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Case Study Comparison of Two Pellet Heating Facilities in Southeastern Alaska

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Abstract

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Over the past decade, wood-energy use in Alaska has grown dramatically. Since 2000, several dozen new wood-energy installations have been established, with numerous others in the design or construction phase. This case study report compares two wood-pellet heating systems in Juneau, Alaska. The Tlingit-Haida Regional Housing Authority, a native housing authority that serves more than 27,000 tribal residents in 11 communities in the southeast, recently established a wood-pellet boiler to provide heating to their 10,000-square-foot warehouse. The Sealaska Corporation is an Alaska Native Corporation that recently installed a wood-pellet system to heat its 58,000-square-foot office building in downtown Juneau. In this case study, we consider the ongoing efforts of both organizations to advance wood energy in southeast Alaska. We review the wood energy conversion process—including the motivation for change, feasibility work, construction, system operation, and lessons learned.

Keywords: Wood energy, pellets, Alaska, rural, community, Tlingit-Haida Regional Housing Authority, Sealaska Corporation, Alaska Native Corporations.

Contents

Introduction

Over the past decade, wood-energy use in Alaska has grown dramatically. Confronted by high fuel costs, many communities in rural Alaska have committed to renewable energy. Since 2000, several dozen new commercial-scale wood-energy systems have been installed in schools, government buildings, and other facilities (table 1) in various locations throughout Alaska ranging from Craig in the southeast to areas north of Fairbanks in the interior. This growth has been facilitated in part by numerous feasibility studies that outlined the economic, environmental, and social importance of community-scale wood energy. Several other important drivers have helped spur this growth, serving as catalysts for wood-energy development in Alaska. Among these are financial support from the Alaska Energy Authority, professional support from numerous partners and government agencies, and prefeasibility study reviews

Table 1—Wood energy systems in Alaska, both operating and under construction, as of July 2014

Location	Host site	Number of systems	Wood-fuel type	System selected
Coffman Cove	School	1	Cordwood	GARN system
Craig	School and swimming pool	1	Sawmill residues	Chiptec chip system
Delta Junction	School	1	Sawmill residues	Messersmith chip system
Elim	Water plant	1	Cordwood	GARN PAK model 2200 system
Fort Yukon	University of Alaska at Fairbanks	1	Cordwood	Tarm system
Galena	Senior center	3	Cordwood	Tarm Innova Solo 50 system
Gulkana	Village council	2	Cordwood and pellets	GARN cordwood and Tarm pellet systems
Haines	Chilkoot Indian Association	2	Pellets	Pellergy system
Haines	Senior center	1	Pellets	Okafen boiler
Ionia	Ionia, Inc.	1	Cordwood	GARN system
Juneau	Tlingit-Haida Regional Housing Authority	1	Pellets	Maine Energy Systems
Juneau	Sealaska Plaza	1	Pellets	KÖB pellet boiler
Ketchikan	U.S. Forest Service discovery center	1	Pellets and chips	Hurst boiler
Kasaan	School	1	Cordwood	GARN system
Ketchikan	Federal building	1	Pellets	ACT Bioenergy system
Ketchikan	Public library	1	Pellets	ACT Bioenergy system
Kokhanok	Lake and Pen Borough	1	Cordwood	GARN system
Tanana	Washeteria	3	Cordwood	GARN/Econoburn systems
Tetlin	School	3	Cordwood	Tarm Innova Solo system
Yakutat	Tlingit-Haida Regional Housing Authority	1	Cordwood	WoodMaster/Woodgun

by the Alaska Wood Energy Development Task Group during the initial phases of wood-energy planning.

Most of the systems have been thermal, providing heat to schools, wood-products facilities, federal buildings, libraries, senior centers, and other community buildings. However, at least one facility (the school district in Tok) has installed a cogeneration system that supplies both heat and electricity.

The employment benefits of wood energy in Alaska, although modest statewide, can be significant at local levels. For example, several communities require part- or full-time labor to monitor and perform routine maintenance, and in some instances, "stoke" their systems. Other communities experience increased employment in logging, transportation, and manual splitting of cordwood. Concurrent with the trend of community-scale wood energy has been an increased use of wood for heating residential units. An estimated 6 percent of households are heated with wood (U.S. Census Bureau 2013)—historically, more often cordwood than pellets (Nicholls et al. 2010)—with usage likely highest in the southeast.

Across Alaska, wood-energy use is increasing for both residential heating and small industrial-scale operations, and pellet systems have recently begun to contribute to that growth. Much of this motivation has stemmed from very high energy prices for heating homes and other community buildings—and this is particularly apparent in rural Alaska. After more than a decade of growth and learning, wood-energy use in Alaska is now entering a "second generation," and with it comes a strong need to summarize the success stories and lessons learned from the early adopters.

Growth in wood-energy use has been aided by funding from the state of Alaska's renewable energy fund, which has provided millions of dollars to develop an array of renewable-energy projects. However, state funding is currently (2015) uncertain on many fronts. Ultimately, the hope is that wood-energy projects that once required subsidies will become economically attractive on their own financial merits without the need for subsidies. The experiences, trials, and successes of Alaska's current wood-energy systems will help this development path.

Both of the wood-pellet systems reviewed in this case study could be considered as early adopters; however they differ widely in their system designs and heating needs. This case study considers both systems—evaluating motivations for wood energy, project development, and system operation—with the goal of benefiting future communities who are adopting similar installations. Thus, a primary objective of this paper is to provide valuable information as part of the "learning curve," and to help inform future wood-energy adopters. We do this by evaluating operational data for each system, as well as conducting an economic analysis of the potential cost savings.

Case Study 1: Tlingit-Haida Regional Housing Authority Warehouse (Juneau, Alaska)

Background

The Tlingit-Haida Regional Housing Authority, headquartered in Juneau, was established by the Central Council of the Tlingit-Haida Indian Tribes of Alaska in 1973 to serve nearly 29,000 members in southeastern Alaska (CCTHITA 2014). Its programs include funding for home ownership, rental-unit leasing, house repairs, weatherization services, assistance for elders, and youth programs (THRHA 2014). Pursuing renewable-energy projects is consistent with its mission of helping members become self-sufficient and empowering the communities it serves to manage local resources sustainably and create new jobs.

Motivation for Wood Energy

Several factors have stimulated efforts by the Tlingit-Haida Regional Housing Authority to increase use of wood energy. One of the primary motivations has been the high cost of fuel (primarily heating oil) in the villages it serves. Many of these communities experience heating-oil prices that are often high or widely variable (or both). Use of wood energy would not only help lower fuel prices through use of biomass in place of more expensive fossil fuels, but would also boost employment in underserved communities and retain money in those local economies. The Housing Authority was able to benefit from synergies created with Sealaska Corpo-

Tlingit-Haida Regional Housing Authority

Figure 1—At the Tlingit-Haida Regional Housing Authority, a primary motivation for using wood energy has been the high cost of fuel (primarily heating oil) in the rental units it manages and the villages it serves. Many of these communities experience heating-oil prices that are often high or widely variable (or both).

ration, which was already using wood pellets to heat its corporate offices in downtown Juneau. The existence of the Sealaska system reduced the need to find a separate fuel supplier and delivery system, as both systems could be serviced together. Integral to the decision-making process were the efforts of the management team and local partners. Project champions included Craig Moore, vice president of planning and development, and Ricardo Worl, president and chief executive officer, Tlingit-Haida Regional Housing Authority; Nathan Soboleff, former renewable energy program manager, Ha-Ani LLC (a subsidiary of Sealaska Corporation); and Bob Deering, environmental and engineering manager, U.S. Coast Guard.

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Figure 2—The wood-pellet burner installed by the Tlingit-Haida Regional Housing Authority at its warehouse in Juneau, Alaska.

System Implementation

The wood-energy conversion process consisted of several steps, including a preliminary feasibility assessment, a detailed feasibility study, project financing, a fuel supply assessment, equipment selection, permitting, and construction. During the preliminary feasibility assessment, Housing Authority managers evaluated several potential wood-fuel sources and system types and determined that wood pellets would be the most appropriate fuel for their installation despite cheaper purchase costs for other wood-fuel types. Factors in favor of pellets included higher transportation efficiency, higher combustion value, and less system maintenance.

The wood-pellet system was installed as part of a new warehouse construction completed in 2013 (table 2). The system uses a hydronic heating system coupled with a heat exchanger. Housing Authority managers researched vendors of pellet combustion systems, selecting Maine Energy Systems,[1] a company with a well-established reputation in Europe for proven reliability, durability, low maintenance, and high efficiency. An additional benefit of purchasing a high-quality boiler was the opportunity to showcase the system to other communities, thereby serving a valuable demonstration function. Maine Energy Systems is licensed to distribute the Okofen wood-pellet systems, which was established in Europe almost 20 years ago, and has more than 45,000 customers worldwide (Okofen 2014).

Table 2—Timeline for the wood-pellet heating system installed by the Tlingit-Haida Regional Housing Authority at its warehouse in Juneau, Alaska

Month and year	Milestone
June to December 2011	Initial planning
January 2012	Decision on type of wood feedstock
January to June 2012	Detailed feasibility and design
June to July 2012	Equipment selection
September 2012	Construction underway/system in place
April 2013	Construction completion
May 2013	System startup
May 2014	Completion of first heating season
December 2014	Completion of first full calendar year of operation

[1] The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

The cost of the combustion system was almost $65,000 (table 3). However, when the control system, distribution system, and other accessories were taken into consideration, the total cost approached $215,000. Financing was negotiated through the American Recovery and Reinvestment Act (ARRA 2009).

With this new system, Juneau doubled the number of commercial facilities heated by wood pellets, including the system at Sealaska Plaza. A third facility, Sealaska Heritage Institute in Juneau, came online in May 2015. These systems are helping generate a small economy of scale for use of wood pellets, creating a synergy for future systems while potentially lowering costs by increasing overall pellet consumption. This is already evidenced by the shared use of delivery trucks and of common pellet unloading and storage methods at the port of Juneau.

Operation

Pellet transport—

Most of the pellets are transported from a manufacturing facility in Tacoma, Washington, with the remainder coming from a pellet mill in Ketchikan (about 300 miles to the south). Fuel handling and transport continues to be an important consideration, especially with an anticipated increase in pellet volume in the Juneau area. The pellets are carried by a delivery truck owned by Sealaska Corporation.

Alaska Marine Lines, which has become a key partner in this effort, designed a special container to facilitate bulk transfer of pellets and agreed to allow pellets to be stored for up to 30 days without charging demurrage (Soboleff 2011).

Table 3—Specifications of the wood-pellet boiler installed by the Tlingit-Haida Regional Housing Authority at its warehouse in Juneau, Alaska

Specification	Description
Year established	2013
System size	191,000 BTUs per hour
Installed cost[a]	$65,000
Wood pellet consumption	22 tons per year
Fuel storage capacity	10 tons
Fuel type	Pellets
Primary fuel source	Tacoma, Washington
Equipment vendor	Maine Energy Systems
Area heated (warehouse)	10,000 square feet
Wood pellet cost	$300 per ton

[a] Cost of wood-pellet system only; including the costs of the control system, distribution system, and other accessories would bring the total to nearly $215,000.
BTUs = British thermal units.

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Figure 3—Exterior shot of the 10-ton wood-pellet silo installed by the Tlingit-Haida Regional Housing Authority at its warehouse in Juneau, Alaska.

Fuel storage and handling—

A 10-ton outdoor silo was built for onsite pellet storage. Fuel is loaded into the silo by auger delivery using the truck owned by Sealaska Corporation. Because the delivery truck can carry more than 10 tons of pellets, the silo can be filled to capacity for each delivery. The pellets are transferred by pneumatic conveyor to a day hopper located inside the warehouse next to the pellet system. The day hopper is an integral part of the boiler system because it serves as a small buffer immediately before the pellet combustion chamber. Using a vacuum system rather than an auger reduces the number of mechanical parts for easier maintenance. Wood pellets are transported by auger the short distance from the day hopper to the combustor.

Pellet combustion—

Pellets are burned in an underfeed combustion chamber. A precise amount of wood is metered onto the combustion plate, which is initially ignited electronically. Once combustion is established, hot combustion gases are fed to a heat exchanger that is coupled to a hydronic heating system and then out through the powered exhaust vent on the side of the building. The heat exchanger tubes are automatically scoured by an integrated turbulator cleaning device, which periodically removes ash from the heat transfer tubes. Another function of the turbulator is to increase turbulence in the flue gas flow within the heat exchanger, thus increasing the efficiency of the heat transfer process. A variable-speed induced draft fan, which provides airflow through the system, required some adjustments early on to correct a clogged auger at the bottom of the storage silo (most likely a weather-related moisture problem). This problem was easily remedied and has not resurfaced.

Emissions control—

No emissions control devises were needed because the design and high efficiency of the pellet system ensures clean burning. Small amounts of smoke are sometimes present on system startup. One modification that is planned for the system is to replace the powered exhaust system with a more traditional flue pipe system extending past the roof line. The powered exhaust, which blows flue gases out of the wall of the building approximately 10 feet above the ground surface, was deployed as an attempt to reduce capital costs and avoid penetrating the roof membrane, but smoke during system startup has been leaking into the building.

Ash management and disposal—

An ash auger automatically transfers any ash that is formed in the burn chamber into the adjacent ash bin. Ash management requires very little work, with removals of about a gallon equivalent every two weeks during the intensive heating season (typically December through February). The system came with an ash compression device in the ash box, which reduces the frequency of ash disposal. The small amounts of ash generated are discarded as normal waste.

Fuel Calculator Results

Numerous factors will influence the performance of the pellet system, chief among them being total fuel costs. The fuel calculator developed by the vendor (Maine Energy Systems 2015) was used to evaluate these factors at five levels of pellet use. A 2 percent inflation rate was assumed, as was a $65,000 system cost. The pellet price range for the evaluation was $220 to $380 per ton. At a usage of 25 tons per year, annual savings (versus heating oil costing $4.50 per gallon) ranged from

$5,090 to $9,105 and total energy savings over a 25-year planning horizon ranged from $166,297 to $297,461 (table 4). The range for evaluating annual pellet consumption was 20 to 50 tons per year, which reflects the higher end of annual pellet usage and allows for additional pellet use to heat other buildings on an expanded heating loop. At that usage, annual savings ranged from $5,873 to $14,267 and total energy savings over a 25-year planning horizon ranged from $191,887 to $466,114 (table 5). Heating oil was not evaluated directly, but any future increases in oil prices will undoubtedly make pellets more economically attractive, assuming that pellet prices remain stable (as was the situation in 2007 when oil prices spiked). Both tables reflect the impact of wood-pellet cost and of wood-pellet consumption on project economics. The Maine Energy Systems fuel calculator, although developed by the equipment manufacturer, is expected to provide meaningful results for the purposes of this case study.

Table 4—Projected savings with variable pellet costs for the wood-pellet system installed by the Tlingit-Haida Regional Housing Authority at its warehouse in Juneau, Alaska[a]

Pellet cost per ton	Annual savings	Total savings over 25 years
	U.S. dollars	
220	9,105	297,461
260	8,101	264,670
300	7,097	231,879
340	6,094	199,088
380	5,090	166,297

Source: Maine Energy Systems 2014.

[a]Assumptions: the inflation rate is 2 percent, 25 tons of pellets are consumed per year, the equivalent oil use is 3,250 gallons per year, heating oil cost is $4.50 per gallon, and the installed cost of wood-pellet system is $65,000.

Table 5—Projected cost savings over 25 years for the wood-pellet system installed by the Tlingit-Haida Regional Housing Authority at its warehouse in Juneau, Alaska[a]

Annual pellet consumption	Equivalent oil use	Annual savings	Total savings over 25 years
Tons	*Gallons*	- - - - - - - *U.S. dollars* - - - - - - -	
20	2,680	5,873	191,887
30	3,870	8,481	277,091
40	5,160	11,308	369,455
50	6,510	14,267	466,114

[a]Assumptions: the inflation rate is 2 percent, the cost of pellets is $300 per ton, the cost of oil is $4.50 per gallon, and the installed cost of wood-pellet system is $65,000.

Future Operation and Prospects

The Tlingit-Haida Regional Housing Authority manages residential housing programs in 12 communities across southeastern Alaska. Forests owned by Alaska Native corporations are often close to communities, where the need for rural employment is substantial. These factors are increasing interest in expanding the wood-energy model to communities beyond Juneau. Below is the status of expansion effort as of December 2014.

Lemon Creek (Juneau)—
With the warehouse wood-pellet system having completed its initial heating season—nearly 8 tons burned from May 2013 to December 2013 followed by about 22 tons in 2014—the Housing Authority is contemplating an expansion of the system to include a heating loop to a second building across the street from the warehouse. If new buildings were to be constructed on several vacant lots adjacent to the warehouse, they also could be heated with wood, either through a district heating loop or with additional stand-alone systems. Additional buildings would have the potential to greatly increase the heating demand and the tons of pellets burned.

Yakutat—
A cordwood system is installed and has been in use at the Yakutat senior center since 2013. This system is heated with a Wood Gun E-180 cordwood boiler (Alternate Heating Systems), which includes underground piping to the mechanical room. A flat plate heat exchanger is used, with two Tarm 400-gallon buffer tanks housed in the mechanical room. An oil boiler serves as the backup system. The system requires properly sized fuel dried to an optimal moisture-content level for best operation. During the initial heating season (2013 to 2014), some sizing and moisture-content problems were encountered, but these will be resolved before the second heating season.

Kake—
Another proposed expansion is in Kake, a community that experiences heating-oil prices that are often high or widely variable (or both). Efforts are now underway to replace oil boilers with wood systems in 17 housing units, expected to reduce heating costs by 38 percent (THRHA 2012). Work is underway to install several residential units in Kake as well as a district heating loop for a senior center with the option to include a school complex later. Mayor Henrich KaDake has been a project champion for the system.

Library of Congress

Figure 4—Cannery at Kake.

Angoon—

A feasibility study is nearing completion for a wood-energy installation in the community of Angoon. The proposed system would include a district heating loop and would provide residential heating for nearly 80 residents. Importing pellets is the most likely option because the community is surrounded by Admiralty National Monument where harvesting wood is not permitted. The feasibility study will evaluate the technical and economic options for their wood-energy system. A subdivision with 22 housing units could become part of a single district heating loop—single family units, an elders housing unit, and a senior center. This means that a broad cross section of the Angoon community would be served with one heating system. The Angoon system is unique in that it would become the first residential heating loop of this scale in southeastern Alaska.

Tlingit-Haida Regional Housing Authority

Figure 5—Energy Cents movie day at Angoon, where residents pledged to keep thermostats below 68 °F and water heaters below 120 °F.

Craig and Klawock senior centers—

Klawock and Craig are communities on Prince of Wales Island in southeastern Alaska that are separated by fewer than 10 miles. The Municipal Housing Authority is considering wood energy to heat the senior centers in both locations, replacing fuel-oil systems. Because local wood residues are abundant, viable options include pellet, chip, or cordwood systems. A final decision on fuel type and other operating parameters is imminent, after the two feasibility studies now underway are completed. Other operating wood-energy systems on Prince of Wales Island (including a chip-fired school heating system in Craig) could create fuel-supply opportunities and synergies for the senior centers.

Conclusions

The Tlingit-Haida Regional Housing Authority is providing significant economic and social benefits to its members in southeastern Alaska. It has already installed two successful wood-energy systems (in Juneau and Yakutat) and has plans to expand to Kake, Craig, and Klawock. This effort is promoting more self-sufficiency, sustainable use of local resources, and job creation in underserved communities. Converting their building inventory to wood energy could provide the "critical mass" within communities to allow other facility owners to make a similar switch. Bringing in new fuel supplies and system-support networks can have a powerful catalyzing effect for these communities.

The flagship wood-energy system at the construction warehouse in Juneau is already providing tangible benefits and demonstrating effective use of wood energy. Using wood-pellet fuel is providing a synergy with Sealaska Corporation, which recently installed a pellet boiler at its downtown Juneau location.

The future of wood energy for the Tlingit-Haida Indian Tribes is bright. They have several wood-energy projects underway and are already realizing cost savings and employment benefits. They are integrated into a strong network of agency and partner support in Alaska. They are pursuing flexible fuel types (pellets, chips, and cordwood) tailored to locations and available resources. They are also exploring different wood-energy configurations depending on specific needs (including residential stand-alone systems, small industrial-scale stand-alone systems, and district heating loops). As with all startup ventures, the effort faces many challenges, for example developing the critical mass for efficient and cost-effective biomass supply and distribution chains.

Tlingit-Haida Regional Housing Authority

Figure 6—A demonstration for the U.S. Forest Service staff by Craig Moore at the Tlingit-Haida Regional Housing Authority.

Case Study 2: Sealaska Corporation (Juneau, Alaska)

Established in 2010, the Sealaska system is the oldest small industrial pellet system in southeastern Alaska, having accumulated four heating seasons worth of operating data. Its 220-kilowatt (750,000 British thermal units [BTUs] per hour) wood-pellet boiler provides heat to the 58,000-square-foot Sealaska Plaza, annually replacing roughly 35,000 gallons of oil with 280 tons of pellets. Already, this wood-energy system is guiding the establishment of new facilities in Juneau and Ketchikan.

Conversion Process

The Sealaska project was the first pellet installation of its kind in Alaska. Sealaska began the conversion process by evaluating the demand for pellets in Alaska. Market research showed that 39 percent of the 82 retailers in Alaska sell pellets in 40-pound bags; that most of the demand for pellets is in areas outside southeastern Alaska; that pellet manufacturers are largely from Oregon, Idaho, Washington, Missouri, and Canada; and that a pellet mill near Fairbanks started production in 2010 (but has not supplied pellets to Sealaska). Sealaska also did extensive research on pellet boiler manufacturers, and decided on a "top-of-the-line model," partly because of limited space in the Sealaska boiler room and partly because a reliable system was a top priority. A significant part of the total project cost was incurred for infrastructure improvements and site work.

Nathan Soboleff, former renewable energy program manager, Haa Aaní, LLC (a subsidiary of Sealaska Corporation) and Rick Harris, executive vice president, Sealaska Corporation, championed the conversion process and worked steadily over several years to spearhead efforts for the new system.

Motivation for Change and System Implementation

Several factors led Sealaska Corporation executives to consider installing the wood-pellet system to replace their aging fuel-oil system. First, the corporation had long been in the timber business and was anticipating the benefits of its second-growth forestry and timber operations, with large volumes of harvesting residues and other wood wastes expected in the coming decades. These wastes could be used to help stimulate a biofuels industry in southeastern Alaska and could be manufactured into wood pellets, chips, or other densified products such as "biobricks." Although the potential has always existed for pellet production in the southeast, the initial supply has been shipped from Washington. Following the Sealaska model, several other wood-pellet energy systems have since been installed and are operating in Ketchikan, creating additional regional demand for wood pellets.

Sealaska Plaza is a 58,000-square-foot facility located in downtown Juneau, and is home to the Sealaska Corporation, an Alaska Native corporation. Before 2010, it was heated with a fuel-oil system built in 1976. Situated near the high-tide mark for the Juneau waterfront, this outdated system could have posed environmental risks in the event of a leak. Another factor that Sealaska executives considered was the rapid escalation in heating-oil prices in 2006 and 2007. Given these conditions, the decision was to “lead by example” and install a new wood-energy system. Sealaska executives considered a variety of wood feedstocks—including chips, densified “pucks,” and “biobricks”—before settling on wood pellets. Factors in favor of pellets included better control over moisture content and more efficient transportation. Together, these more than compensated for the higher delivery cost of wood pellets. Given the small area available for a wood-energy system and the need for reliable operation, Sealaska invested the extra amount needed for a high-quality pellet system.

The new system became operational in November 2010—the first small industrial-scale wood-pellet boiler in the southeast and a demonstration model for other organizations. The following timeline describes major events in the startup of the Sealaska system (Soboleff 2011):

- Autumn 2009 Emerging Energy Technology Grant awarded to Sealaska
- December 2009 Official news release announcing wood-pellet system
- May 2010 Bulk delivery truck in place
- October 2010 Boiler in place
- November 2010 Boiler startup

System Operation

The Sealaska system burns nearly 280 tons of premium grade wood pellets per year, eliminating the need for 35,000 gallons of heating oil (Grass 2010). Its Viessmann (2012) Pyrot boiler—rated as 750,000 BTUs per hour (the equivalent of 220 kilowatts)—operates at 85 percent overall efficiency (ACEP 2013). The pellet system provides energy for both heating and hot water to Sealaska Plaza (tables 6 and 7).

Routine maintenance includes manual removal of clinkers from the firebox and periodic cleaning of the firetubes with a pneumatic cleaner. Ash is automatically conveyed into a small storage bin and is periodically given to local gardeners and other organizations (Soboleff 2011). Once a year, the flue gas filters are removed and steam cleaned.

During the first year of operation, an electrical backup system was installed, eliminating any need for the old oil system. Relatively few startup operational problems occurred, although some issues have been encountered since (noted below).

Table 6—System cost for the wood-pellet boiler installed by the Sealaska Corporation in Juneau, Alaska

Component	Cost
	U.S. dollars
Wood pellet boiler	524,400
Electric heating system	119,000
Site work and boiler room renovation[a]	164,750
Contingency and overhead	484,000
Concrete silo	56,500
Total	1,348,650

[a] Includes substructure, exterior closure, interior construction, and mechanical and electrical work.
Source: Alaska Energy Engineering LLC.

Table 7—Operational overview of wood-pellet boiler installed by the Sealaska Corporation in Juneau, Alaska

Specification	Description
Year established	2010
System size	220 kW (750,000 BTU per hour)
Installed cost	$1.35 million
Wood-pellet consumption	250 metric tons per year
Fuel storage capacity	19 tons (900 cubic feet)
Fuel type	Premium wood pellets
Fuel source	Primary: Tacoma, Washington Secondary: Ketchikan, Alaska
Amount of heating oil not burned	30,000 to 35,000 gallons per year
Auxiliary energy type	Electric

BTU = British thermal unit.

Fines management and fuel quality—

On rare occasions fines that accumulate in the silo result in clogging, which can lead to a boiler shutdown. This is a problem that can be easily fixed by manually removing the fines (Soboleff 2011) or mitigated by purchasing wood pellets with low levels of fines and a high durability index. Pellets must be kept dry during storage to prevent problems with the pellet feeding system.

System outages—

Sealaska reports that on several occasions during the first heating season, high winds extinguished the wood pellets in the combustion chamber. This was remedied by simple modifications to the flue, and has not been a problem since.

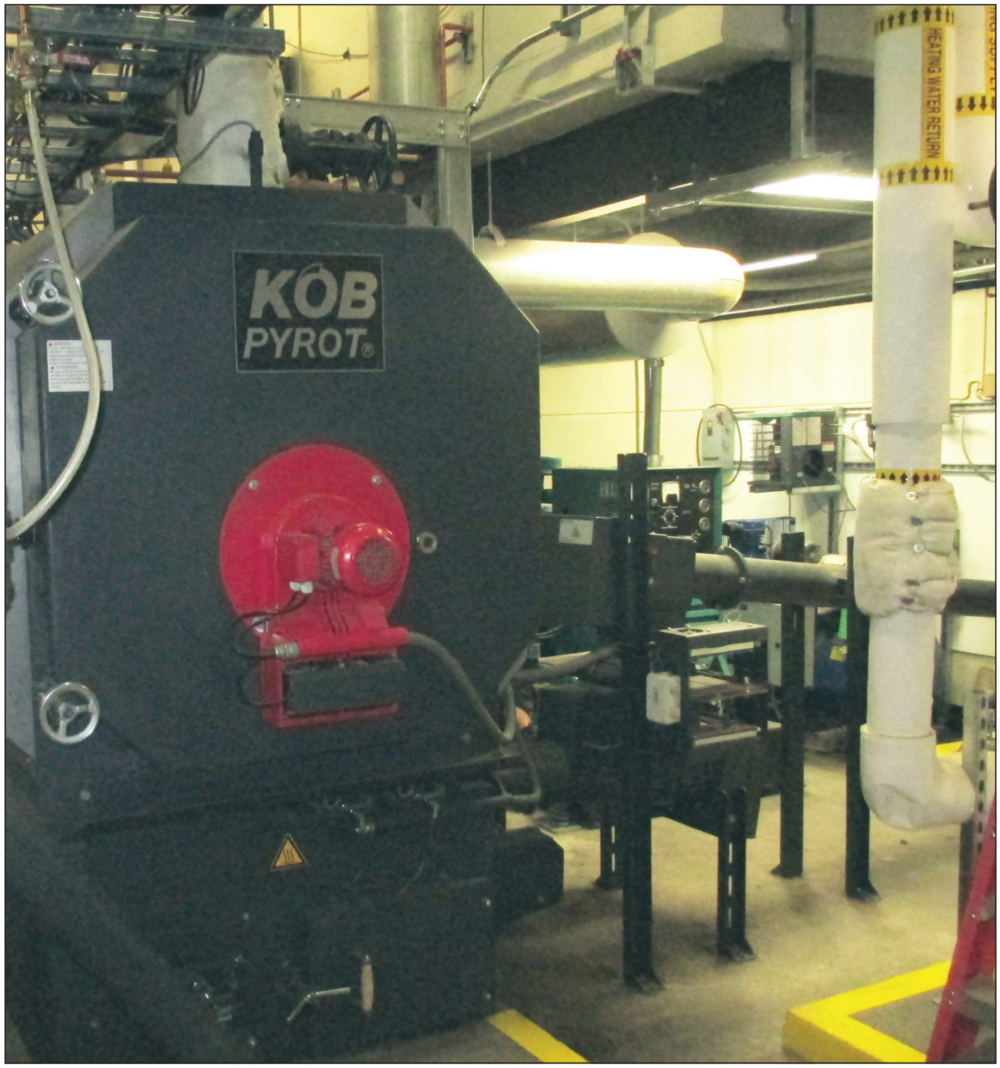

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Figure 7—The wood-pellet boiler system installed by the Sealaska Corporation in Juneau, Alaska.

Emissions control—

Given the downtown location of Sealaska Plaza, emissions control is an important concern from an aesthetic and human health perspective. No visible emissions have been reported, likely because keeping pellets dry during transport and storage has been an integral part of operations.

Pellet transport—

Most pellets are transported from a manufacturing facility in Tacoma, Washington, with the remainder coming from a pellet mill in Ketchikan (about 300 miles to the south). During the first year of operation, Sealaska began using "supersaks" for delivery. Fuel handling and transport continues to be an important issue, especially

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Figure 8—Outdoor wood-pellet storage silo at Sealaska Plaza in downtown Juneau, Alaska.

with an anticipated increase in pellet volume in the Juneau area. Sealaska owns the pellet delivery truck and is working to maximize this resource by developing more efficient pellet unloading and transportation processes.

Alaska Marine Lines, which has become a key partner in this effort, has designed a special container to facilitate bulk transfer of pellets and has agreed to a 5-year contract that allows Sealaska to store pellets at their facility in Juneau for up to 30 days without being charged a daily use rate (Soboleff 2011). Local delivery by someone with a commercial driver’s license costs at least $100 per truckload and requires not only a time-consuming auger delivery but also a climb onto the storage silo. Therefore, continued efforts to streamline the pellet transport and delivery process will help reduce costs.

Pellet storage—

Sealaska is exploring options for bulk storage, including a small silo farm. Having pellet silos would reduce costs by eliminating the need for shipping in super sacks and would permit transloading from barge to delivery truck. It would also allow delivery truck drivers more flexibility in scheduling pickups (Soboleff 2011). Currently, a 19-ton pellet silo stores fuel adjacent to Sealaska Plaza. The silo is located less than 20 feet from the boiler room and the pellet burner. All fuel conveyance from the delivery truck to pellet silo and then to the boiler room is done by auger transport.

Future Operations and Prospects

Expansion—

Sealaska Heritage Institute Center (The Walter Soboleff Center) is a 29,500-square-foot, three-story building located adjacent to Sealaska Plaza. It has a new wood-energy thermal system that is independent of the Sealaska Plaza system. The new system has benefited from the learning experiences of the Sealaska system. Several new features have been incorporated, including below-grade pellet storage in fabric “bunkers,” external delivery by means of a chute system, a thermal storage buffer tank, two pellet boilers that operate in a coordinated tandem lead-lag fashion, and an electric boiler backup. The initial heating season for the Soboleff Center wood-pellet system is expected to be the autumn of 2015.

Cost-saving measures—

Sealaska is exploring the possibility of training custodian staff to perform routine boiler firetube cleanings (less than $20 per hour) rather than using the current method, which involves a trained plumber (nearly $100 per hour). Most of the other periodic maintenance is performed as prescribed, through outside sources and contractors, with little opportunity for further cost reductions.

With the growing inventory of Maine Energy System boilers being installed in Alaska, the company has offered to provide regional training classes for facility operators interested in performing their own boiler maintenance. This training typically takes about 5 hours to complete.

Wood fuel handling—

Sealaska is interested in streamlining fuel handling (and therefore reducing costs) at several points in the delivery process. At the barge terminal in Juneau, pellets are unloaded into specially built fuel containers to facilitate transfer into delivery trucks. Sealaska is able to wait up to 30 days after arrival to take delivery of the pellets, which helps manage inventories in the onsite storage silo. Pellets are transferred in supersaks to delivery trucks, and then unloaded street-side into the pellet silo at Sealaska Plaza. One potential area for improvement is in the weighing of pellets. Presently, the delivery truck must be weighed before and after deliveries to determine the actual weight transferred—a metering device that could determine the actual weight unloaded would make this step more efficient (ACEP 2013).

A future step for Sealaska could be to establish a wood-pellet "silo tank farm." Advantages of a tank farm are that at least one handling step would be eliminated and truck drivers would have more flexibility in setting delivery schedules. Additional pellet storage space would also be advantageous if Sealaska becomes a regional supplier of wood pellets.

Conclusions

The Sealaska facility was the first small commercial-scale pellet-boiler system in southeastern Alaska. Operational in 2010, it has served as a regional wood-energy demonstration site and has provided a real-world example for future facilities. Over the past 4 years, numerous visitors have toured the Sealaska pellet boiler, while others are reminded of its wood-energy presence daily as they drive past the outdoor pellet silo in downtown Juneau.

Through the first 4 years of operation, Sealaska has avoided using an average of 35,000 gallons of heating oil per year (table 7). The net present value of cashflows associated with oil versus wood-pellet systems shows clear advantages for wood-pellet systems at discount rates up to about 10 percent (fig. 10). Also, the economic advantages of using wood pellets (versus oil) are clear when pellets cost between \$250 and \$400 ton, assuming annual inflation is 2 percent over the next 30 years (fig. 2). Assuming zero inflation, the crossover point for net present value would be close to an 8 percent discount rate.

Perhaps the most significant role that the Sealaska system can play is to help stimulate wood-pellet use and infrastructure. Although system operation has proceeded smoothly, several "learning-curve" items have been solved, and lessons learned will be available to future facilities.

Table 8—Pellet deliveries in 2010 and 2011 to the wood-pellet system installed by the Sealaska Corporation in Juneau, Alaska

Start date of delivery period	Amount
	Tons
October 15, 2010	27.6
December 15, 2010	51.4
February 15, 2011	49.5
April 15, 2011	32.0
June 15, 2011	44.3
August 15, 2011	36.2
October 15, 2011	10.4

Source: ACEP 2013.

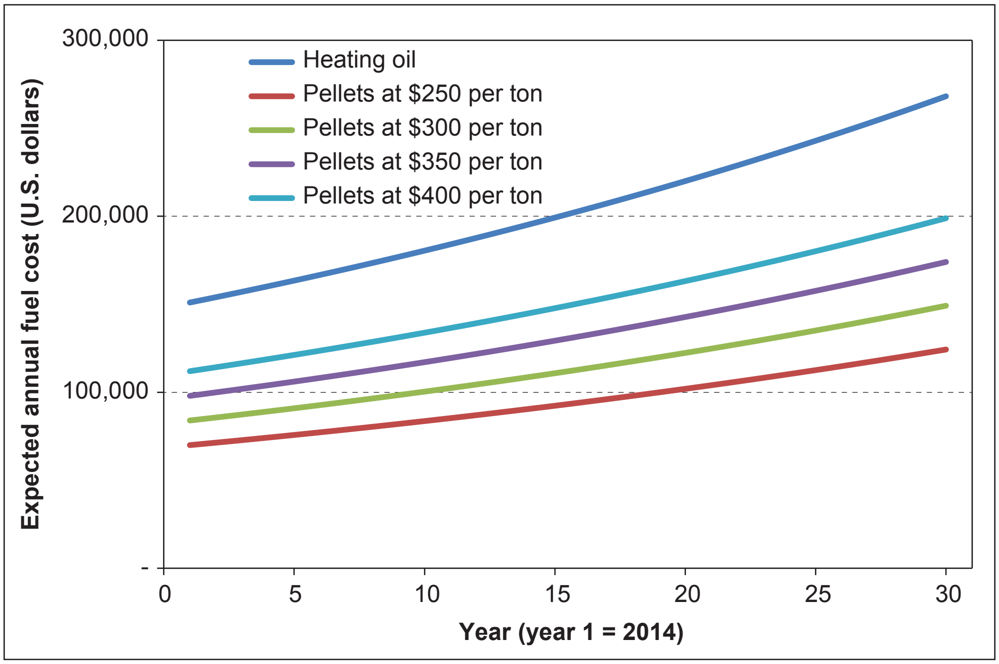

Figure 10—Expected future fuel costs for heating oil versus wood pellets (assuming a 2 percent annual inflation for both fuel types) for the Sealaska Plaza, corporate headquarters of Sealaska Corporation in Juneau, Alaska.

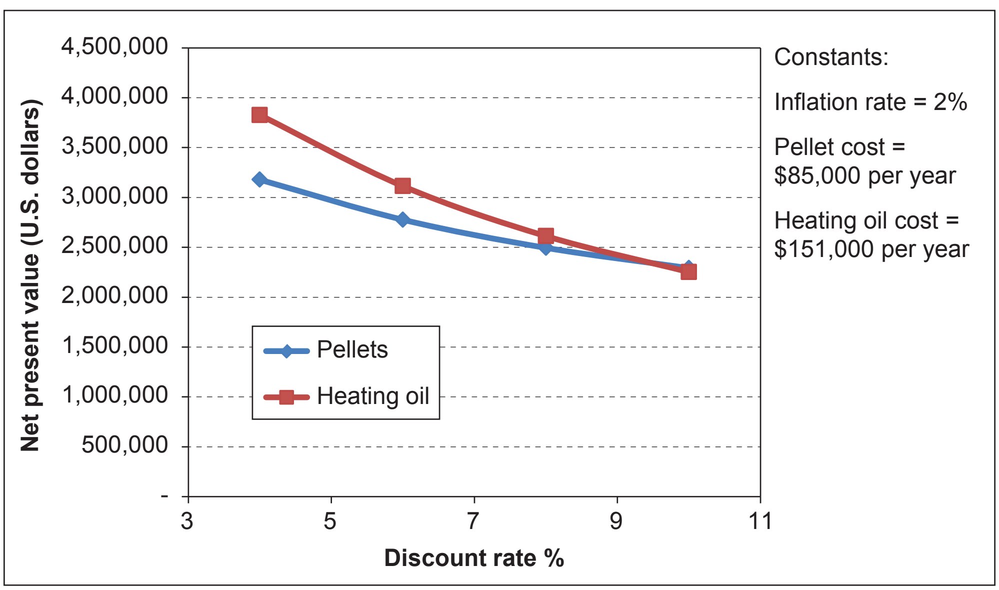

Figure 11—Net present values of cashflows for wood-pellet versus heating-oil system reported by the Sealaska Corporation (assuming an annual inflation rate of 2 percent, pellet costs of $85,000 per year, and oil costs of $151,000 per year).

Discussion

The past decade has seen significant growth in wood-energy use in Alaska, with more than 20 successful systems in operation, which not only provide a broad array of community benefits, but are also helping to clarify strategic planning goals for renewable energy in Alaska. For example, wide use of wood-pellet fuel in Alaska would require sufficient infrastructure and economies of scale. Once pellet transportation, supply, and storage systems are established, others would be able to use bioenergy systems with reduced startup costs and less challenging learning curves. This network must be fully developed before widespread use of pellet fuels will be economical in Alaska.

The presence of a local pellet production facility is perhaps the most vital chain in the link of wood energy development. Currently, most of the wood pellets burned in southeast Alaska are produced in the Pacific Northwest, then transported by barge more than 700 miles to their final markets. For extensive use of pellets to become a reality, a full-scale production facility would be needed, serving numerous markets and communities across southeast Alaska. Such a facility could create economies of scale while providing consumers an economically viable source of wood fuel and reducing or eliminating the need to ship fuel long distances. Further, local jobs would be created at the production facility, during pellet transport, and at wood energy facilities. At the same time, an overriding issue in the coming years will be finding markets for woody biomass from the Tongass National Forest—an issue of increasing importance as more and more second-growth trees reach merchantable size. Creating wood-pellet fuel from Tongass biomass will require careful examination of how wood quality (including the presence of bark and limbs) could influence pellet use.

This case study has examined two substantially different wood-pellet heating systems, finding that both can effectively serve different niches. The Sealaska system is a relatively large pellet burner supplying heat and domestic hot water to one of the larger office buildings in Juneau. The Tlingit-Haida Regional Housing Authority system is considerably smaller, running more intermittently and having greater seasonal variations. Yet both burners share the same pellet supply and distribution system and have common economic interests in greater regional use of pellets. Further, both systems are able to serve as demonstration sites, giving prospective wood-energy adopters a firsthand look at successful operation. Already this has helped establish another pellet burner in downtown Juneau (at the Walter Soboleff Center), with other units under construction elsewhere in Alaska. The environmental benefits of these burners, in terms of reduced greenhouse gas emissions, are substantial. Because nearly 300 tons of pellets are burned each year in Juneau, this translates to many tons of carbon dioxide already being avoided.

Perhaps the greates benefit in "testing the waters" with the two Juneau burners could be to evaluate whether pellets will indeed become a preferred wood-fuel type in southeast Alaska (versus chips, cordwood, or some other densified fuel). Time will tell how this story unfolds, and will depend on a host of yet unknown conditions, including markets for fuel oil, forest policy on the Tongass, the development path of production infrastructure, the role that Native corporations play, and the presence (or lack of) site-specific project champions.

Metric Equivalents

When you know:	Multiply by:	To find:
Inches	2.54	Centimeters
Feet	.3048	Meters (m)
Miles	1.609	Kilometers
Acres	.405	Hectares
Tons	.0907	Tonnes
Gallons	3.75	Liters
Pounds	454	Grams
Board feet	.00566	Cubic meters

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