moisture content, depending on wood species</td>
<td>Moisture can be present (e.g., through condensation); fuel filters may be installed</td>
</tr>
<tr>
<td>Emissions$^{iv}$</td>
<td>Generally lower emissions with an efficient, low emissions boiler</td>
<td>Generally higher emissions than pellets, though many new cordwood boilers have very low emissions when used correctly and with dry wood</td>
<td>Generally higher greenhouse gas emissions when burning diesel than burning wood</td>
</tr>
<tr>
<td>Feed</td>
<td>Automatic pellet feed system optional</td>
<td>Requires manual cutting and loading</td>
<td>Automatic fuel feed standard</td>
</tr>
<tr>
<td>Ash Content</td>
<td>0.5-6% ash content, depending on pellet grade</td>
<td>~1% ash content, depending on wood species</td>
<td>N/A</td>
</tr>
<tr>
<td>Supply Chain</td>
<td>Locally sourced product typically not available; subject to supply chain transportation costs and vulnerability</td>
<td>Locally sourced products typically available</td>
<td>Locally sourced product typically not available; subject to supply chain transportation costs and vulnerability</td>
</tr>
<tr>
<td>Delivery</td>
<td>Bulk delivery by specialized truck</td>
<td>Bulk delivery by truck</td>
<td>Bulk delivery by specialized truck</td>
</tr>
<tr>
<td>Energy Content$^{v}$</td>
<td>16,000,000 Btu/ton</td>
<td>14,000,000 Btu/ton$^{vi}$</td>
<td>134,000 Btu/gal</td>
</tr>
<tr>
<td>Cost per MMBtu$^{vii}$</td>
<td>$19$</td>
<td>$18$</td>
<td>$34$</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Removal of ash every 3 months; daily visual checks$^{viii}$</td>
<td>Removal of ash periodically; daily visual checks and daily wood loading and firings</td>
<td>Annual and periodic maintenance (system cleaning, nozzle and fuel filter replacement, etc.) and tuning (air flow adjustment, etc.)</td>
</tr>
<tr>
<td>Environmental Liability</td>
<td>Minimal spillage clean-up and effects on local environment</td>
<td>Minimal spillage clean-up and effects on local environment</td>
<td>Significant spillage clean-up and effects on environment</td>
</tr>
</tbody>
</table>

Table 1. Comparison of Fuel Considerations between Wood Pellet, Cordwood, and Heating Oil Boiler Systems
Viessmann PYROT Boiler

For this project, a Viessmann PYROT boiler was specified by Ventek Energy Systems, Inc. (Ventek), a bioenergy equipment and service provider based in British Columbia and the technical contractor for the project (Figure 2). The particular Viessmann Pyrot model for this project can produce 220 kW of heat (750,000 BTH), has a published efficiency rating of 85%, and will burn wood fuels that have less than 35% moisture content. The system uses a screw auger to automatically move wood pellets from a pellet silo to the firebox. Once the pellets are in the firebox, a moving grate transports the pellets through the combustion chamber and onto another grate that moves the remaining ash to an ash box. The heat that is produced from the combustion of the wood pellets is transferred to water through a heat exchanger found at the top of the combustion chamber. The water is plumbed to a hot water tank to provide a means of heat storage. Water from the hot water tank is then plumbed throughout the building to hydronic baseboard heaters that regulate the temperature of the rooms in the building.

Until 2009, commercial-scale wood pellet boilers such as the Viessmann system, widely used in Europe and Canada, had not been certified by the American Society of Mechanical Engineers and were not available in the U.S. Ventek was one of the first distributors of this technology to the U.S. and Alaska. Other boiler manufacturers, such as ACT Bioenergy, have since supplied systems to Alaska and are discussed below (see Review of Wood Pellets in Alaska).

Project Review

Sealaska Plaza, the headquarters for Sealaska, is a four-story office building located in Juneau. Prior to 2010, the main heating system was an oil-fired boiler system that used over 30,000 gallons of heating oil annually. Interest in a wood pellet boiler system retrofit stemmed from several factors, including the need for a major system upgrade/replacement due to operational life, the high cost of heating oil, and interest in developing sustainable economics for Southeast Alaska. Leadership for the project came from a Sealaska Board of Directors green initiative to introduce renewable energy into Sealaska and eliminate the use of imported fuel oil for heating.

The project was developed and managed by Haa Aani, LLC (Haa Aani), a subsidiary of Sealaska dedicated to improving the economic conditions in Southeast Alaska communities through innovation, sustainability, and collaboration. The primary goals of Haa Aani are to:

- Expand the regional economy
- Foster new and sustainable industries within rural communities

Sealaska and Haa Aani applied for funding through the Denali Commission EETG program for this project with the stated objectives to:

- Demonstrate that wood heat can be cost-effective and feasible for large commercial, industrial, and municipal buildings
- Investigate the potential creation of demand for Southeast Alaska second-growth wood fiber

The project was awarded $510,000 in funding through the EETG program, with an additional $790,000 contributed in Sealaska matching funds. Project construction was managed by Synergy Systems (Synergy), a subsidiary of Sealaska, while Ventek was the technical contractor and pellet system vendor.
Installation

Project activities formally commenced in February of 2010 with the finalization of system design and engineering plans and the ordering of equipment and supplies. Installation commenced in September 2010, with the removal of the old oil-fired boiler system and the pouring of concrete pads for the new boiler system. Originally, the oil-fired system was to remain as a backup or supplemental heating system. Given the Sealaska green initiative however, the oil-fired system was completely removed and a new electric heating system was installed as backup, resulting in a building that was completely powered by renewable energy. The new system was installed in the existing boiler room of Sealaska Plaza, which posed some typical design and installation challenges since the project needed to conform to the dimensions of the existing space and electrical, mechanical, and plumbing infrastructure. It was reported by Synergy that the installation was, however, "very easy and not unlike doing a conventional oil boiler replacement." Given the limitations of the existing space and the location of Sealaska Plaza in a downtown, urban environment, pellet storage was another critical consideration during the design and planning of the system. The resulting design was a pellet silo outside the building near the existing boiler room and adjacent to Main Street. The capacity of the 900 ft³ silo was 19 tons. The proximity to the street allowed for truck access and delivery while the proximity to the existing boiler room allowed for automated auger transport of pellets from the silo to the pellet boiler.

The system commenced operation

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Figure 3. System Cumulative Energy Output

Figure 4. System Average Daily Energy Production

Figure 5. System Energy Output per HDD
on November 23, 2010, and the electric boiler system was installed in December; system commissioning was finalized in January 2011.

**Operations**

For monitoring purposes, an independent energy meter was installed in the system to record the energy output of the boiler in gigajoules (GJ). Readings were recorded manually every few days from November 23, 2010 through November 16, 2011, the end of the monitoring period. Figure 3 is a summary of the cumulative energy produced by the system, with cumulative heating degree days (HDD) noted for reference.

Daily average energy production was calculated from these periodic energy readings. Figure 4 depicts the average daily energy output of the system, with average daily temperature noted for reference.

There are several notable trends depicted in Figures 3 and 4. In general, the trends of HDD and average daily temperature are as expected, with reduced HDD during the summer months (derived from the slope of the HDD line in Figure 3) and a general annual temperature trend corresponding to summer and winter months (depicted by an overlain polynomial trend line in Figure 4). One critical consideration for Ventek during system design was the annual average daily temperatures in Juneau, which are much colder than even locations such as Dawson, Yukon Territory. In fact, the highest average daily temperature noted in Figure 4 is 58°F. Utilizing HDD derived from a target building temperature of 65°F, every day is a heating day, so operationally, the Sealaska boiler runs year-round, whereas typical Viessmann installations shut down during the summer months.

The trend not expected is the increased heating production during the peak of summer. In particular, the highest daily energy production occurred on July 9. Figure 5 further highlights this trend, depicting higher system energy output per HDD during summer months when energy demand is the least (but still present).

This trend could be due to several factors, including anomalous events within the building or boiler control systems or systems operations (a boiler cleaning and service occurred, for example, on July 12). Further monitoring, with detailed system and operational monitoring during summer months, would be required to identify key drivers to this trend and to make recommendations for system optimization.

Another minor contributing factor could be boiler size, which is of particular importance in biomass systems. Fuel oil boilers are typically oversized to ensure that they can handle the coldest temperatures that may occur. Biomass boilers, in contrast, have a limited turndown capacity without losing efficiency. Nonetheless, summer operation of a biomass boiler, particularly in Southeast Alaska, is a critical consideration for system sizing and operational strategy. For example, it may be advantageous for Sealaska to operate the backup electric system during the times of low heat demand.

One unexpected issue discovered during operations was that in extremely high-wind events, the system had some backdraft issues that caused the boiler to go out. This was only in very rare, high-wind events and was eventually rectified with an adjustment of the exhaust stack. Other notable system events are listed in Table 2, some of which affect discrete points depicted in Figures 3-5.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 20-23, 2011</td>
<td>Boiler cleaning and service</td>
</tr>
<tr>
<td>February 27, 2011</td>
<td>High winds, boiler fire blown out, offline</td>
</tr>
<tr>
<td>February 28 - March 1, 2011</td>
<td>High winds, boiler fire blown out, offline</td>
</tr>
<tr>
<td>March 9 - 17, 2011</td>
<td>Boiler cleaning, service, and restart</td>
</tr>
<tr>
<td>July 12, 2011</td>
<td>Boiler cleaning and service</td>
</tr>
<tr>
<td>October 3, 2011</td>
<td>Full system cleaning for Rural Energy Conference</td>
</tr>
<tr>
<td>November 1 - 8, 2011</td>
<td>Boiler offline</td>
</tr>
</tbody>
</table>

**Maintenance**

Periodic cleaning of the system, noted in Table 2, involved shutting down the boiler for 24 hours to cool, removing ash from the combustion chamber, brushing the boiler tubes, emptying the extra ash bin in the firebox, and emptying the ash box of the flue gas filters. Sealaska reported that the process took approximately 1 hour and occurred every 2,000 hours of operating time. Originally, Sealaska estimated this to equate to two cleanings per year; however, operational experience has indicated that three cleanings are required per year (fall, mid-winter, and spring). Sealaska also reported that it used a contractor for these cleaning efforts, since Sealaska Plaza has no full-time facilities staff. This added significant cost to maintenance of the system that, given the
presence of facilities staff, could be taken care of in-house. In addition to these periodic cleanings, continuous cleaning of the system was required and involved twice-weekly duties such as tending the firebox (breaking up solidified ash and raking solids into the ash auger) and cleaning the glass inspection ports for proper operation of the laser level indicator. Sealaska reported that these duties were minimal, requiring 5 minutes total. In addition, the ash bin needed regular emptying. Sealaska noted that this was a minimal job; a large garbage bin was sufficient to contain ash from over three months of boiler use (Figure 6).

**Wood Pellet Delivery**

The wood pellets for the system were purchased from Oregon during the monitoring period. Pellets were shipped to Juneau by barge and transferred to an offsite “pellet bulker” that was used to load Sealaska’s pellet delivery truck. The truck then made regular deliveries to Sealaska’s exterior pellet silo. The cost of pellets was reported to be $300 per ton during the first year of operation. Figure 7 depicts pellet delivery during the monitoring period.

Sealaska noted that the inclusion of an instantaneous metering system in the delivery truck bed is something that would be a good addition to the delivery system since not all of the pellets were necessarily transferred to the delivery truck from the pellet bulker. During the monitoring period, the Sealaska pellet delivery truck would drive underneath the pellet bulker and the pellets would be released into the truck. With an unknown quantity being transferred, the truck had to be weighed on a permanent scale before and after every pellet transfer. An instantaneous metering system would be able to read the tonnage of transferred pellets and would reduce the extra work of truck weighing.

**Emissions Considerations**

Given the installation of the system in downtown Juneau, the issue of emissions (visible and non-visible) was carefully considered during project planning. In 2008, an ordinance was enacted by the City and Borough of Juneau regarding solid fuel emissions. Wood smoke emission standards for the City and Borough state that visible emissions must not reduce visibility through the exhaust effluent by 50% or more for longer than 15 minutes in any one-hour time period. This ordinance includes condensed water vapor in the visual emissions. With this in mind it is imperative that the Sealaska pellet boiler have minimal to no visual emissions.

In 2009, the City of Juneau set a goal of reducing greenhouse gas emissions by 21% by 2012. This goal was based on the Greenhouse Gas Inventory Report for 2007, which investigated carbon dioxide (CO2) concentrations in the Juneau area. In the report, the emissions from wood burning were estimated at 9,081 tons CO2, while petroleum fuels were estimated to total 399,303 tons (Table 3).

As mentioned above, the pelletizing process for premium grade pellets results in a product with moisture content around 5%. By displacing 30,000 gallons of diesel, the Viessmann Pyrot boiler reduces fossil fuel CO2 emissions at the Sealaska Plaza by 290 metric tons annually, with emission levels of carbon monoxide at less than 10 parts per million (ppm), nitrogen oxides at less than 75 ppm, and dust particles at less than .06 pounds per MMBtu. These levels are under current and future EPA emission guidelines.

**Figure 6. Ash Waste in a Wheeled Garbage Bin**

**Figure 7. Delivered Pellets**
A Review of Commercial-Scale Wood Pellet Boilers in Southeast Alaska

<table>
<thead>
<tr>
<th>Source</th>
<th>MMBtu</th>
<th>Percent MMBtu</th>
<th>CO2 (tonnes)</th>
<th>Percent CO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>1,236,029</td>
<td>17%</td>
<td>4,358</td>
<td>1%</td>
</tr>
<tr>
<td>Petroleum</td>
<td>5,822,076</td>
<td>81%</td>
<td>399,303</td>
<td>96%</td>
</tr>
<tr>
<td>Propane</td>
<td>63,800</td>
<td>1%</td>
<td>4,032</td>
<td>1%</td>
</tr>
<tr>
<td>Wood</td>
<td>90,276</td>
<td>1%</td>
<td>9,081</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>7,212,181</td>
<td>100%</td>
<td>416,775</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 3. Community Total Emissions and Energy, by Source

Additional flue filters were installed in the stack to remove any particulate matter from the gas prior to release into the atmosphere. These filters are not generally installed by Ventek on their boilers, but given the concern of emissions in Juneau, the downtown location of the system, and its association with a corporate headquarters, extra precautions were taken. This addition proved to be unnecessary — Sealaska reported that even without the additional filters, the emitted air contained very low pollutant concentrations. In addition, the flue filters were found to draw extra electricity for operation.

Economics

A preliminary cost analysis of benefits was performed for the Sealaska project based on 2011 data gathered by the Alaska Center for Energy and Power (ACEP) and the Institute for Social and Economic Research (ISER) to identify potential key cost drivers of a commercial-scale wood pellet boiler system. For detailed cost and assumption information, please see the original report.

The report, citing the Sealaska project as an example, notes that a primary economic barrier to using pellets in a commercial facility is the cost of switching over from an oil-fired boiler. The report shows that 98% of the initial Sealaska project cost (excluding pellet cost) was due to capital cost; the remaining 2% of the total initial project cost was due to general and administration (G&A) and operation and maintenance (O&M) costs. Forty-seven percent of the total capital cost was due to the high cost of the pellet boiler system and silo. The remaining 53% of capital cost was due to permitting and insurance, design and preconstruction activities, and the cost of converting the building to a biomass heating system. Figure 8 shows the breakdown of these initial project costs.

A projection of total cost for the project’s lifetime (assumed to be 20 years) shows a different picture. Pellet cost (44%) is almost equal to capital cost (45%) and is a large portion of the total cost. Labor and O&M costs equal 4% of the total cost, and administrative costs (mentioned as “other cost”) is 7% of the total cost. Figure 9 shows the breakdown of total cost over the lifetime of 20 years.
lifetime costs of the project.

Of note, the report found that the project only realized a positive benefit-cost ratio and a payback period of less than 20 years when assuming a scenario of high fuel (heating oil) price projections. The report also noted, however, that the Sealaska project was not designed strictly with a benefit-cost ratio or payback period in mind; it was a demonstration project also intended to fulfill Sealaska’s green initiative to replace fuel oil and fulfill a larger vision of using locally available wood waste to spur pellet production in Southeast Alaska. In the case of the Sealaska project, additional capital costs were incurred because of the facility’s location in downtown Juneau and its role as a corporate headquarters. System elements such as the flue filter system, a custom silo, and high-quality system components reflect this reality. Similar projects in other commercial buildings may have more favorable economics, especially if initial capital costs are reduced and pellet costs can be reduced either up front or over time, a function of overall market growth in the region.

Review of Wood Pellets in Alaska

Projects

The Sealaska pellet boiler was the first of its kind to be installed in Alaska. Since its installation, many other communities in Alaska have investigated or installed commercial-scale pellet boilers. The largest installations include the Coast Guard base in Sitka and the federal building and public library in Ketchikan. The following is an overview of these relevant projects.

Sitka

In 2011, a commercial-scale pellet boiler system from ACT Bioenergy was installed at the U.S. Coast Guard Station in Sitka. The station had been burning about 89,000 gallons of fuel oil annually at a cost of more than $4 per gallon of diesel, so the choice to move to pellets was economic. The ACT pellet boilers installed include the 1.7 MMBtu, 1.5 MMBtu, and 0.5 MMBtu models. Together they use an average of 1,000 tons of pellets per year, offsetting the 89,000 gallons of fuel oil. Pellets are imported from British Columbia at a rate of $338 per ton. It is estimated that the new pellet boiler system saves $100,000 per year with a payback period of about 5 years.

In 2012, an incident occurred during boiler startup and commissioning where one of the pellet boilers failed due to a fuel feed and ignition malfunction; this resulted in an explosion in the combustion chamber which damaged the boiler. This incident is currently receiving thorough investigation in order to fully understand the causes and ensure that proper, corrective measures are taken. This incident was unique and did not halt any other pellet boiler projects in Southeast Alaska, and projects will likely learn from the incident.

Ketchikan

The Ketchikan Public Library was built with a pellet boiler incorporated into the design. It opened its doors in January 2012 with a new ACT pellet boiler in the basement. The total cost of the project was around $413,000. The library has used 20 tons of pellets since the boiler started operating and sources these pellets from a new pellet mill, Tongass Forest Enterprises, in Ketchikan. Of note, the heating system for the library has run mainly on electricity since November 2012 because of issues with the pellet feed system.

The system has experienced issues with pellet storage and the boiler feeding system. The library opted for a concrete bunker pellet storage facility in the basement, which includes a 40-ton pellet storage bin, instead of an outdoor pellet silo; the decision for the underground system was made for aesthetic reasons. There was an issue with the feed auger where the auger angle was too steep and created disruptions with the delivery of pellets to the system. A modification of the angle has solved this problem. It was reported that the locally produced pellets (not a premium-quality pellet) appeared to breakdown in storage, jamming the auger. It was also noted, however, that the pellets in the storage bin were previously removed for the auger repair and were exposed to humidity. The outside humidity coupled with additional handling may have been the cause for pellet breakdown.

It has not been determined if moisture has been able to enter the concrete pellet storage bunker, and the local pellet mill is currently working to develop a premium-quality pellet.

The Ketchikan Federal Building, the first U.S. Government Services Administration (GSA) building in the country to use biomass heating, also recently installed an ACT pellet boiler. The boiler was part of a $5 million project undertaken by the GSA through the American Recovery and Reinvestment Act to upgrade an old, inefficient oil-fired steam heating system with a pellet-fired hydronic heating system. The old boiler remains in place and is running approximately 40% of the time, while the new boiler, still in a trial mode, runs at 60%. During this first year, the boiler upgrade offset around 4,000 gallons of the facility’s 9,000-12,000 gallon annual diesel usage with 90 tons of pellets. Maintenance on the boiler system is completed in-house; it generally takes
a weekend to shut down and cool the boiler and half a day to clean the boiler. Maintenance is performed approximately every six weeks. xlviii

The federal building’s pellet storage is an outdoor silo. During the summer of 2012, the silo was filled with the maximum 23 tons of pellets; it was noted at the end of the summer that there was very little moisture build-up in the silo, even in Ketchikan’s high-humidity climate. The pellets for the Federal Building were initially purchased through Sealaska, but a new contract is currently being negotiated through the GSA’s fuel contractor. The boiler has not been operational since December 2012 due to ongoing negotiations. xxxix

In 2012, the Tongass National Forest installed a wood fuel boiler in the Southeast Alaska Discovery Center as part of a federal mandate to reduce energy use by 30% by 2015. The Discovery Center system uses ½ ton of locally produced wood chips per day, with a fuel saving of up to 12,000 gallons of diesel per year.xl

Haines

In November 2012, an OkoFEN 32Kw boiler was installed in the Haines Senior Center, replacing an oil-fired boiler. It is reported that the pellet boiler has worked flawlessly since the installation on November 16, 2012. The switch to wood pellets has displaced an estimated 1,500 gallons of heating oil, removed the liability of onsite oil storage tanks, reduced net carbon emissions and saved the Haines Borough an estimated $2,000 in the first year of operation. Pellets were purchased from Sealaska Corporation at a delivered cost of $420/ton, and an estimated 5.5 tons have been used at a rate of 0.0369 tons/day. Using a heating oil inflation rate of 6% and pellet price inflation rate of 3% the Haines Borough expects to save a minimum of $100,000 over the 20 year lifespan of the boiler. They have also found the maintenance costs to be equal to the costs of maintaining an oil boiler. Overall this project has proven to the Haines Borough that the technology exists to have a fully automated, cost saving wood pellet system that requires no additional manpower to run. They are subsequently looking to switch more of their buildings to pellets in the near future.xl

Kodiak

The U.S. Coast Guard Station in Kodiak is initiating an energy savings performance initiative to convert their central steam plant to biomass energy. This process would use a Department of Energy (DOE) Energy Service Contract to design, finance and install a functioning biomass system; the cost of the project would be paid for by the resulting savings. Currently, the steam engine burns around 1.3 million gallons of diesel annually. Feasibility assessments were conducted, and instead of pellets, the system may use woodchips since they were found to be less expensive than pellets on a per-Btu basis (see discussion on woodchips versus pellets in Findings). The project has not been authorized, but planning is underway. xliii

Markets

Interior

Superior Pellet Fuels, located in North Pole, is the first large-scale pellet mill in Alaska. It has been in operation since 2010 and currently runs at one-fifth capacity, manufacturing 6,000 tons of pellets annually. Superior Pellet Fuels supplies a growing market in the region. The pellets are sold to consumers in a 150-mile radius from the plant (primarily Fairbanks) at around $275 per ton delivered, and the pellets are reported to show a 41% cost savings over diesel fuel at $4.11 per gallon.xlv

There are currently around 12 customers who use the pellet mill’s bulk delivery service, including churches, commercial buildings, and schools.xlv Superior Pellet Fuels offers a program that assumes upfront costs to replace a customer’s old fuel oil system with a complete pellet system and take the savings as the repayment. As of May 2013, there has been limited interest in this program, possibly because as Superior Pellet Fuels is still a fairly new company. In addition, pellets are available in local retail stores (Walmart, Home Depot, etc.); the store pellets are sourced from outside Alaska but come in at a lower cost because of the shipping costs associated with economy of scale ($260 per ton in 40-lb. bags in 2013).

During the past 5 years, the mill has operated whenever the weather and supply allowed. A recent wind incident affected a 30,000-acre forested area by causing significant blowdown. Three thousand acres of that land is easily accessible by Logging and Milling Associates, a local company located in Delta Junction, which has been harvesting and delivering wood to Superior Pellet Fuel, 40 tons at a time. With increased wood delivery and demand for pellets, the mill plans to increase production from 120 tons per week to 450–500 tons per week. The increased production will last while the increased feedstock is available, which may be many years.

Southeast

Prior to the Sealaska project in Juneau, no local pellet mill existed in Southeast Alaska. One of the project’s goals was
to spur a pellet industry in Southeast. Since the installation of the Sealaska pellet boiler, most communities in Southeast Alaska have experienced some level of pellet usage, and one pellet mill (Tongass Forest Enterprises) has started. Communities such as Sitka and Ketchikan have installed commercial-scale pellet boilers, and throughout Southeast, including Haines and Thorne Bay, many homes have small pellet boilers for home space heating. Sealaska’s leadership in moving to pellets was a key motivator for those communities that needed to see in order to believe that pellets could replace diesel.

Ketchikan’s Tongass Forest Enterprises was the first company in the area to produce pellets. It began production in response to the installation of pellet boiler systems by Sealaska and the Ketchikan Southeast Discovery Center and Federal Building. It has been in operation since 2011 and currently runs at one-tenth capacity, manufacturing 150 tons of pellets annually. The pellets are produced from sawdust and wood shavings from the Tongass Forest Enterprises furniture manufacturing business and whole log production business; previously, the material was usually burned for disposal.

Most customers are seeking premium-quality pellets, which require a dry feedstock and very controlled conditions to produce, and Tongass Forest Enterprises is working to increase the quality of its pellets. To help increase pellet quality, a wood dryer was installed to reduce the moisture content before pellet production. One of the biggest issues for this company was a delivery mechanism, and an old grain delivery truck with an auger was purchased from the Midwest. This resolved a local delivery issue and pellets are currently delivered at a cost of $300 per ton, but with increased production, the price could drop to $275, or even $250, per ton. Of note, a key project aspiration for Tongass Forest Enterprises was finding a local use for its waste; project success will be measured mainly on whether or not the company can cover investment and operational costs by using its waste stream to make pellets.

With an increased demand for pellets, there may be an increase in pellet supply in the Southeast, especially if lumber and furniture mills can see a profitable or break-even use for their waste streams. However, with low-cost, high-quality pellets coming from other sources such as British Columbia, or Washington State, it may not be economical to produce pellets locally.

Sealaska has had success in procuring a steady supply of premium pellets from the Pacific Northwest, and it will continue to act as a vendor to supply Southeast with pellets to supplement local pellet production.

Report Finding

As a demonstration of wood pellet boiler technology, the Sealaska project in Juneau has been very successful. Since operations commenced in November 2010, Sealaska has held a number of public and private tours of the system and has given many public presentations discussing its experience in designing and operating the system. As learned through interviews conducted in support of this report, the success of the project can be directly attributed to the implementation of several commercial-scale wood pellet businesses in Southeast Alaska. As a result of the Sealaska demonstration project, many other communities have decided to move from fuel oil to wood pellets. Sealaska has been available for feedback and assistance in the review process for designing, constructing and managing boiler systems in other community buildings.

Project data reflects unexpected system performance during peak ambient (summer) temperatures, which warrants further investigation by system operators. As outlined in the performance review above, appropriate sizing of a wood pellet system is of particular importance in Southeast Alaska and requires further detailed data collection and analysis to inform future system sizing and optimization. In addition, the economics of a project outside the context of a demonstration project still need to be proved. A reduction in project capital costs is critical, as is reducing the cost of wood pellets, which, presumably, can only be addressed through an increase in regional wood pellet demand. Sealaska has had success in procuring a steady supply of premium pellets from the Pacific Northwest, and it will continue to act as a vendor to supply Southeast with pellets and supplement local production from mills such as Tongass Forest Enterprises.

It has been reported that since the Sealaska project, a flood of new boilers have come onto the North American market, primarily from established European companies. Price competition is evident in this growing arena, and may be reflected in a drop in project capital costs. In addition, it has been reported that there may be a significant trend in pellet price reduction for the Pacific Northwest, although the price impact for Juneau and other Southeast Alaska communities is unknown at this time.

The following is a summary of additional findings and lessons learned from this analysis or otherwise gathered during reporting.

- Premium pellets are more expensive than lower-quality pellets, but have less ash content; the wood material, as well as the manufacturing process, accounts
for the difference between premium quality and lower-quality pellets. Superior Pellet Fuels in Fairbanks actually discontinued a previously manufactured standard-quality pellet since the pellets failed to reach the higher standards that the market requires. They do not plan to make any pellet lower than premium quality. In addition, Tongess Forest Enterprises in Ketchikan is currently working to develop a premium-quality pellet.

- A high-quality pellet will likely be more durable during shipping and will be less likely to create sawdust than a lower-quality pellet. Silos with less than premium-quality pellets are advised to draw down the supply at least once a year to remove sawdust. Sealaska found that its supply of Pacific Northwest pellets rarely produced sawdust and drawdown was not necessary.

- Wood pellets have much lower emissions than cordwood, depending on the boiler system design. Even so, Sealaska was very concerned about its position in downtown Juneau and its role as a showcase for pellet use. In order to ensure that its boiler had minimal emissions, Sealaska installed additional flue filters. This additional equipment was costly and it also uses additional electricity.

- Biomass boilers require considerable expertise in their design, selection, and installation. The same practices used for fossil fuel boilers may not be applicable with biomass boilers. Thus it is essential to bring in a team of professionals with strong biomass boiler experience to help ensure that the system installed has the fewest number of ‘teething pains’ possible. In addition, availability beyond the installation and commissioning of the system.

- Pellet production is reliant on the availability of feedstock and market demand, and unlike fuel oil distribution, it may not be consistently reliable. There are only 140 pellet mills across the United States and many of those are small manufacturers. The first main pellet supplier to Sealaska won an account for a large retail store, and it no longer wanted to ship smaller amounts to Alaska. Finding a reliable vendor of high-quality pellets is essential if a large-scale pellet boiler is to be installed.

- Some pellet boiler systems can burn both pellets and woodchips. In some situations, it may make more sense economically and practically to use locally available woodchips. One drawback to woodchips is that they are not as consistently sized as pellets, and they may also contain more moisture. But the delivered cost of premium pellets is much higher than that of woodchips. The delivered cost of pellets is between $275 and $350 per ton (or $24 per MMBtu), and the delivered cost of wood chips starts at around $30 per ton (or $10 per MMBtu)\(\text{\textsuperscript{xix}}\). Again, the efficiency may be decreased by the moisture, but it is a consideration for communities that do not have a local pellet mill or access to a pellet vendor such as Sealaska.

- The Ketchikan Library has had some issues with its pellet boiler, which may be in part because of lower-quality pellets and possibly moisture affecting the pellets in storage. One possible solution for the library is to use woodchips to fire the boiler instead of pellets. The installed boiler, as some other commercial-scale boilers, can burn either pellets or woodchips, and woodchips could prove to be easier to manage, especially if moisture is an issue. A small change on the control panel settings can be made in order to change the feedstock to woodchips.\(^1\)

- One of the design lessons with the Sealaska pellet boiler was fitting a new boiler system into an existing building. Industrial-sized boilers are generally installed as part of a new building project, and the building designs can be adjusted to account for the boiler size and piping. The boilers can be fit into existing space, although this can be a challenge when working around the boiler and when adequate space is needed for safety.

References and Notes


2. MMBtu represents 1 million British thermal units (Btu).

3. A comparison of emissions is inherently difficult and subject to many factors, including life-cycle assumptions. CO\(_2\) emissions of wood pellets, for example, are a lot higher if just looking at the combustion of pellets versus the full carbon life cycle of pellets.

4. Ibid.

5. For more information on energy content of wood pellets, cordwood, and heating oil, please see the following links: [www.alaskawood-heating.com/energy_content.php](http://www.alaskawood-heating.com/energy_content.php) and [http://extension.oregonstate.edu/lincoln/sites/default/files/home_heating_fuels_ec1628-e.pdf](http://extension.oregonstate.edu/lincoln/sites/default/files/home_heating_fuels_ec1628-e.pdf)

6. Energy content of cordwood is dependent on many factors, in particular moisture content. This number reflects air-seasoned wood (an average of several common species) with 20% moisture content.

7. Costs per MMBtu estimated for Southeast Alaska. Pellet cost estimated at $300 per ton (the price realized by the U.S. Coast Guard station in Sitka), cord wood estimated at $250 from Juneau market research, and heating oil estimated at $4.62/gal.

8. Information from Nathan Soboleff, former project manager and employee of Sealaska Corporation.

9. For more information, please visit [www.ventekenergy.com](http://www.ventekenergy.com).
pellets from the supplier has gone up 2%, as have shipping costs. Sealaska reports that since the first year of operation, the cost of woodchips has increased by 20%.

Pellets were sourced from Oregon through 2011 and are now sourced from British Columbia. Sealaska reports that since the first year of operation, the cost of woodchips has increased by 20%.

Sealaska reports that since the first year of operation, the cost of woodchips has increased by 20%. The average annual fuel usage between 2005 and 2009 was 30,536 gallons.

Electricity in Juneau is typically generated by hydroelectricity. With the installation of a backup supplemental electric heating system, the building is powered by renewable energy regardless of the operational status or contribution level of the pellet boiler.

The energy meter recorded the difference in energy leaving from and returning to the boiler. This energy, expressed here in GJ, may not be the actual energy delivered to conditioned space. The energy meter was not incorporated into the existing controls system.

HDD is a measurement designed to represent building heat demand. To calculate HDD, daily high and low temperatures are averaged and expressed in terms of a 65°F base temperature. The summation of all the days is the total annual HDD.

For more information, please visit www.sealaska.com/page/hao-aani-llic.html

$790,000 was the required reported match for the project. Any additional match did not have a reporting requirement.

For more information, please visit www.degreedays.com.

The average annual fuel usage between 2005 and 2009 was 30,536 gallons. CO2 Emission Factor (Coefficient): 73.15 kg CO2/MMBtu; data is from U.S. Energy Information Administration.


Information from Robert Deering, U.S. Coast Guard Sitka, December 2012.

For more information, please visit www.okforestenterprises.com

Information from Ketchikan Public Library Librarian in a telephone conversation, April, 2013.

Information from David Dungate, President of ACT Bioenergy.

Information from Tongass Forest Products.

The GSA has commissioned a comprehensive boiler performance study to be conducted by the National Renewable Energy Laboratory. The study is expected to be available by 2014.

Information from Ron Balzer, General Services Employee at Ketchikan Federal Building, April 2013.

Ibid.

Email communication with Darsie Culbeck from the Borough of Haines Sept. 9, 2013.

Email communication from Robert Deering, April 2013

Superior Pellet Fuels produces three pellet qualities. Details in this report are on their premium pellet product. Pellet quality is generally measured by ash content. A premium pellet generally has a between 0.5 and 1% ash per weight, standard quality has <2% ash, and utility has <6% ash (www.woodpellets.com/preface-of-pellet-fuels.pdf).

Information from Chad Schumacher, Superior Pellet Fuels General Manager, April 2013

Superior Pellet Fuel uses a 16-ton capacity delivery truck that is very similar to Sealaska’s 12-ton capacity truck in design.


Information from Larry Jackson, Tongass Forest Enterprises Plant Manager.

Information from Robert Deering, September 2013.


For comparative purposes, Craig School on Prince of Wales Island has a chip-fed boiler and its delivered cost of woodchips is $30 per ton. Information from Brian Templin, boiler manager at Craig School, September 2012.