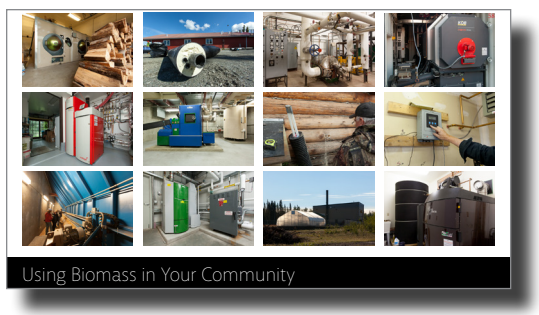
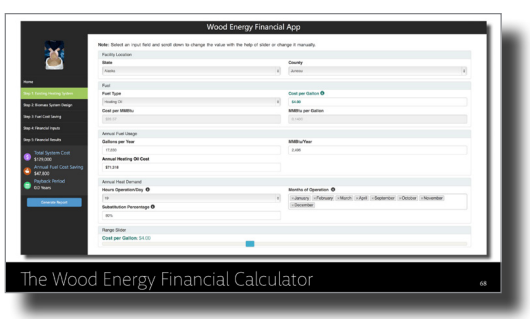
United States Department of Agriculture

Community Biomass Handbook

Volume 2: Alaska, Where Woody Biomass Can Work

Eini C. Lowell, Daniel J. Parrent, Robert C. Deering, Dan Bihn, and Dennis R. Becker





Forest Service

Pacific Northwest Research Station

General Technical Report PNW-GTR-920

September 2015

Foreword

If you're a local businessperson, an entrepreneur, a tribal partner, a community organizer; a decision-maker for a school district, college, or hospital; a government leader; a project developer; an industry leader; or an equipment manufacturer, the Alaska Community Handbook will be helpful to you. This handbook is the first stop for individuals, businesses, and communities considering biomass heating in Alaska. It can help you ask the right questions to quickly narrow your range of options and take unrealistic ones off the table.

The Alaska Biomass Handbook was developed as part of two ongoing initiatives in the Alaska Region; the USDA Southeast Alaska Economic Diversification Strategy, and the Tongass transition framework. It was funded primarily by the Forest Service's Pacific Northwest Research Station with support from the Alaska Region as well as the University of Minnesota.

—Beth Pendleton, Regional Forester,

USDA Forest Service, Alaska Region

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Sponsors and Collaborators

This handbook was developed in collaboration with the USDA Forest Service as part of the USDA Southeast Alaska Economic Diversification Strategy and Tongass Transition Framework. Primary funding was provided by the USDA Forest Service, Pacific Northwest Research Station. Additional support was provided by the University of Minnesota, Department of Forest Resources, and USDA Forest Service Alaska Region.

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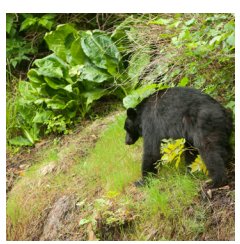
Preface: Why Woody Biomass Works in Alaska

Unique need. Alaska is rich in energy resources but lacking in practical ways to access those resources. Limited transmission and infrastructure lead to disparities in energy costs across the state, with the heaviest burden often falling on remote communities. Access to affordable energy is a powerful determinant of a community's economic and social prosperity.

Hazardous fuel reduction. Reducing wildfire risk is an important part of forest management in some Alaska forests, on state, federal, tribal, and private lands. Biomass utilization can offset hazardous fuel reduction costs, allowing more acres to be treated and more communities to be protected.



Wildlife habitat improvement. Subsistence ways of life depend on healthy wildlife populations. Biomass utilization and the markets provided by wood energy create opportunities for management activities that improve wildlife habitat.

Young-growth resource management. The Tongass National Forest is transitioning from managing old growth to managing the young-growth timber resource. Low-value forest residuals from timber harvesting and other forest management activities such as forest restoration could play an important role as cost-efficient feedstock for energy markets.

Forest restoration. Biomass utilization can be used strategically to address forest insects and disease problems. For example, much of south-central Alaska, including the Chugach National Forest, has experienced a widespread infestation of spruce bark beetle (*Dendroctonus rufipennis* (Kirby)), leaving millions of acres of dead and damaged trees and increasing the likelihood of severe wildfire.

Proven technology. Many biomass heating systems have been working for years—even decades—throughout the United States and Europe. Options exist for a wide range of applications at differing scales. There are also many new exciting technologies entering the market that may be relevant to Alaska.

Table of Contents

About This Handbook 1
Who Should Use This Handbook 2
How To Use This Handbook 3

The Alaska Context 4
A Land of Contrasts 5
The Land 6
The Forests 7
The People 8
The Infrastructure 9
The Energy Economics 10
Heating Fuels 11
Hydropower 12
Fuel Costs at a Glance 13

Where Biomass Works 14
Biomass Project Map 15
Biomass Fuel Types—At a Glance 16
Cordwood 17
Southeast Island School District 18
Gulkana Village 22
Tanacross Village 24
Wood Chips 26
Tok School 27
Craig Aquatic Center, Elementary and Middle Schools 31
Mentasta Lake 33
Wood Pellets 35
Ketchikan Federal Building 36
Sealaska Corporation 38
Tlingit-Haida Regional Housing Authority 40
Haines Borough and Chilkoot Indian Association 42
Chistochina Energy District 48
Karen and Jim's Home 51
Tongass Forest Enterprises 53
Superior Pellet Fuels 56
Lessons Learned 58

Using Biomass in Your Community 60
Benefits of Biomass Utilization 61
Your Biomass Supply 62
Matching Technology to the Fuel and Application 63
Clean and Proven Technology 64
Building Knowledge and Technical Capacity 65
The Power of Partnerships 66

The Wood Energy Financial Calculator 68
Using the Wood Energy Financial Calculator 69
Step 1: Current Heat Demand 70
Step 2: Biomass System Design 71
Step 3: Fuel Cost Savings 72
Step 4: Estimate Project Finances 73
Step 5: Compare Financial Results 74

Promising Technologies for Alaska 76
Large-Scale Pellet Production in Southeast Alaska 77
Microchips 79
Combined Heat and Power 81
City-Scale District Energy 82

Featured Stories 83
Southeast Island Schools 84
Ketchikan Federal Building 87
Haines Borough 91
Tanana Village 95

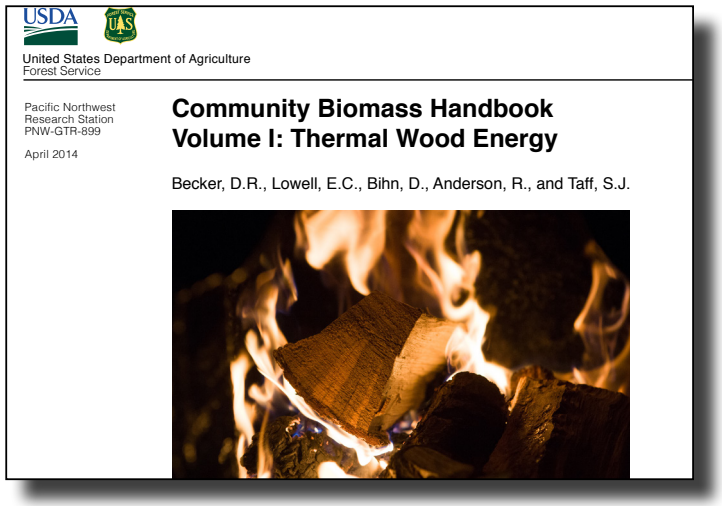
Acknowledgments 97

References 99

Appendix 1: Residential Heating Challenges 101

Appendix 2: Resources 102

About This Handbook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Community Biomass Handbook
Volume I: Thermal Wood Energy

Becker, D.R., Lowell, E.C., Bihn, D., Anderson, R., and Taff, S.J.

The Community Biomass Handbook. Volume 2: Alaska, Where Woody Biomass Can Work, is a companion volume to the Community Biomass Handbook. Volume 1: Thermal Wood Energy, published in April 2014 (Becker et al. 2014).

Why an Alaska volume? The original handbook contains information to help answer initial questions about development of wood heating projects for any location, whereas the Alaska handbook addresses issues and conditions specific to Alaska—transportation logistics, access to resources, energy costs, and climate to name a few. The handbooks collectively provide:

- ✓ **Thermal heating solutions**—Proven biomass technologies and applications in Alaska
- ✓ **Reality check**—Challenges of biomass heating in Alaska and underlying conditions for success
- ✓ **Vision**—The future of biomass heating and opportunities for job creation, resource management, and energy security
- ✓ **Project screening**—Initial assessment of project feasibility using the companion Wood Energy Financial Calculator, which allows users to quickly evaluate or compare biomass heating options, and the capital investment and fuel cost savings associated with them

This information can serve as an effective outreach and education tool for discussing biomass with interested parties. The reference materials and guidance provided can help businesses understand key cost factors, assist communities in planning for their energy futures, and support agencies in their forest planning efforts. This information can also help identify investment pathways and opportunities for administrative and legislative involvement to achieve collective goals to reduce fossil fuel consumption and build economically stable communities.

Note: Throughout this book you will see the terms Btu and MMBtu. These are common units of heat in the United States. A Btu is an abbreviation for the British thermal unit—the amount of energy needed to heat one pound of water one degree Fahrenheit (about the amount of energy released by lighting a match). An MMBtu is a million Btus ("M" comes from the Roman numeral for 1,000—in this particular case, "MM" means 1,000 times 1,000, or 1,000,000).

Who Should Use This Handbook

Community-wide adoption of biomass energy does not happen spontaneously. It requires the persistent efforts of enlightened leaders and empowered champions. Changing to biomass energy can be threatening or seem daunting to a community. It can cause disruptions in the existing energy economy or can conflict with some beliefs. The best path forward is one of openness—bring all parties to the table from the outset and provide as much information as possible to community members.

Success is dependent on having the right people involved in the process at the right time. This handbook is suitable for:

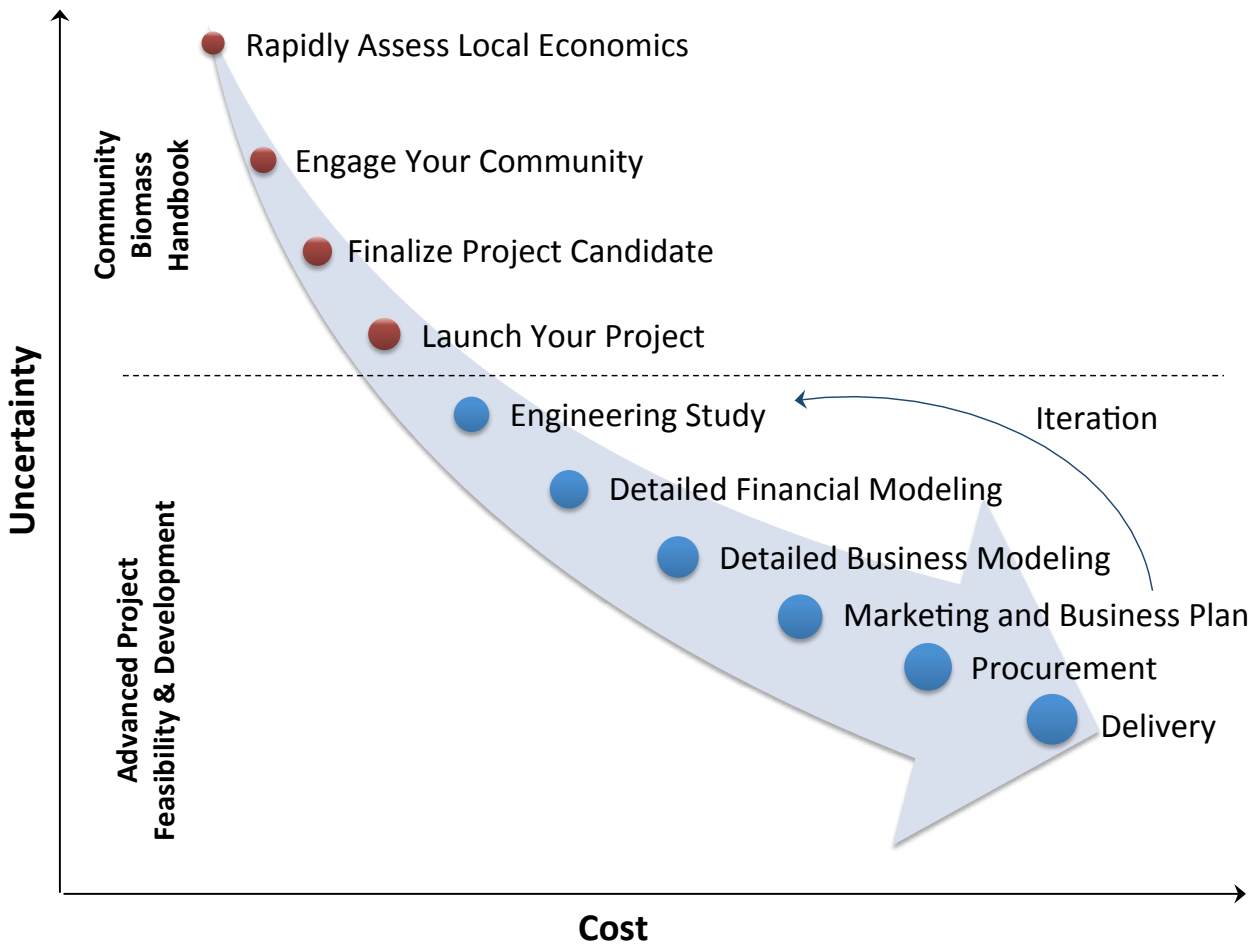
- ✓ Local businesses and entrepreneurs
- ✓ Regional economic development specialists
- ✓ Tribal planners
- ✓ Community organizations and stakeholders
- ✓ School districts, colleges, and hospitals
- ✓ Project developers and consultants
- ✓ State and federal forest management agencies
- ✓ Industry and trade associations
- ✓ Equipment manufacturers and distributors

How To Use This Handbook

This handbook serves as an initial resource for individuals, businesses, and communities who are considering biomass heating in Alaska. It can help you ask the right questions to quickly narrow the range of biomass heating options. It will help you set objectives, define your project scope, and conduct a preliminary financial appraisal of a range of options using the Wood Energy Financial Calculator.

With just a few inputs, users can estimate capital investment and operations costs, biomass requirements, and return on investment, which can significantly reduce early-stage costs, thus saving resources for engineering and business plan development.

When considering a project, the handbook can help you get through the early uncertainty phases of project consideration and save you time and resources for when you get "below the line" to advanced project planning.



Based on original work by the International District Energy Association.

The Alaska Context

A Land of Contrasts

Alaska is a picture of contrasts, from the modern urban setting of Anchorage to remote villages where inhabitants live largely subsistence lifestyles. These contrasts extend to transportation, from four-lane freeways to no paved roads whatsoever, as well as to energy, from small-scale distributed systems to more sophisticated interconnected systems. Equipment and infrastructure range from modern glass and steel skyscrapers in Anchorage to log cabins with no running water.

With more than 656,000 square miles, Alaska is the largest state in the Union, covering more ground than the 22 smallest states combined. With its population of 710,231 spread over this vast area, Alaska is by far the least densely populated state (U.S. Census 2010).

In Barrow, the sun doesn't set for almost 4 months during the summer, but doesn't rise for nearly 2 months during the winter. Elsewhere around the state, summer daylight typically lasts 18 to 20 hours, while winter daylight lasts only 4 to 6 hours.

Alaska's official record high temperature of +100 degrees Fahrenheit was recorded in Fort Yukon in 1915. The record low temperature was –80 degrees Fahrenheit at Prospect Creek Camp in 1971. Average annual rainfall ranges from about 10 inches in Alaska's interior to 120 inches or more in the southeast panhandle.

Interior Alaska's forests are prone to wildfire, while southeast Alaska is a temperate rain forest. These extremes create unique challenges for heating with biomass. They also create opportunities for localized solutions.

Alaska truly is different.

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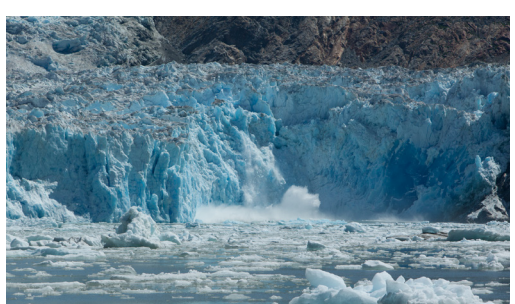
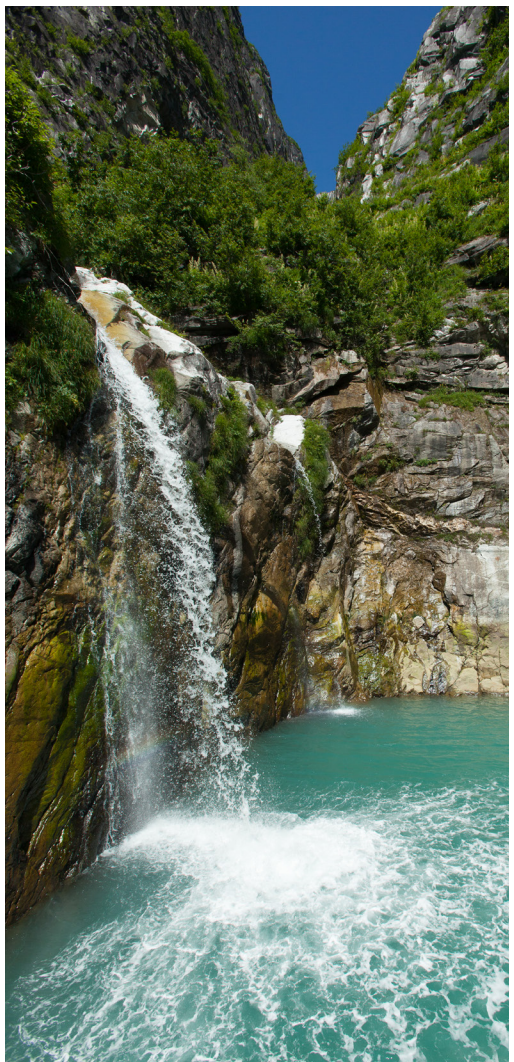
The Land





The name Alaska is derived from the word "Aleyska" meaning "the great land." Alaskans call it "The Last Frontier." Alaska is about 1,400 miles long (north to south) and 2,700 miles wide (east to west). Nearly one-third of the state lies within the Arctic Circle.

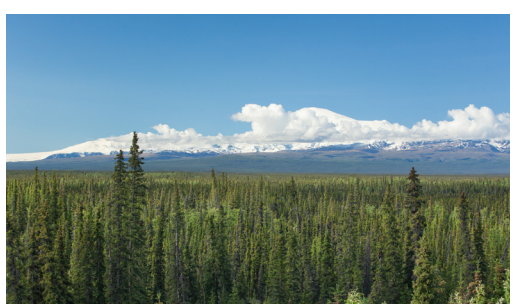
Alaska encompasses nearly 420 million acres, less than 1 percent of which is owned by private individuals. The remainder is owned by a host of entities. More than a dozen federal agencies manage 222 million acres—roughly 53 percent of the state—and the state of Alaska manages another 99 million acres. The Alaska Native Claims Settlement Act of 1971 created 13 regional and 224 village Native corporations, which own and manage 42 million acres.

There are more than 80 potentially active volcanoes in Alaska, over half of which have had at least one eruption since 1760. Each year, Alaska has about 5,000 earthquakes including 1,000 that measure above 3.5 on the Richter scale. Of the 10 strongest earthquakes ever recorded globally, three have occurred in Alaska, including the Good Friday earthquake in 1964 that measured 9.2 and caused an estimated 139 deaths.

Over half of the world's glaciers can be found in Alaska, feeding rivers and ocean estuaries. There are close to 3 million lakes, with Lake Iliamna alone larger than the entire state of Connecticut. Almost 3,000 miles of rivers support fisheries, and nearly half of Alaska is classified as wetlands.

Alaska is truly a great land.

The Forests



There are 126 million acres of forestland in Alaska, which is 30 percent of the state's total area. There are 115 million acres of boreal forests and another 11 million acres of maritime forests, including the rain forests of the southeast. The boreal forest is susceptible to wildfires, with annual acres burned ranging from about 100,000 to over 6 million (Alaska Division of Forestry 2010). The second-growth forests of southeast Alaska are at varying stages of development with vast acreages requiring treatment (USDA FS 2014a).

The Nation's two largest national forests are located in Alaska: the Tongass in southeast and the Chugach in south-central Alaska. With nearly 17 million acres, the Tongass National Forest represents 94 percent of the land base in southeast Alaska. Forest management activities were a large part of the economy in southeast Alaska in the past, but this focus has shifted, and communities are transitioning to other sources of support. Relative to biomass energy, the Tongass National Forest has a vision for the future: **replacing 30 percent of the heating oil currently consumed annually with woody biomass fuels over the next decade in southeast Alaska.**

South-central Alaska, which includes the 4.8-million-acre Chugach National Forest, has experienced a different scenario. A long-term spruce bark beetle (*Dendroctonus rufipennis* (Kirby)) infestation has affected over 6 million acres, causing significant tree mortality and changes in forest composition (Alaska DNR 2013). These forest conditions can lead to uncharacteristically severe wildfires that threaten life, property, and habitat, and ultimately affect livability.

Despite extensive forest resources, timber harvesting and biomass utilization face significant challenges in Alaska: rugged terrain, poor soil conditions, limited access, long winters with short daylight, rain, snow, fog, wind, and extreme temperatures. But an increasing number of Alaskans are seeing opportunities rooted in local solutions and experience. Using locally sourced wood fuel instead of imported fuel oil can save money, create jobs, improve forest health and wildlife habitat, reduce the risk of wildfire, and contribute to healthier communities. Biomass utilization for heating is not only possible but a key element of forest and wildland fire management.

Alaskan forests can truly be a suitable biomass energy source.

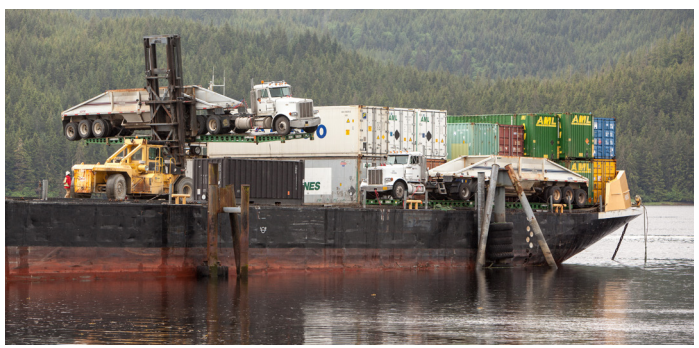
The People

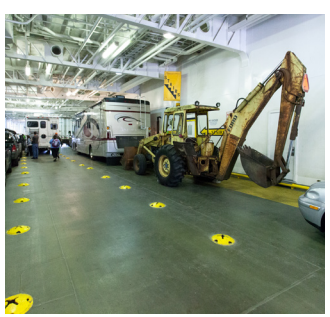
Alaska's population is growing by 3.5 percent annually, faster than the U.S. growth rate of 2.4 percent. Generally, the state has more males than females, and currently trends to a youthful population with a median age of 33.6 years (U.S. Census 2010). Most of the people live along the rail-belt from Seward to Anchorage to Fairbanks (Alaska Division of Forestry 2010). Anchorage supports more than half of the population of Alaska. In contrast, there are hundreds of small Alaska villages and unincorporated areas accessible only by floatplane or boat. Almost 15 percent of the population is Alaska Natives, many of whom live in these rural areas.

Energy costs can drive people out of rural communities, where residential energy prices can be up to 300 percent higher than in urban settings. It is difficult to sustain these communities when many of those leaving are young adults searching for brighter prospects. This also creates an imbalance in the availability of skilled and educated workers. Even those who are interested in staying to work in the wood energy industry, like boiler plant operators and fuel suppliers, must leave home to increase their technical skills or gain necessary training. In addition, competing demands for people's time such as a subsistence lifestyle that relies on other natural resources and associated activities (e.g., fishing, hunting, and gathering) are part of the Alaskan culture. Energy is just one component of livability.

But the one or two family-wage jobs that may be created by converting a public facility to wood energy could have far more impact in rural communities than in urban areas. Local jobs, keeping energy dollars in the community, and price stability are just a few of the benefits of wood energy in Alaska.

The Infrastructure





Think of Alaska as an island. The state has a coastline longer than that of the entire continental United States. When a scale map of Alaska is superimposed on a map of the 48 conterminous states, Alaska's outline extends from the Atlantic to the Pacific. But only about one-third of Alaska is served by highways. The total length of all public roads is only about 15,300 miles, and the state is further bisected by several large rivers (Yukon, Kuskokwim, Tanana, and Chena).

With few roads and limited rail infrastructure, many Alaska communities are completely isolated from each other. Water access is therefore vital for delivering goods and services. The Alaska Marine Highway System, operated by the state of Alaska, is a vital link to many coastal communities, providing transportation for people, vehicles, and goods through a system of ferries.

The limited options for transportation drive prices up. In southeast Alaska, most goods are barged from Seattle, over 900 miles to the south, on a regular transport schedule. Therefore, shipping goods just between ports within southeast Alaska can be more expensive than might be thought.

In Interior Alaska, infrequent barge deliveries can be restricted to summertime when rivers are not frozen.

With few roads, limited transmission and infrastructure, but abundant local resources, Alaska has a unique need and an opportunity to heat with forest biomass.

The Energy Economics

Eini Lowell

Alaska is rich in energy resources but has poor accessibility to those resources. While many think of the Alaska pipeline and assume the state has abundant oil, there are no oil refineries in the state. Crude oil is shipped to refineries in the lower 48 before being barged back to Alaska communities and sold at much higher prices, sometimes double the price paid in the lower 48. Water is plentiful and hydropower is relatively inexpensive where it is available, but most communities are isolated.

There are no connections to the continental electrical grid. Thus, each community or region independently generates power using local or imported resources. Consequently, utility costs can vary dramatically by location, resource availability, and existing energy infrastructure (e.g., hydroelectric dams, transmission lines, gas pipelines, and power plants). Resulting high power costs are an existential threat to many smaller communities where electricity rates can range from $0.60 to $1.00 per kilowatt-hour (kWh) compared to more fortunate communities paying less than $0.15 per kWh.

Differences in energy consumption are great when comparing regions in the lower 48 with those in Alaska that are classified as “cold” or “very cold” by the U.S. Energy Information Administration. On a square-foot basis, the average Alaska housing unit uses three times as much energy as houses in the lower 48 (app. 1). However, in some regions, such as the NANA region in northwest Alaska, average households spend $9.15 per square foot for home energy, which is more than nine times higher than the $0.97 per square foot national average for cold climates.

Nowhere are the disparities in energy costs exemplified more than those associated with schools. A recent study by the Alaska Housing Finance Corporation (AHFC 2012) revealed that one Anchorage school spent an annual average of $190 on energy per student in contrast to a remote school that spent $15,961 per student.

Heating Fuels

Following World War II, the predominant heating fuels in most of Alaska have been heating oil or liquefied propane, which have typically been the cheapest and most convenient options, and for good reason. They are "energy dense," easily transported, and easily stored. In addition, the technology for using them is ubiquitous and easily understood and serviced. Alaska currently has the highest per capita consumption of oil of any state and also the highest oil prices. The price of heating oil has escalated rapidly over the past few decades, approaching $10 per gallon in some places.

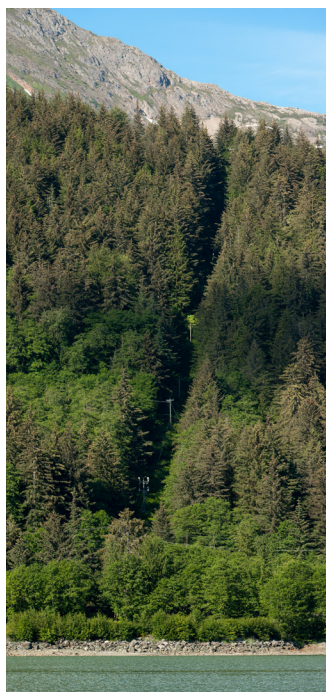
As the world economy has globalized and more people have entered the middle class, the demand for petroleum fuels and the conveniences they bring has risen. At the same time, political instability in key petroleum-producing regions of the world means that world supplies are at greater risk of being disrupted. At least in the short term, Alaska oil prices do not appear to be declining, and rural Alaska will be one of the places that experiences these increases in prices most acutely.

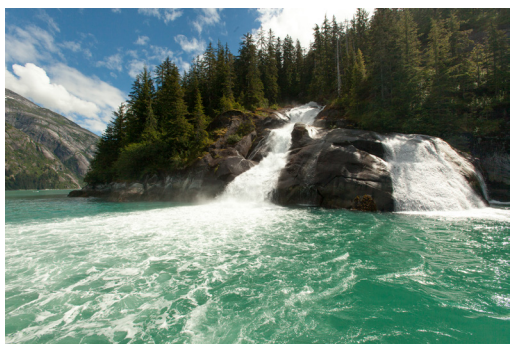
Alaska has vast quantities of natural gas stranded on the north slope oil fields, but only small portions of Alaska have access to piped natural gas, principally the Anchorage, Mat-Su, Kenai, and Barrow areas. Heating costs are comparatively low in these areas. Natural gas in Anchorage costs around $9 per thousand cubic feet, which equates to about $11 per MMBtu. Even low-cost biomass will have a hard time competing with that price. But the efficient use of natural gas in other locations is unlikely any time in the near future because of the lack of customers relative to the cost of building necessary infrastructure.

Liquefied natural gas (LNG) could be an alternative to gas pipelines, except that LNG conversion and transportation infrastructure is also expensive. So even where there is adequate population density, the delivered price of LNG is often higher than with natural gas pipelines.

For the vast majority of rural Alaska, neither natural gas nor LNG is a likely solution.

Hydropower





In southeast Alaska, heating with biomass can help keep electric utility rates from going up. Electricity from lakes, rivers, and dams provides a majority of the electricity in the southeast. This hydroelectric power provides most of the communities with some of the lowest electric rates in the state, cheaper than that for much of the lower 48.

Hydropower is cheap because the "fuel" is free—indirectly harvesting the power of the sun through rainfall at higher elevations. It is also cheap because most of the power plants from which it originates and transmission lines were built decades ago and are fully paid for (some are more than 100 years old). They're like a well-maintained used car that doesn't need gas.

Traditionally, even with the low cost of electricity, it has been cheaper to heat homes and buildings with heating oil (diesel) or propane. However, as the price of these fossil fuels rises, people have been switching to electricity for their heat. And this is putting a strain on the electricity utilities.

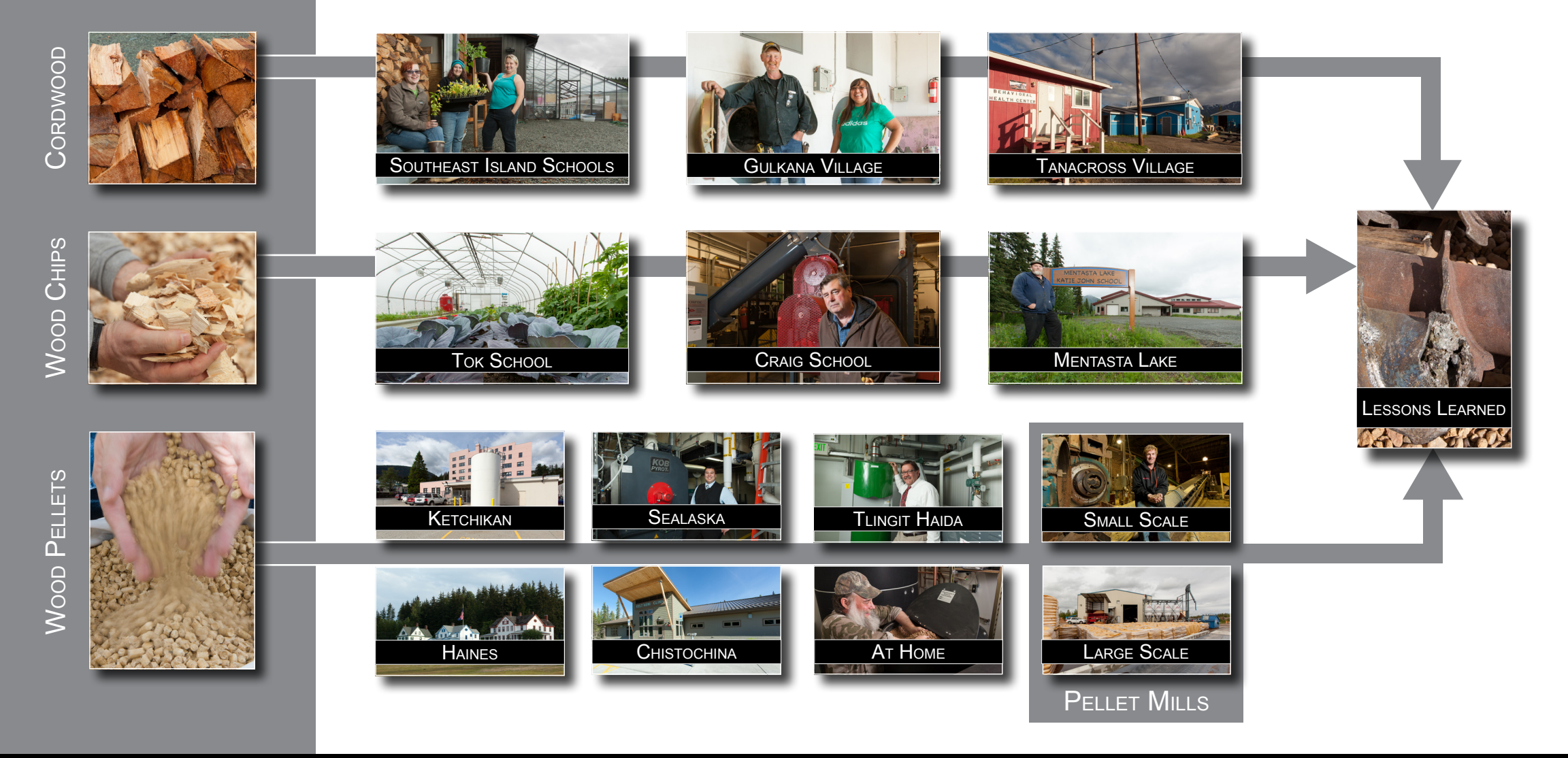
But this cheap generating capacity is limited. When the demand for electricity increases, new power plants need to be built. Diesel power plants are relatively easy and affordable to build, but the fuel cost is very high. New hydroelectric power plants are expensive and can easily take more than a decade to permit and build. Either way, building new power plants will lead to higher electric utility rates.

That's where biomass comes in. Switching to this local and affordable alternative to heating fuels instead of electricity significantly reduces the need for new power plants. This keeps electric rates low. And low electric rates are key to the economic health of southeast Alaska.

Fuel Costs at a Glance

Comparing the cost of energy for different types of fuel is difficult given different units of measurement and energy content. The following tabulation provides a comparison of energy fuel types on an equal-unit basis. (Note: Data based on Fuel Value Calculator published by USDA Forest Service, Forest Products Laboratory, and the Pellet Fuels Institute)

Fuel Type	Conversion Efficiency	Example Unit Price	MMBtu/Unit	$/MMBtu
Natural gas	80%	$11.00/MCF	1.025/thousand cubic feet (MFC)	$13.41
Propane	79%	$3.00/gallon $10.00/gallon	0.0913/gallon	$41.59 $138.64
Fuel oil, #1	83%	$3.00/gallon $11.00/gallon	0.134/gallon	$29.97 $98.90
Fuel oil, #2	83%	$5.00/gallon $7.00/gallon	0.1385/gallon	$43.50 $60.89
Retail electricity	98%	$0.15/kWh $0.60/kWh $1.00/kWh	0.0034/kWh	$43.96 $175.85 $293.08
Wood – 8% moisture content (pellets)	83%	$275/ton $450/ton	15.548/ton	$21.31 $34.87
Wood – 20% moisture content (dry cordwood)	77%	$250/cord $500/cord	22.308/cord	$14.55 $29.11
Wood – 30% moisture content (semidry cordwood)	74%	$250/gallon $500/gallon	21.885/cord	$15.44 $30.87
Wood – 50% moisture content (wet chips)	67%	$50/ton $100/ton	5.66/ton	$13.18 $26.37



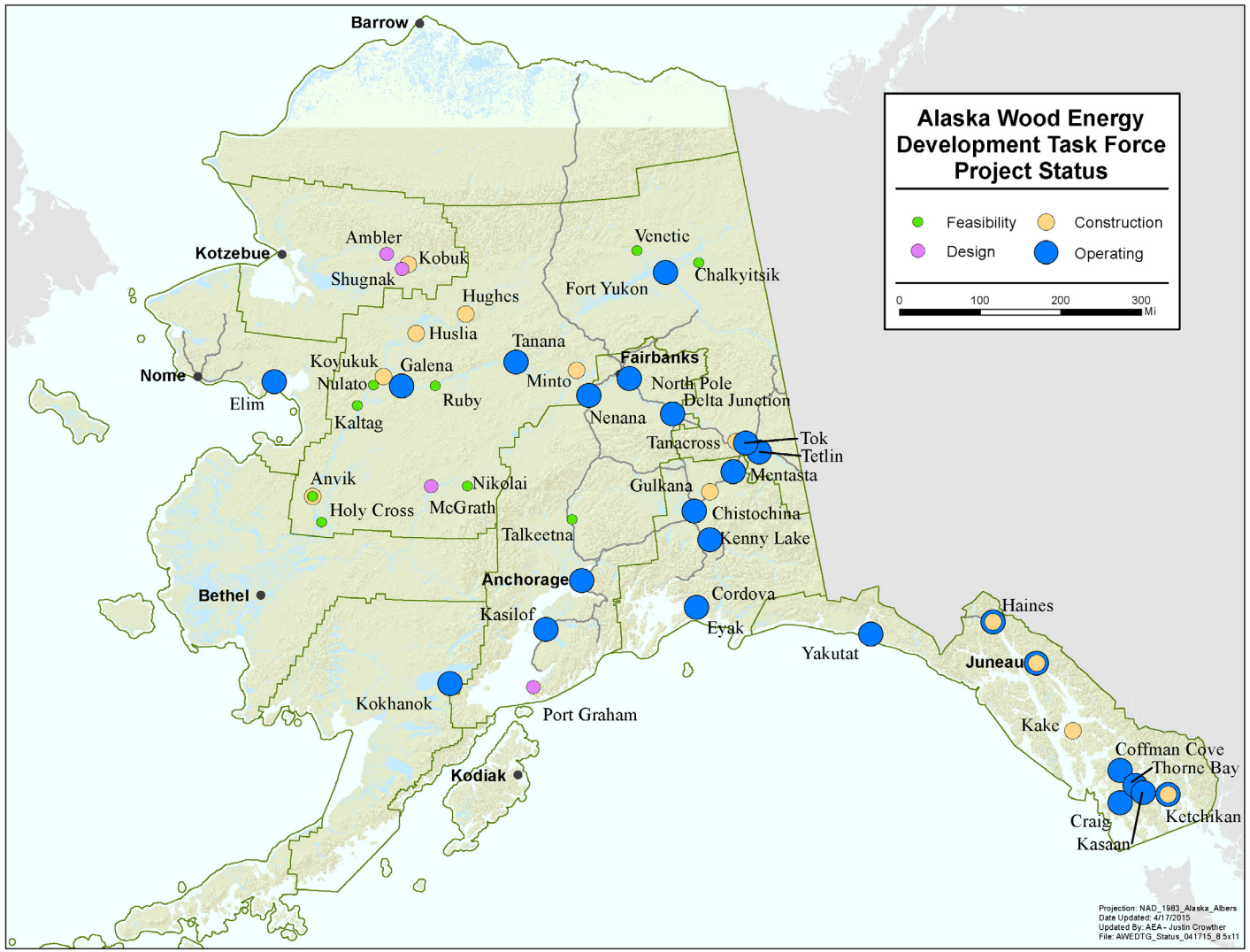
Where Biomass Works

Biomass Project Map

There are many small, rural communities in Alaska that have biomass energy systems. This map shows those projects and their status as of April 2015.

Just What Is Biomass?

Biomass means different things to different people. For this publication, we follow the customary practice in the forest and wood products sector of using the term to mean woody biomass. Woody biomass is typically a byproduct of manufacturing or forest management activities (e.g., wildfire risk reduction, forest health restoration) that can be used for fuel—cordwood, chips (used as is or converted to pellets), sawdust, and hog fuel.



Biomass Fuel Types—At a Glance

Cordwood

Affordable, local supply, labor intensive, small projects

Cordwood fuel needs the least amount of processing and the smallest amount of capital to both process and burn. Modern cordwood boilers can be clean and efficient. The capital investment is typically lower than for chip or pellet systems, but the labor requirement is higher. However, if you have a wood supply and staff that can feed the boilers several times a day, cordwood fuel can work for you.

Wood Chips

Automatic, local supply, large projects

Wood chips are the workhorse of the biomass world. Small working wood chip systems start at about 500,000 Btu/hr (British thermal units per hour) and can be quite large. System complexity and maintenance are similar to coal-fired systems. The capital investment is typically high, but can work for heating 50,000 square feet or more.

Wood Pellets

Simple, automatic, expensive without local source

Wood pellet fuel is the most processed, most uniform, and easiest to use type of biomass fuel. It is also the most expensive to buy. The small uniform size of pellets is similar enough to grains such as corn that the same processing equipment (augers, bins, etc.) used to process these grains can be easily adapted for processing pellets. Pellet systems are suitable for projects ranging from residential to commercial to industrial or projects that are more than 100 miles from a biomass source.

Cordwood

Cordwood, or firewood, is the least expensive of all biomass fuels, but also the most labor-intensive. Locally sourced firewood creates income opportunities for local residents, keeps fuel dollars in the local economy, can mitigate the threat of wildfire, and can improve habitat for wildlife. Cordwood production can be as simple as using a pickup truck (or snow machine/all-terrain vehicle), a chainsaw, and a splitting maul, or it can be fully mechanized with harvesters and automated firewood processors. The fact that cordwood production can be easily scaled up makes it a good fit across a variety of facilities and communities that have access to wood. Most commercial systems are sized between 100,000 and 1,000,000 Btu/hr and often require manual fuel loading several times a day when operating at full capacity.

High-efficiency, low-emission cordwood boilers have proven themselves in numerous applications in Alaska, from washeterias (laundromats and showers), water plants, and health clinics to district heat systems, small rural schools, and greenhouses. However, for the installation to be successful, several conditions are necessary: a sustainable source of wood, dry space for seasoning and storing the wood, compatibility with the building's existing heating system, and a willingness to stoke the boiler several times a day.

There are many cordwood systems successfully operating around Alaska, with most heating between 5,000 and 25,000 square feet.

Southeast Island School District

Facility: Thorne Bay School, greenhouse

Startup date: January 2013 – fully commissioned

Fuel supply: cordwood

Equipment: 2 GARN WHS 2000

Maximum heat output: 650,000 Btu/hr

Cost: $478,179 in grant funding. $102,000 cash and in-kind match from the community

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Facility: Howard Valentine School, Coffman Cove, teacher housing, greenhouse

Startup date: 2010

Fuel supply: cordwood

Equipment: 2 GARN WHS 2000

Maximum heat output: 650,000 Btu/hr

Space heated: teacher housing (4,000 square feet), greenhouse (6,000 square feet)

Cost: engineering $34,000, construction $424,000

Locally sourced firewood is what heats schools and greenhouses throughout the school district. But the energy comes from the students and teachers.

Southeast Island School District

Small communities in the Southeast Island School District (SISD) can struggle to maintain the minimum number of students (10 children) to keep their school open. Employment is one key to community stability. The wood energy experience at Coffman Cove, where jobs were created supplying firewood and keeping the boiler stoked, resulted in enough energy savings to install a commercial bakery thus creating even more jobs. Success in one community can lead to replication elsewhere. In this case, SISD decided that converting the Thorne Bay School to wood heat was the way to go. The lessons learned in putting these systems in place provide others considering a biomass heating system with a valuable resource on which to call.

Engaging everyone in the process, from students and their parents to community members who purchase produce from the greenhouse or supply firewood, builds ownership in the community.

Southeast Island School District: The Students

The boiler is powered by firewood, but the school is powered by students. Some students split the wood. Some students feed wood to the boiler. Some students designed and built firewood crates to reduce the labor costs that were eating into their profits. And, at the end of the day, it is all about eating and profits.

The heat warms the greenhouse so lettuce can be harvested at 11 a.m. and sold to the cafeteria for lunch. Proceeds help pay for extracurricular activities including off-island school trips.

Tim Lindseth (upper right), owner of Cornerstone Excavation Services in Thorne Bay, Alaska, saw an opportunity to diversify his business and provide a biomass utilization opportunity. Management of young-growth stands on the Tongass National Forest is complicated, but having a local market for material not suitable for the existing wood processing infrastructure on the island is an important part of the equation.

Gulkana Village

Facility: Gulkana Village Council, District heating system

Startup date: October 2010

Fuel supply: cordwood and pellets

Equipment: 2 GARN WHS 3200 cordwood boilers and 1 Tarm pellet boiler

Maximum heat output: 1.5 MMBtu/hr

Space heated: 9 buildings totaling 14,000 square feet and their water system

Cost: $500,000

Gulkana is heating their tribal offices and elder housing using firewood. They measure and sell their heat by the Btu.

The tribal heat plant (right) houses two side-by-side GARN WHS 3200 cordwood boilers (above) capable of producing 700,000 Btu/hr each.

Hot water is circulated to several nearby buildings via insulated underground piping, and then integrated with a conventional hot water heating system using a heat exchanger (lower right). A Btu meter (lower left) measures the amount of heat delivered to "customers," allowing the tribe to sell energy to the housing authority. It also encourages residents to use their energy wisely.

The Ahtna people have occupied the Gulkana area for more than 5,000 years. The village of Gulkana was established in 1903 as a telegraph station and was named "Kulkana" after the nearby river. Originally located across the river from its present site, Gulkana was bisected by construction of the Richardson Highway during World War II. In the early 1950s, the first house was built at the new site. Chief Ewan and his family were the first Native residents, and eventually all of the villagers relocated.

Gulkana is located in the continental climate zone, with long, cold winters and relatively warm summers. Temperature extremes range from –65 degrees to +91 degrees Fahrenheit. Annual snowfall averages 47 inches, with 11 inches of precipitation.

The Gulkana Village Council was an early adopter of modern biomass energy. They received funding for a feasibility assessment in 2006 through the Alaska Wood Energy Development Task Group. With funding from the Alaska Energy Authority's (AEA) Renewable Energy Fund and a USDA Forest Service's "Jumpstarting Wood Energy in Alaska" grant, a small district heating system was created to serve several community facilities as well as the Copper River Basin Regional Housing Authority's four residential duplexes.

The system consists of two GARN cordwood boilers and one Tarm pellet boiler. The system is designed so that it can be manually operated in cordwood mode whenever someone is available, or automatically in pellet mode during the night and weekends. The primary source of wood is from hazardous fuels reduction treatments on nearby village lands. The Gulkana Village Council is also currently building a new pellet mill—a larger version of the one they ran several years ago. It is anticipated that the new pellet mill will produce at least 1 ton of pellets per hour, which would provide enough product to supply the local heating system as well as other communities in the Copper River Basin.

Tanacross Village

Facility: Multiuse facility (10,000 square feet)**, water/sewer system heating loop, fire station** (3,400 square feet)**, community hall** (4,500 square feet)

Startup date: under construction

Fuel supply: cordwood

Equipment: GARN x 3

Maximum heat output: 3 x 700,000 Btu/hr

Space heated: 17,900 square feet

Cost: $590,000

Gallons displaced: 26,500

Tanacross Village is similar to villages across Alaska: a washeteria, a school, a clinic, a tribal office, and increasing fuel costs. The system being built could be replicated across the state.

Washeteria (above)—a combined laundromat and shower facility—are big energy users year-round. In many tribal communities, washeterias, clinics (left), administration buildings, and schools are close enough to make small district heating systems practical.

Three GARN cordwood boilers (right) are being installed to provide most of the heat for the Tanacross district heating system.

The old clinic in Tanacross with its one small exam room took a lot of energy to heat (OMB 2012).

Yet, there was a growing need for a new community health care center that could provide not only more health care services but additional social services as well. And this would require even more energy to heat. What to do?

As you drive the roads in the Tanacross area, you cannot help but notice the trees that were brought down by the windstorm in 2012, or those that were killed in wildfires, which, by the way, almost burned down the village. By installing cordwood boilers, these available biomass resources could heat community facilities, create wildfire buffer zones around the village, and save the community money while providing local jobs.

Wood Chips

Large facilities with heating needs of 1 million Btu/hr (MMBtu/hr) or more—such as large schools, hospitals, and district energy systems heating multiple buildings (especially with significant hot water demand)—are best served with fuels that can be delivered to the boiler in an automated fashion, such as by conveyor belt or auger. The most commonly used fuel in these applications is wood chips, although wood pellet systems are gaining traction where pellets are readily available. Wood chips are usually provided by local sawmills, but land clearing and hazardous fuels reduction projects are also major sources.

Wood chip systems come at a price, both in terms of initial capital cost and ongoing operation and maintenance costs. However, if the fossil fuel displacement is large enough and the chips are cheap enough, the financial metrics can be quite favorable.

Because these systems are normally 1 MMBtu/hr or larger, they must also conform to strict Environmental Protection Agency emission requirements, which means that contemporary technologies are more efficient than boilers of old, but also more expensive. Practically, this means you will need to be replacing at least 35,000 gallons of fuel oil annually.

Tok School

Facility: K-12 school and greenhouse

Startup date: January 2010

Fuel supply: chips

Equipment: Messersmith boiler and generator

Maximum heat output: 5 MMBtu/hr

Maximum electric output: 50 kW

Space heated: 75,000 square feet

Cost: $3.2 million

With nearly 200 students, Tok School is one of the larger schools in rural Alaska. Large schools are a good match for an automatic wood chip system. By investing a bit more, it is economically feasible to make enough heat for things like greenhouses—and even generate electricity.

Tok School

David Nicholls

Tok, Alaska, is about 225 miles south of the Arctic Circle in eastern Alaska. Densely stocked stands of white and black spruce forests make the risk of wildfire very high. Tok has the dubious distinction of having the greatest extreme temperature difference in the state of Alaska, ranging from –83 degrees Fahrenheit in January 1981 to +96 degrees Fahrenheit in June 2004. In 2004, 4 million acres of Alaskan forests went up in flames. To reduce threat of fire, trees are cleared around buildings and roads and other infrastructure to create buffer zones. These hazardous fuels reduction treatments generate the woody biomass now used as fuel at the Tok School.

Built in 1996, the Tok School occupies approximately 75,000 square feet. Until firing up its new Messersmith boiler in 2010, it used roughly 51,000 gallons of fuel oil annually. By 2013, the school was also generating electricity with the boiler and a small steam turbine, saving the school district about $350,000 a year—enough to employ two new staff: a counselor and music teacher (Alaska Public Media 2014). In 2014, a new greenhouse and food processing facility heated by the same biomass heat plant as the school were added, providing fresh produce for student lunches. A second greenhouse is planned for 2015. Wood ash from the boiler is recycled and used as a local soil amendment.

Tok School (cont.)

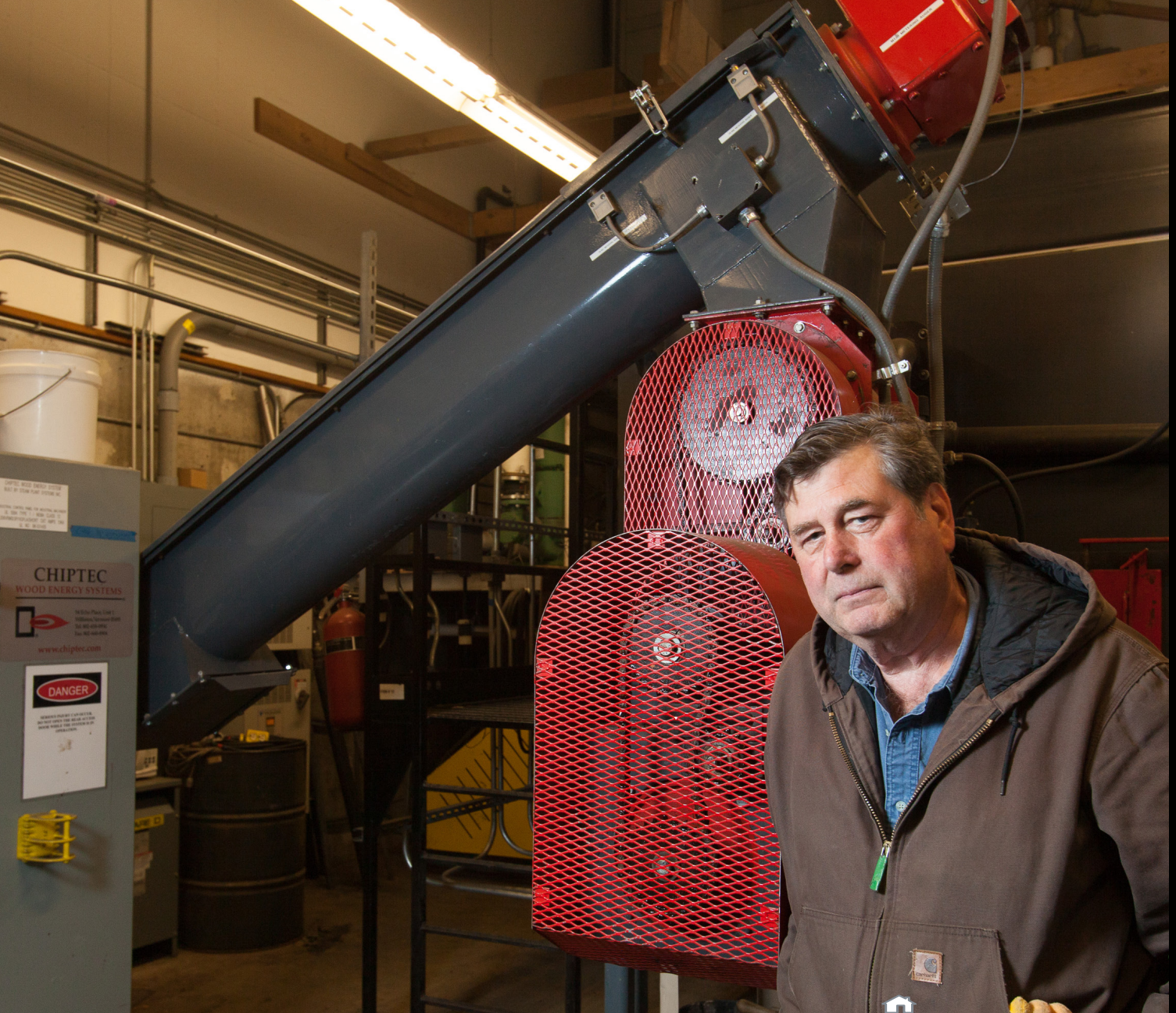
David Nicholls

Tok School (upper left) is primarily heated from wood chips made from local wildfire mitigation projects, making the marginal cost of heat low enough to heat a greenhouse in the winter.

Tok School (cont.)

When a biomass project is large enough, it can sometimes make sense to generate electricity, especially if you are paying $0.60/ kWh—more than five times the U.S. national average.

Chips are stored and kept dry inside the heat plant (a). Augers transport the chips from the main bin (b) to the boiler (c) where they are burned to create steam. An electrostatic precipitator (d) scrubs particulates (e.g., smoke) from the flue gas before going up the chimney. The steam passes through a turbine to spin a generator that produces electricity (e). The steam is then condensed into hot water and circulated throughout the school for heat (f).



Craig Aquatic Center, Elementary and Middle Schools

Facility: Aquatic Center (12,600 square feet)**, elementary School** (16,659 square feet)**, middle school** (16,295 square feet)**, middle school gym** (10,267 square feet)

Startup: 2008

Fuel supply: chips

Equipment: Chiptec, hot water

Maximum heat output: 4 MMBtu/hr

Space heated: 85,080 square feet

Cost: Design and engineering—$100,000, construction—$1,457,055

The remote coastal village of Craig on Prince of Wales Island isn't the most convenient place to test new technology, but it is a great place to find committed pioneers like Greg Head, facilities and maintenance supervisor for Craig City School District.

Larger Schools and Aquatic Centers: Craig

Karen Petersen

Karen Petersen

Craig, Alaska, is a community of about 1,200 people located on Prince of Wales Island in southeast Alaska. Craig's economy revolves around commercial fishing, fish processing, health care services, and timber harvesting and processing.

Craig is surrounded by water, making knowing how to swim an essential life skill. The Craig Aquatic Center is the only public swimming pool on Prince of Wales Island and serves more than 5,000 people. In addition to offering swimming lessons, the aquatic center serves as a health and fitness center and offers low-impact, aquatic physical therapy. Heating the 10,000-gallon pool in this cold maritime environment cost about $88,000 in 2006. Today, annual propane costs would run between $100,000 and $120,000.

Nearby are the Craig Elementary and Middle Schools, which serve about 200 students. The aquatic center and the school buildings share a wood chip-fired boiler. This was Alaska's first major, nonindustrial biomass district heating system and represents the first schools in Alaska to be heated with wood chips. In 2004, the Craig School District was spending more than $45,000 a year to heat the schools. In 2008, with the spike in fuel prices, that cost would have been nearly $230,000.

With a large sawmill just a few miles away, wood chips were the ideal solution to budget-busting heating costs. Depending on the weather, the Craig Aquatic Center/ Elementary School/Middle School system burns 750 to 800 tons of green mill residuals, and achieves annual fuel cost savings of about $100,000 a year (UAF 2008).

Before installing the system, Jon Bolling, Craig City Administrator said, "I didn't want there to be a blue haze of smoke over our town, and I didn't want people complaining and coughing because of effluent in the air" (BERC 2009).

But after the system was in place he admitted, "We've had people ask why we're not operating our wood boiler. Sometimes when it's running, you can't see steam coming out of the stack."

Mentasta Lake

Facility: District heat system, school

Startup date: October 2014

Fuel supply: chips

Equipment: Portage and Main, hot water

Maximum heat output: 500,000 Btu/hr

Cost: $460,000 grant, $50,000, in-kind match

Cordwood solutions aren't for everyone. Mentasta Lake is pioneering a small-scale automatic wood chip solution that could become a standard in many remote villages.

Native Villages: Mentasta Lake

The biomass heat plant (upper left) houses the wood chip boiler (left) and hot water storage tank (below). Hot water is circulated through underground insulated tubing to several of the nearby buildings (above).

The best-known route of Alaska Native immigration across the Alaska Range passes through the Mentasta Lake area. The families presently residing in Mentasta Lake come from Nabesna, Suslota, Slana, and other villages within the area and are heavily dependent upon subsistence activities.

Mentasta Lake is located 6 miles off the Tok-Slana Cutoff of Glenn Highway on the west side of Mentasta Pass, 38 miles southwest of Tok Junction. Located in the continental climate zone, it experiences long, cold winters and relatively warm summers. Temperature extremes range from –57 to +93 degrees Fahrenheit. Average annual snowfall is 69 inches, with a total of 16 inches of precipitation per year.

In 2007, the Alaska Wood Energy Development Task Group gave the Mentasta Traditional Council a grant for a feasibility assessment. The project involved a district heating system for the community hall, recreation center, elders' center, health clinic, post office, and village council office. All were located in proximity to each other with a combined fuel usage of about 6,000 gallons of oil annually. The Mentasta Traditional Council received funding in 2013 (Alaska Energy Authority Renewable Energy Fund) for design and construction of a district heating system, and construction began in 2014. The Mentasta Lake Katie John School (named for Alaska Native rights leader Katie John and part of the Alaska Gateway School District) was later added to the system. The school had consumed about 13,500 gallons of fuel oil annually.

The selected system was a Portage and Main EnviroChip series chip-fired boiler. This is the first installation of this size and style boiler in Alaska and, if successful, could prove to be a model for other small facilities. The automated system is designed to operate with minimal manual labor; chips are delivered to the boiler by means of a motorized auger, and ash is removed automatically. Connections to the various buildings consist of underground insulated plastic tubing.

Initially, it is anticipated that the chips will come from Tok, generated from the same hazardous fuels reduction material that is fueling the Tok School biomass heating system.

Wood Pellets

Wood pellets are of uniform size, have high energy density, and are easy to use. The small, uniform size of pellets helps simplify boiler system design, thereby increasing reliability and reducing construction and maintenance costs versus wood chip and cordwood systems.

Pellet boilers are nearly as easy to operate as an oil boiler and are highly automated. The pellets are easy to store using agriculture storage bins and augers customized to your needs. Scalability is also a benefit: wood pellets operate in a wide range of equipment, from small residential space heaters to large industrial boilers.

High-energy density relative to cordwood and wood chips increases the value of wood pellets, which is important in Alaska where shipping costs play such a large role. But there are very few local suppliers. Most pellets in Alaska are imported from British Columbia or the lower 48 via barge, which can double the price, making pellets two to three times as expensive as wood chips on an equivalent Btu basis. The benefits of pellet systems can be substantial, but the costs must be carefully weighed.

Ketchikan Federal Building

Facility: Office building

Startup date: January 2012

Fuel supply: pellets

Equipment: ACT Bioenergy

Maximum heat output: 1 MMBtu/hr

Space heated: 49,000 square feet

Cost: $450,000 (does not include building retrofit of $4.247 million)

Equipment: $193,000

Installation: $260,000

The General Services Administration (GSA) invested in helping to create local demand for wood pellets. Local entrepreneurs stepped up to make and deliver wood pellets, reducing the need for pellets to be shipped in from out of state.

Ketchikan Federal Building

Building engineer Joe Kuharich shows the small amount of ash this boiler produces, and assures, "It is no different than taking care of an oil-fired boiler." The biggest problem has been that the system was designed for the coldest winter days, so it only runs at maximum efficiency a few days a year. A smaller system would have been a better solution.

The white external 20-ton silo holds enough pellets for several months of heating.

Pellets are transported from the exterior pellet silo (right) into the boiler room (right) through this 4–inch flexible auger.

The GSA Alaska Region installed the system at the federal building in Ketchikan, Alaska, and submitted the project to the Green Proving Ground (GPG) program. The GSA's GPG program contracted with the U.S. Department of Energy's National Renewable Energy Laboratory to assess the installation and the technology. The system serves as a demonstration to assess actual system efficiencies, as well as operating characteristics and financial benefits. In addition to installation and operational issues, the project team/researchers examined other issues, including fuel transportation costs, building energy savings, and overall economics.

The GSA is interested in biomass heating technologies as conventional fuel prices are high in remote locations, biomass fuel is abundant in many remote areas, and GSA is interested in supporting a biomass fuel market in Alaska and the Northwestern United States. This ACT biomass boiler can burn pellets or wood chips, is generally low maintenance, and boasts smooth fuel delivery through an auger. An automatic ash-removal system avoids interruptions.

Owing to the oversizing of the boiler and the low capacity factor of the system, the payback period is around 30 years. A smaller system could have been installed meeting 60 percent of peak load and having a shorter payback period of around 5 years.

In the future, the excess heating capacity could be shared with nearby public buildings using underground insulated pipes. In fact, the new fire department building next-door was designed with this possibility in mind.

Sealaska Corporation

Facility: Sealaska Plaza (office building)

Startup date: 2010

Fuel supply: pellets

Equipment: KÖB/Viessmann

Maximum heat output: 750,000 Btu/hr

Space heated: 58,000 square feet

Cost: approximately $750,000

Fuel displacement: 35,000 gallons/year

Sealaska is investing in both supply and demand. They created a bulk pellet distribution operation that supplies their downtown Juneau buildings. Their long-term goal is to be part of the pellet-production process, too.

The Sealaska Building in downtown Juneau (upper right) is heated in large part by this fully automatic 750,000 Btu/hr KÖB/Viessmann pellet boiler (above). Wood pellets are delivered several times a month in bulk by this converted grain delivery truck (right).

With a 30-year-old heating system that guzzled oil (very expensive oil in 2006–2007), Sealaska Native Corporation had to decide how they would replace their aging boiler at their headquarters building in Juneau. Owning large tracts of timberlands and under an active forest management program, Sealaska saw an opportunity for increased benefits from biomass utilization.

They opted for a pellet boiler, the first to be installed in Alaska. The purpose of this installation was to demonstrate the viability of this technology and to hopefully act as a catalyst towards more biomass development in the region and the state.

The challenge of pellets in Juneau is that they currently have to be imported from the lower 48. Shipping to Juneau roughly doubles the purchase cost. Plus, it requires Sealaska to own and operate its own pellet delivery truck.

While the pellets are still substantially cheaper than heating oil, they might be even cheaper if there were a local pellet manufacturer in or near Juneau.

Tlingit-Haida Regional Housing Authority

Facility: Tlingit-Haida Regional Housing Authority, warehouse and shop

Startup date: 2013

Fuel supply: pellets

Equipment: Maine Energy Systems

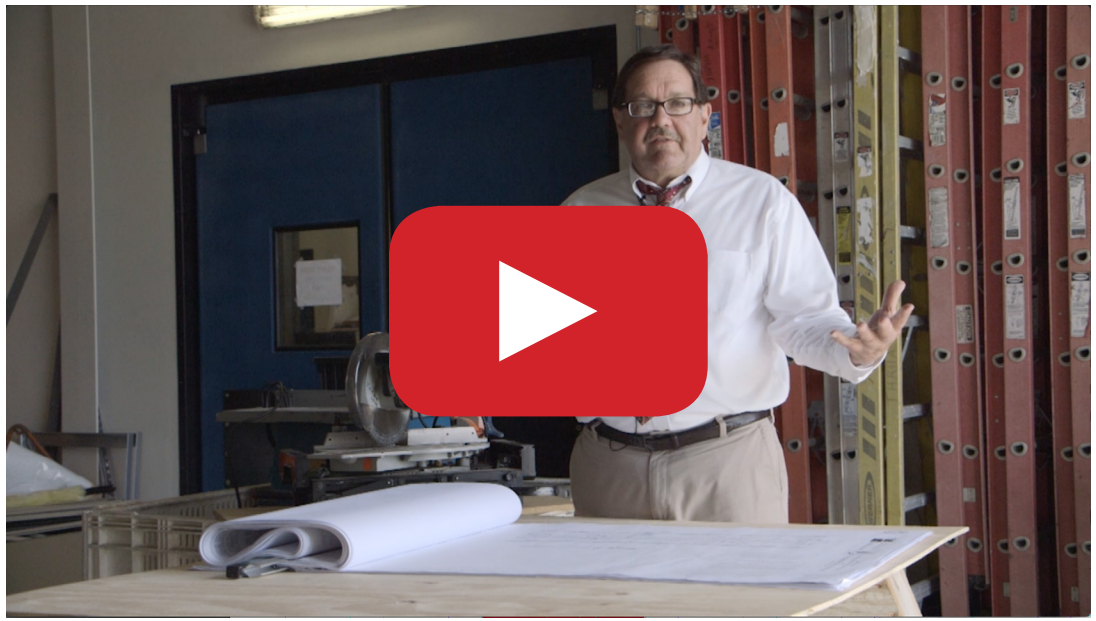
Maximum heat output: 191,000 Btu/hr

Space heated: 10,000 square feet

Cost: $65,000 (wood pellet system only)

Tlingit-Haida Regional Housing Authority is actively preparing to expand the use of biomass in their remote communities by first getting things right in Juneau.

Tlingit-Haida Regional Housing Authority



In 2013, the Tlingit-Haida Regional Housing Authority (THRHA) built a new maintenance headquarters in Juneau and installed a pellet boiler to heat it. Their pellets are delivered by Sealaska's truck with pellets coming from the lower 48, causing THRHA to experience the same higher pellet costs as Sealaska due to increased transportation costs. They too, are hoping for a local source of pellets in the near future.

THRHA had a goal to test out this energy technology for potential deployment in the housing inventory that they own and manage throughout southeast Alaska.

After a year of operating the system, they have been convinced that the technology is mature, low maintenance, and cost-effective. They are now developing plans for installing similar systems throughout their property portfolio.

Haines Borough and Chilkoot Indian Association

2012	Chilkoot Estates low-income housing
2012	Haines Borough Senior Center
2013	Chilkoot Indian Association office building
2014	Sporting goods and grocery store
2015	High school and nine other buildings
201?	Regional pellet mill

Learn from your neighbors. Improve on that. Have your neighbors learn from you and improve on that. It is a virtuous cycle that is transforming Haines, Alaska, into a Pellet Community.

"I am the fourth generation of my family to live in this wonderful community. Haines traditionally is a financially disadvantaged area. We have a lot of people who are underemployed, part-time employed, and unemployed," explains David Franklin Berry, Jr., tribal administrator of the Chilkoot Indian Association, located in Haines, Alaska.

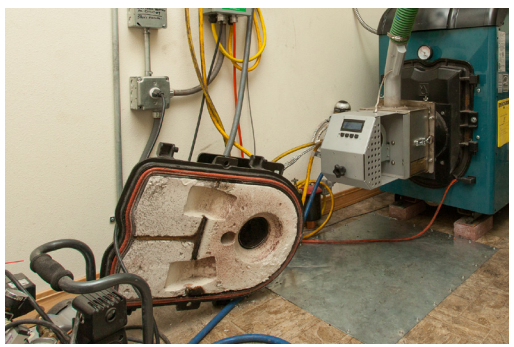
It was this desire to create opportunity for the tribe and keep valuable energy dollars in the community that brought biomass to town.

Their first project heats the two fourplexes they were building in Chilkoot Estates subdivision. Proactively managing energy costs is key to keeping affordable housing affordable. Flexibility and redundancy are key to successfully introducing a new and unfamiliar technology to a small, remote community.

With financial help from the U.S. Forest Service and the Renewable Energy Alaska Project, the eight-unit housing project was opened in November 2011. Construction of this project was funded by the Renewable Energy Fund.

The dual-fuel boiler systems of the fourplex in the foreground and the identical fourplex in the background are connected by underground insulated piping (similar to the pipe shown on the right). If one boiler goes down, they can borrow heat from their neighbors.

By opening and closing a few valves (left), hot water from one building can be shared with the other. Not only does this provide backup redundancy; but in the warmer seasons, just one boiler needs to run, significantly reducing the wear and tear from cycling the boilers on and off.



Scott Hansen (left), transportation coordinator for the Chilkoot Indian Association, explains how the burner (above) of this 185,000 Btu/hr Pellergy boiler can be switched from pellets back to heating oil if necessary.

For fuel convenience, they selected wood pellets. In terms of delivery, refueling, and system automation, pellets are much more similar to heating oil than cordwood or wood chips.

For fuel flexibility, they selected a boiler that, with a small amount of work, can be configured to burn either wood pellets or heating oil. If they can't get enough pellets, they can switch back to their conventional supply.

For redundancy, they connected the two buildings' heating systems using underground insulated hot water piping. If one of the boilers breaks down—or it just isn't cold enough to need both—heat can be shared. This has proved itself on more than one occasion when one of the boilers needed unplanned maintenance. No one was left in the cold.

As seen in the picture on the left, the boilers are fueled by bagged pellets. While it is more labor intensive to fill hoppers by hand than with a bulk storage silo, it allows the pellets to be sourced and delivered through well-established commercial channels. It has also turned into a profitable business venture supplying pellets to others in the community.

Haines: Senior Center

The silo on the side of the Senior Center (above) holds 12 tons of pellets—about a year's supply. Unfortunately, it is a bit too tall for many pellet delivery trucks.

Haines Borough has never let its small size or remoteness stand in the way of thinking big. Although there are only 2,300 or so residents, "...we have a lot of people who are willing to take that extra step just to make things happen," explains Christina Baskaya, special projects manager for Haines Borough, whose grandparents moved here after World War II. "You do whatever you can do to survive, but it's more than just surviving—you create an environment that you want to live in."

Haines' local Energy Sustainability Commission was looking for local energy alternatives to importing heating oil. Seeing the success of their neighbors at the Chilkoot Indian Association got the borough thinking seriously about biomass. The opportunity presented itself when the borough received a grant to weatherize their Senior Center.

In spite of an initial biomass feasibility study not being encouraging, they persevered.

Darsie Culbeck, assistant to the Director and biomass champion, elaborates, "I talked to some guy in Maine who had three of these boilers and their public works director told me, 'It takes about seven minutes a week.' ... The feasibility study says it's going to be three hours a week. Wait a minute something is different here."

So they decided to just do it. "We took kind of the leap of faith that it would work ... It was an experiment."

The borough used its own money to select and buy the pellet boiler—an Auto Pellet from Maine Energy Systems. "We lucked out. ... It worked out so well, we picked a boiler that has worked flawlessly."

Not everything worked out as well as they'd hoped. The pellet silo is so tall that it can only be filled by one of the region's pellet delivery trucks. And, because of a lack of instrumentation and measuring protocols, they have had a lot of trouble figuring out exactly how many tons of pellets they are using.

109,000 Btu/hr pellet boiler heats the 3,500-square-foot Senior Center.

Haines: Chilkoot Indian Association Office and a Local Business

The Chilkoot Indian Association was paying attention to what the borough was doing too (after all, many tribal members are active residents of the borough). Seeing how well the boiler was working at the Senior Center, they decided to use the same system for their new tribal office building (left).

Selecting a good boiler is important, but having the same system as your neighbors can change the game. The maintenance is easier and a whole lot cheaper—the same instruction manual, the same training class, and just one set of critical spare parts that can be shared.

These projects have been so successful that local business owner and second-generation Haines resident Doug Olerud (upper right) installed the same system for the family-run sporting goods shop and grocery store (lower right).

Doug Olerud—Olerud's Market Center and adjacent Alaska Sport Shop.

David Berry, Jr., tribal administrator of the Chilkoot Indian Association, explains how this pellet boiler heats their new office building.

Creating demand for wood pellets is half the equation. Supplying those boilers is the other half. Today, The Chilkoot Pellet Project imports, warehouses, and delivers pellets. The hope is to create a large-enough regional demand that pellets can be locally manufactured.

In July, 2014, Haines Borough received a grant for $1,237,403 from the Renewable Energy Fund and matched it with $86,448 of their own funds to take things to the next level—10 buildings including the Haines High School and community pool. When it is complete, more than 130,000 square feet of public buildings will be heated from wood pellets.

Chistochina Energy District

Facility phase 1: clinic, tribal office, community hall

Facility phase 2: shop, annex, washeteria

Startup date: pending (projected fall 2015)

Fuel supply: pellets

Equipment: KÖB/Viessmann

Maximum heat output: 750,000 Btu/hr

Space heated: three buildings totaling approximately 10,000 square feet, in phase 1, adding three more buildings in phase 2

Pellet silo storage capacity: 45 tons

Cost: about $500,000 to date

The desire to heat with wood and save money created a project with a broad scope. Fiscal reality has delayed some plans, but Chistochina is a project that continues to evolve.

The containerized pellet boiler system (left) reduces onsite installation complexity and costs, so communities can focus on the things that matter—like this modern dental office (below).

Surrounded by an estimated 1 million acres of beetle-kill timber in the Copper River Basin, the Chistochina community decided that using some dead wood to heat facilities made sense over using heating oil (Copper Valley Development Organization, Inc. 2012). In 2008, a report examining the scenario of heating several community buildings was conducted. Lacking other options, a cordwood-fired system was initially thought to be the best solution. However, with the construction of pellet plants in North Pole and Gulkana, pellets were deemed more suitable.

Economics was the primary driver for the move to biomass heating. However, things do not always work out as planned. The budget was insufficient to accomplish the original plan. The project was rescoped to reduce the number of buildings and carry out the project in phases. Phase 1 included heating the clinic, tribal office, and community hall; phase 2 would heat the washeteria, annex, and shop.

The new clinic opened in June 2013. Unforeseen construction costs have delayed completing the pellet boiler system, but the community is hopeful that funding challenges will be overcome and work will resume later in 2015.

Heat from the pellet boiler (left) is delivered to the various buildings by circulating hot water through buried insulated piping (above).

Karen and Jim's Home

Facility: Single-family residence

Fuel supply: pellets

Equipment: Woodmaster Flex-Fuel

Maximum heat output: 200,000 Btu/hr

Space heated: 4,000 square feet

Annual savings: $2,000 to $3,000

Jim Baichtal shows off his state-of-the-art automatic pellet boiler that heats their 4,000-square-foot house in Thorne Bay, Prince of Wales Island.

Karen and Jim's Home

When Karen Petersen and Jim Baichtal began building their new house in Thorne Bay, they decided to look at a biomass heat system that could heat not only the house and the garage—a total of 4,000 square feet—but also the future greenhouse and hot tub. They had several things the heat system needed to do: work well with in-floor piping, heat the domestic hot water, and be versatile in the type of fuel it could use. They also wanted to buy American made.

After searching extensively on the Internet, they found a Woodmaster Flex-Fuel that met all the required EPA Phase 1 and Phase 2 emission regulations. The Flex-Fuel can use either pellets or cordwood, and since installation in 2011, they have operated the boiler on wood pellets. Jim estimates they use about 13 tons of pellets per year—offsetting around 1,500 gallons of heating oil.

Although pellets delivered to Thorne Bay cost more than $300 per ton, with the cost of heating oil around $4 per gallon, Jim estimates they save more than $2,000 per year.

After an initial operational learning curve, both Jim and Karen said they love their boiler! "We like knowing that our fuel comes from a sustainable source ," says Jim, "and we like being a part of the energy solution in our state."

Tongass Forest Enterprises

Larry Jackson is an entrepreneur and owner of Tongass Forest Enterprises. He makes products from local wood—from cabins to cabinets, and everything in between. In the process, he creates a lot of sawdust. Disposing of the sawdust used to be a problem. Now it's feedstock for his new pellet mill.

Tongass Forest Enterprises

Driven by a need to use waste material from his forest products operation, which produces custom building products, Larry Jackson (owner of Tongass Forest Enterprises) considered pellet production an obvious value-added choice to add to his product line.

This was especially true because GSA had just announced its intent to convert the energy system of the federal building in town to wood energy—a pellet boiler, to be exact. And then the new library also installed a pellet boiler. The Ketchikan Gateway Borough is pursuing additional biomass energy systems at both the airport terminal and the high school. This is good news for Tongass Forest Enterprises as there is no current regional demand for bulk production of pellets, meaning his pellet machine isn't operating at full capacity.

Producing pellets not only helps Tongass Forest Enterprises deal with its residuals from its primary wood production line but, according to Larry Jackson, "It reduces importing of heating fuel, saves the taxpayer money on heating public buildings, adds jobs to the local economy, and diversifies the energy supply of the region."

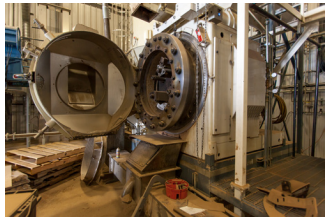
Tongass Forest Enterprises (cont.)

Tongass Forest Enterprises started off making wood pellets from the dry mill waste from their wood products manufacturing line. Now, with the addition of a homemade waste-wood-fired dryer (above), they are also able to use green waste and low-grade roundwood not suitable for lumber production.

Superior Pellet Fuels

With a name like Superior Pellet Fuels, you would think that is their only product. In fact, they have expanded their line to include densified “fire logs.” Their philosophy is to use locally available raw materials and have their products used to heat Alaska.

Superior Pellet Fuels



Superior Pellet Fuels makes wood pellets and densified fire logs from sawmill residues and wood from community wildfire risk-reduction projects.

Superior Pellet Fuels is located in the town of North Pole, Alaska, near Fairbanks. It is Alaska's first large-scale producer of wood pellets.

Their raw material is sourced from local sawmill residues, land clearing, and fire risk reduction treatments on nearby forestland. They may even take recycled materials. Essentially, they are using the lowest quality wood in the industry that might otherwise be burned or left on site (Fairbanks Daily Newsminer 2012).

They have just added a densified fire log product (12 inches long by 3 inches diameter) that is being well received in the wood-burning community. Both pellets and densified fire logs have benefits for improved air quality. This is especially good news for Fairbanks, which has struggled to meet federally mandated air quality standards.

At last count, the company employed 20 full-time employees. This does not include seasonal employees involved in supplying raw material or other associated jobs. According to a study by the Fairbanks Economic Development Corporation, it will directly add $4 million to the local economy, with another $4 million expected in indirect benefits.

And best of all, their product is consumed in the state of Alaska, keeping dollars local.

Most of these projects were built to gain practical experience in Alaska. Here are some of the key lessons:

- ✓ **Before embarking on a biomass project, conduct a feasibility study to determine its technical and financial viability.** This study needs to be conducted by a highly qualified professional with hands-on experience with biomass boilers. There are many evaluators who claim to have biomass system credentials to secure jobs, but in fact have little practical experience or have a bias towards other technologies or against biomass. It is highly recommended to have any feasibility study reviewed by a biomass expert to ensure that the correct assumptions are used and that the conclusions are valid. When an analysis projects 20 or more years into the future, small mistakes can be amplified into large errors.
- ✓ **The first consideration should be energy efficiency.** An efficient facility results in smaller, more efficient, less expensive boilers, and less fuel consumption. Additionally, if a boiler system is installed prior to future efficiency enhancements, the result can be an oversized and suboptimal boiler system.
- ✓ **Use engineers who have experience with biomass boilers.** Architects and engineers should have knowledge and experience with installing different systems. Otherwise you could end up with a nonfunctioning system.
- ✓ **Properly size the boiler.** The most common mistake observed in Alaska biomass system installations is the oversizing of the boiler. If in doubt, go smaller. Another common mistake is the inadequate size or complete lack of thermal storage in a system. For biomass boilers, which cannot be as easily switched on and off as oil or electric boilers, thermal storage acts as a "flywheel," providing smooth and efficient system operation.
- ✓ **Do not rely on the manufacturers and vendors only.** It is wise to do solid background research on candidate systems. Contact a number of facilities that have operated the systems for an extended period of time. Talk with the people doing the operations and maintenance if possible. Any boiler you install will likely be around for 30 years.
- ✓ **Budget busters.** Be sure to include in your budget any costs for transporting equipment and materials as well as for installation. While it may be difficult to know in advance, also take into account costs associated with weather-related and other potential delays in construction. Most of the biomass thermal energy systems are shipped to Alaska. If you need support, it will most likely involve someone traveling a long way to get to your location, a situation you may not have accounted for in your original budget.

Lessons Learned (cont.)

- ✓ **Followup support.** Support from the manufacturer of your system after you have purchased it is critical. One public works director recommended talking with clients who have purchased systems, not just the salesperson. Operations' people know what is happening with systems so make sure you talk with them. If several of these systems are in place, facility managers can talk with one another to troubleshoot problems and benefit from each other's experiences. Having someone local to help train operators on the system(s) is beneficial.
- ✓ **Feedstock supply and quality.** Unanticipated maintenance costs can occur owing to feedstock quality (e.g., size, moisture content, contamination). Ensuring the quality of feedstock supply is critical. It is recommended to have detailed supply contracts in place. Access to feedstock may also be limited at certain times of year.
- ✓ **Monitoring.** In some of the existing biomass facilities in Alaska, project managers have had difficulties measuring exact fuel savings. In one case, this was because they combined a heating system replacement with other weatherization upgrades, making isolation of fuel savings difficult. It is relatively inexpensive to install monitoring systems during project construction, but may be cost prohibitive to add after the boiler is operational.
- ✓ **Capture opportunities.** Lack of monitoring data has afforded an opportunity to work with the local schools in their science and math curriculum in designing measurement systems and calculating feedstock volume usage. By engaging young students in the technical analysis and enhancement of biomass systems, you create the next generation of biomass advocates and expertise.
- ✓ **It's not just the technology.** Community challenges and opportunities are also important. (See "Using Biomass in Your Community.")
- ✓ **It's not just biomass.** In many cases, biomass may not be the only local energy solution, so it should be integrated into the larger local energy portfolio in a way that is mutually beneficial.

Using Biomass in Your Community

Benefits of Biomass Utilization

It's about doing things right. It's about stewardship. There are good ways and bad ways to do everything. Using woody biomass sustainably has benefits at many levels: at the global level, where carbon and greenhouse gas emissions have long-term implications; at the regional level, where maintaining healthy forests provides clean air, water, recreation, and wildlife habitat; and at the local level, providing jobs, economic resiliency, and energy security.

Environmental. It is not about cutting down trees for energy production. Biomass is removed through a variety of forest management activities including stand improvement, timber harvest, fire-risk reduction, and forest health restoration (Malmsheimer et al. 2011). Active management can keep forests healthy and growing at optimal rates. This can work well for areas such as southeast Alaska, where the objective is to transition its forest products industry from a dependence on old-growth timber to using raw materials from actively managed young-growth stands, (USDA FS 2014b). Growing trees absorb carbon dioxide (CO_2) from the atmosphere. This CO_2 is released back into the atmosphere when wood burns—whether in a wildfire, slash pile, or boiler. The net effect of using biomass rather than fossil fuels for thermal energy is fewer emissions and a reduction of your carbon footprint.

Economics. Keeping dollars local is a major benefit of using locally sourced woody biomass over imported fossil fuels. Job creation through forest management activities and fuels reduction projects is not just in the woods. People are needed all along the supply chain (e.g., transportation, processing) creating a ripple effect throughout the region.

Your Biomass Supply

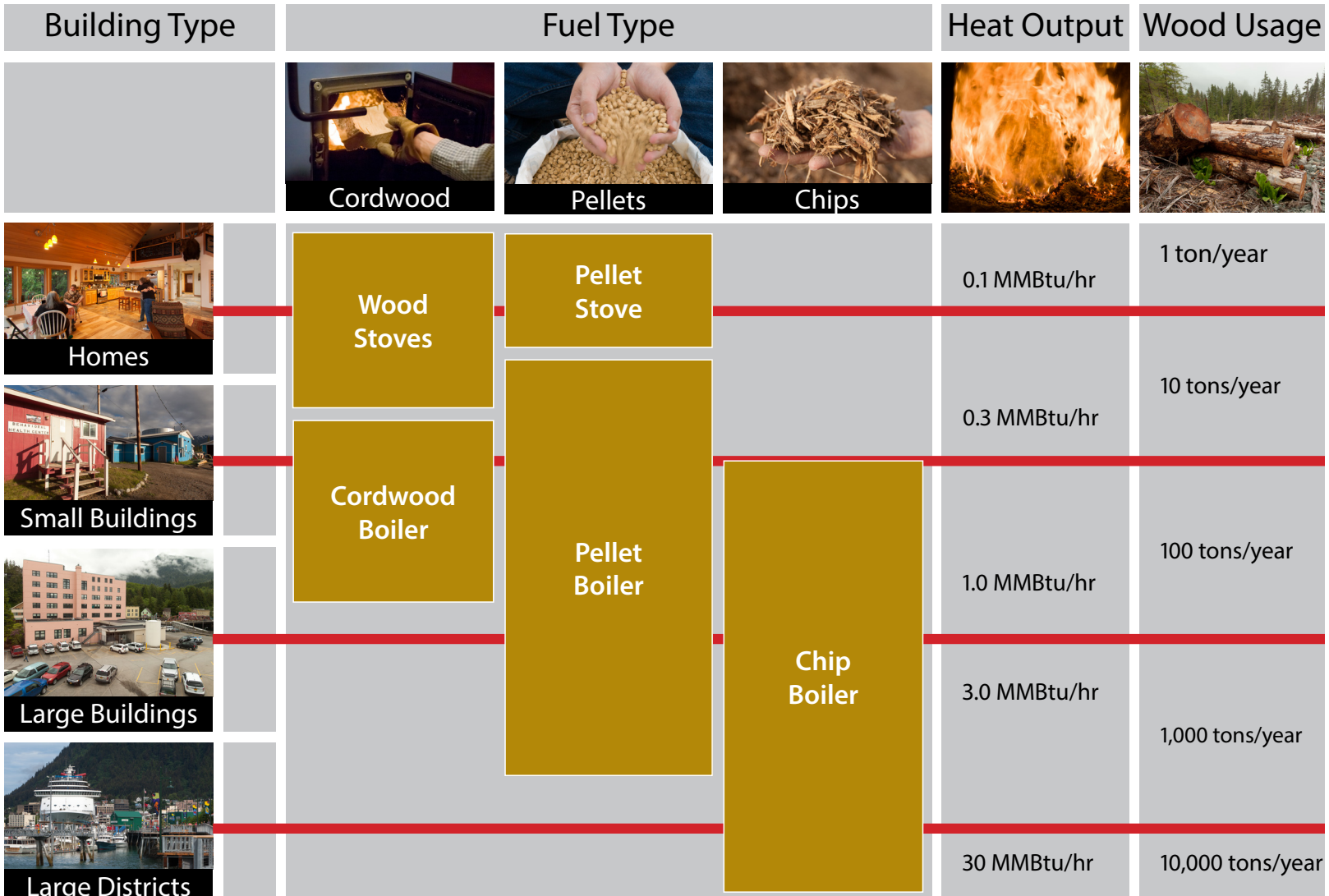
Your biomass supply is a huge part of the equation. Modern wood stoves, chip systems, and wood pellet appliances are highly mechanized, energy efficient, and meet strict standards for air quality emissions. Each system will have a preferred fuel specification. Some chip systems, for instance, can handle variable consistency, lower-quality fuels (often called hog fuel) but can require more maintenance. Wood pellet appliances rely on a more consistent fuel quality.

Regardless of the fuel, it is very important to match your system to the available fuel source.

Success or failure of a project can depend on access to an affordable, consistent source of biomass fuel that meets the operational needs of your boiler. Selecting the right technology is one of the most important choices you'll make. The following pages highlight key considerations when planning your wood heating system.

Matching Technology to the Fuel and Application

The size of your project is an important factor in determining the right technology. For smaller projects, wood pellet or cordwood systems offer the best choice. Pellet systems and appliances have automated fuel handling and low emissions but at a higher cost than cordwood systems, which can be labor intensive. For larger projects, wood chips often are the lowest cost solution but require close attention to fuel quality control. This chart (adapted from CSFS 2011) provides a rough idea about which technologies are most appropriate for your application.



This chart provides a rough idea about which technology makes sense for various applications. It is not a planning or design tool.

Clean Technology

A modern wood burning boiler, properly maintained and operated, is energy efficient, has low emissions, and looks nothing like the technology of even a decade ago. For example, European regulatory agencies have measured emissions from advanced pellet boilers to be on par with many oil boilers. However, not all technology is created equal. Seriously consider the following:

The right design. Select technology that is proven capable of meeting your local emissions requirements.

Match technology to your supply. Many systems are designed to burn biomass that has a particular moisture content. Using biomass outside of that range can lead to serious operational problems, including air quality issues. Be sure to select a system that is designed to work with your biomass supply. And make sure to select a biomass provider who can consistently deliver the type of fuel your system needs.

Match technology to your workforce. Properly operating and maintaining your system is key to low emissions and system longevity. Some systems are easier to maintain than others. Some require expensive training or even visits by factory-trained experts. This can be a serious challenge in remote rural communities.

Leave room for emissions control technology. Most systems in most locations do not require advanced emission control such as electrostatic precipitators. But it is a good idea to design your systems with extra room so this type of technology can be added in the future.

Proven Technology

There are plenty of proven technologies in the wood heating world at the residential and commercial/industrial scale. Taking risks with unproven technology is usually discouraged. If the technology you're interested in has not been used in the region or is experimental, there could be a high risk of failure.

Look through the case stories in the section "Where Biomass Works." If the technology that matches your project is being successfully used elsewhere in your region, that's a very good sign. If possible, visit those projects. It's a good idea to ask the operator of the system if they would use that system again and what might they change. You need to hear the whole story.

Building Capacity

- ☐ Buildings Are Systems
- ☐ Human Component Is Essential
- ☐ Maintenance Is Essential
- ☐ Energy Awareness Is Key

Do as much research as you can. Written material about Alaska's energy issues abound. Much of what is written contains information highly relevant to the subject of wood energy in Alaska. For example, a recently published white paper by the Alaska Housing Finance Corporation summarized the findings from 327 investment-grade energy audits on public and commercial buildings (AHFC 2012). Here are several key lessons they identified you may find useful.

Buildings are systems. To function efficiently, all components—boiler, ventilation, controls, and building shell—must work together. Improving one aspect of a building's heating system without considering the entire system is likely to lead to a suboptimal solution. Any time a building's boiler is being upgraded, the other components of the heating systems should be evaluated for upgrades at the same time.

The human component is essential. Insufficient training of staff was found to be a significant weakness. And the more sophisticated the systems became, the more likely it was that the staff were unable to perform the required levels of operation and maintenance, or were unwilling to troubleshoot problems.

Maintenance is essential. Having a rigorous maintenance program pays dividends in an efficient building. The study recommended that the building's systems be "retro-commissioned" every several years, meaning they be completely tested to ensure that all components are functioning properly and in the proper sequence and range of operation with each other to meet the design intent.

Energy awareness is key. This includes knowing both the usage and costs. Often there is a disconnect between building operations personnel and the people in the business department paying the bills. Knowing what it costs per hour to operate your building can aid in making informed decisions and achieving greater cost savings. Many building operators have no means of tracking the energy usage in their buildings, often owing to inadequate metering of fuel feeds.

Without adequate usage information, it is impossible to make sound energy management decisions. Continued energy use tracking can help spot leaks, fuel misuse, and potential inefficiencies. Providing building operators with a direct financial stake in the energy costs and savings can increase their engagement and motivation to have an efficient and well-functioning system.

The Power of Partnerships

Successful wood energy deployment in Alaska will require more than just selecting the right technology and securing appropriate feedstock. Building diverse, multi-stakeholder teams with relevant knowledge, experience, and professional networks is critical. Creating those partnerships up and down the value chain will reduce uncertainty and risk, while expanding opportunities for funding and complementary projects like greenhouses in Thorne Bay.

Establishing effective partnerships will also help you to focus on where projects make the most sense. There is a need to move beyond projects funded solely by grants and explore options of packaging grants with loans, using heat sales contracts, or securing bridge financing (app. 2). At the end of the day, operating these systems needs to be financially self-sufficient.

Alaska already has a great example of a diverse, multi-stakeholder partnership in the Alaska Wood Energy Development Task Group (AWEDTG). Since its inception in 2004, the AWEDTG has conducted training sessions and provided nearly 150 preliminary feasibility assessments for public and private entities. It continues to provide technical assistance throughout the state of Alaska. Its goals and objectives are to:

- ✓ Help communities displace fossil fuels, reduce heating costs through the use of woody biomass, and create local employment opportunities.
- ✓ Build markets for the products of forest treatments aimed at improving forest health, reducing wildfire hazard, and improving wildlife habitat.
- ✓ Promote the use of woody biomass, such as forest residues and manufacturing byproducts (chips, sawdust, bark, hog fuel, etc.), as viable alternatives to fossil fuels for uses such as heating and power generation, and as a feedstock for the production of biofuels.
- ✓ Demonstrate the benefits of using high-efficiency, low-emission cordwood boilers.
- ✓ Help create and assist “early adopters” as models for other rural communities and Native villages.

The Power of Partnerships (cont.)

The participants making this all happen include (but are not limited to) the following:

Federal Partners:

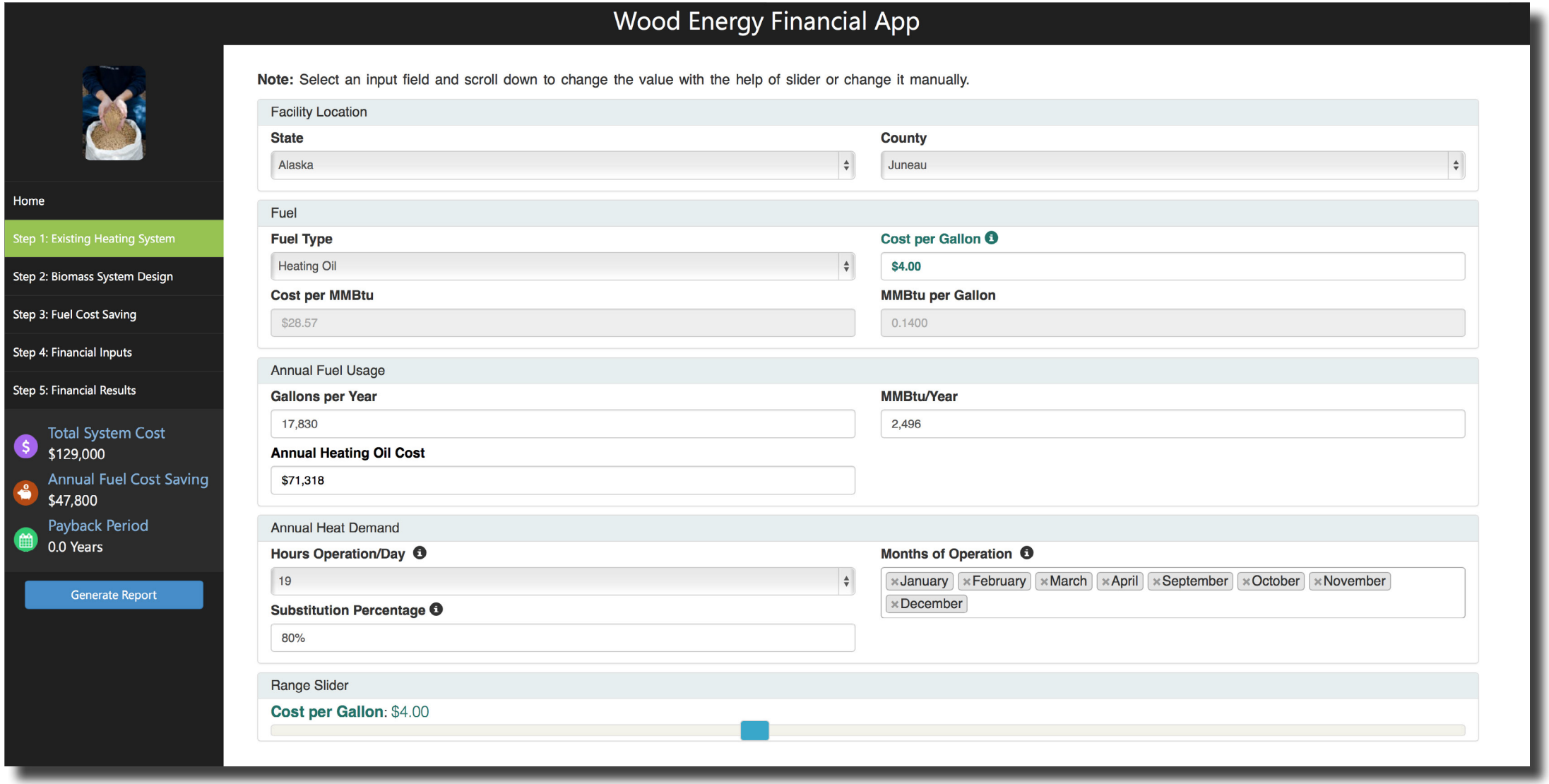
- ✓ USDA Forest Service
- ✓ USDA Rural Development
- ✓ USDA Farm Service Agency
- ✓ USDA Natural Resources Conservation Service
- ✓ USDOC Economic Development Administration
- ✓ USDI Bureau of Land Management
- ✓ USDI Bureau of Indian Affairs

State Partners:

- ✓ Alaska Energy Authority
- ✓ Department of Natural Resources, Division of Forestry
- ✓ University of Alaska-Fairbanks / Cooperative Extension Service
- ✓ University of Alaska-Fairbanks /Alaska Center for Energy and Power

Other Partners:

- ✓ Alaska Village Initiatives
- ✓ Denali Commission
- ✓ Fairbanks Economic Development Corporation
- ✓ Juneau Economic Development Council
- ✓ Sitka Conservation Society
- ✓ Southeast Alaska Conservation Council
- ✓ Southeast Conference
- ✓ Tanana Chiefs Conference
- ✓ The Nature Conservancy



The Wood Energy Financial Calculator

Rapid Assessment

- ☑ ***Current Heat Demand***
- ☑ ***Biomass System Design***
- ☑ ***Fuel Cost Savings***
- ☑ ***Estimate Project Finances***
- ☑ ***Compare Financial Results***

The Wood Energy Financial Calculator is a web-based financial assessment tool to help screen project ideas and conduct early-stage prefeasibility analysis. The calculator was designed in conjunction with the original Community Biomass Handbook (Becker et al. 2014) for making a quick and simple estimate of financial viability.

You do not need to hire a consultant, at least not yet. All you need initially are utility bills of the building(s) you're interested in converting, Internet access to run the Calculator, and an estimate for the delivered cost of biomass in your area. Enter a few other numbers about your facility and location to instantly calculate energy savings and preliminary return on investment.

The next few pages walk you through examples and specific steps to calculate financial feasibility. To launch the Calculator, just tap this icon.

Wood Energy
Financial Calculator

The Five-Step Rapid Assessment Process

Calculator user inputs are organized into five simple steps to guide you through system design, fuel cost calculations, and financial feasibility. You can enter these values directly into the calculator. Useful default values and important design considerations are included for many inputs, including information about how certain values are calculated to help interpret results.

Step 1: Current Heat Demand

Rapid Assessment

- ☑ ***Current Heat Demand***
- ☐ Biomass System Design
- ☐ Fuel Cost Savings
- ☐ Estimate Project Finances
- ☐ Compare Financial Results

Step 1: Describe current heat demand. First, collect information about your existing heating system. What type of fuel is used? How much does fuel cost? This information will serve as the basis for designing your new biomass heating system.

A. **Fuel price.** Identify the current cost of fuel on a unit basis and expected average price over the project lifespan (e.g., $3.50/gallon of heating oil over 20 years). You can find the current price on your heating bills, or for new construction, try finding a similar building in your area, but be sure you're comparing to the same fuel as what your project would otherwise use (heating oil, propane, natural gas, electricity).

B. **Annual fuel usage.** Estimate the annual amount of fuel used in your existing system, either as a function of volume (e.g., 60,000 gallons/year) or cost (e.g., $210,000/year).

C. **Hours of operation.** Think about the number of hours of operation per day and seasonality. Is the building heated for a partial or whole day? What are the months of operation?

D. **Substitution percentage.** Next, identify a target substitution rate, which is the portion of your overall project heating needs to be met with biomass. As a rule of thumb, biomass systems almost never supply 100 percent of heat demand. On the coldest days, you may use supplemental heat from your existing system (e.g., propane), which also serves as a backup in case of emergency. The reason is because you want your new biomass system running at peak capacity as much as possible. Oversized boilers cost more and are inefficient to operate. A good substitution rate is 80 to 90 percent.

Rapid Assessment

- ☑ Current Heat Demand
- ☑ ***Biomass System Design***
- ☐ Fuel Cost Savings
- ☐ Estimate Project Finances
- ☐ Compare Financial Results

Step 2: Design new biomass system. You have already started thinking about the design of your new system. The next step is to think about site factors that influence the cost, the desired type of biomass fuel, and fuel specifications (e.g., moisture content).

Biomass capital investment costs are a function of boiler size and type (e.g., 1 MMBtu/hr pellet burner). The choice of boiler type can be vexing, particularly if your project is of a size where more than one type is operationally suitable. The Calculator allows users to compare cordwood, pellets, and chip systems. The choice of which is a function of the type(s) of biomass locally available, the price you're willing to pay, and annual heat demand of your building(s).

A. **Biomass moisture content.** You also need to know the expected moisture content for the type of biomass used. This is important because the wetter the wood, the less efficient your boiler, which translates to the need for a larger boiler with more biomass. This means higher overall project costs.

B. **Boiler cost.** The Calculator generates an estimated capital cost, which is a function of known projects of similar size and type throughout the United States. But each project is different. Maybe you need more investment in heating ducts or you need to expand to accommodate delivery trucks. Calculator users can override the capital cost estimate with their own information derived from independent experts or known facilities.

C. **Supplemental costs.** Alternatively, users can estimate supplemental building or site costs, which are added to the overall capital cost estimate.

D. **Distribution costs.** If your project includes multiple buildings or piping from the boiler to the facility, estimate the linear foot cost of piping. You can get this from a local trenching contractor. You may also need to consider the cost of building hookup for heat exchangers, metering, and other variables.

Rule of thumb: Finding a recently installed project of similar size and scale, ideally in your region, and using those numbers can give you a good estimate. But each building is different, and factors like hot water storage can dramatically change the size of boiler needed. If there aren't similar projects in your area, consult independent sources to find a similar project working in the United States. At the end of the day, a trained engineer will be needed to calculate your building heat load.

Step 3: Fuel Cost Savings

Rapid Assessment

- ☑ Current Heat Demand
- ☑ Biomass System Design
- ☑ ***Fuel Cost Savings***
- ☐ Estimate Project Finances
- ☐ Compare Financial Results

Step 3: Calculate fuel cost savings. Now that you know the fuel type and annual heat demand, find a local biomass fuel supplier to get a price quote. The Calculator will calculate the quantity of biomass needed and price based on the delivered moisture content and estimated boiler size calculated in the previous step.

A. **Biomass price.** The quote for biomass should include the price per unit (green or dry ton), quantity of biomass available, quality (clean or dirty), and average moisture content. The Calculator allows users to enter prices as a function of dollars/MMBtu, green ton, or bone-dry ton.

B. **Biomass fuel usage.** The Calculator reports annual biomass fuel usage in different units to accommodate the different ways biomass is procured.

C. **Fuel cost savings.** The Calculator then estimates fuel cost savings by subtracting the expected biomass fuel cost for the new system from the fuel cost of your existing system. These annual fuel savings are what's used to offset the capital cost of the new biomass heating system.

Rapid Assessment

- ☑ Current Heat Demand
- ☑ Biomass System Design
- ☑ Fuel Cost Savings
- ☑ ***Estimate Project Finances***
- ☐ Compare Financial Results

Step 4: Estimate project finances. How you pay for the biomass heating system is a separate question than whether or not your project is a good investment. At this stage of planning, you should be more concerned with identifying a project with a solid financial return. The Calculator will help you narrow your options by screening out poorly performing projects.

A. **Outside contributions.** Estimate the amount of capital you can contribute that reduces the financed portion of the project. This could include third-party grants, forgivable loans, or personal capital.

B. **Interest rate.** Identify the expected interest rate for your expected cost of financed capital. You may need separate loans for construction and equipment.

C. **Project lifespan.** Most projects of this sort use 20 years for financial planning even though the equipment may last substantially longer.

D. **Operation and maintenance costs.** Estimate annual labor costs to operate your new boiler. A cordwood boiler will require someone to feed wood daily. Mechanized chip and pellet systems require very little work or maintenance. You must also consider annual maintenance costs. Contemporary biomass systems generally require very few repairs over their lifespan, but they must be properly maintained.

Step 5: Compare Financial Results

Rapid Assessment

- ☑ Current Heat Demand
- ☑ Biomass System Design
- ☑ Fuel Cost Savings
- ☑ Estimate Project Finances
- ☑ ***Compare Financial Results***

Step 5: Compare financial results. You now have an idea of the general feasibility of your project idea. The next step is to alter assumptions, change inputs, and recalculate financial feasibility, which allows you to narrow the range of viable options. This makes decision-making much easier. The Calculator allows you to change inputs to quickly compare results so that you can see where your project is most sensitive to cost inputs. The following are important factors to keep in mind as you compare results:

A. **Project boundaries.** A biomass heating conversion project is often a component of a larger project. Care should be taken to distinguish only those aspects of that larger project that are attributable to the biomass system. This is important for cost allocation. Conversely, a project can have broad financial impacts beyond its immediate scope, such as job creation or wildfire mitigation.

B. **Fuel price escalation.** All fuel prices change over time, but predicting their rate of change (up or down) is full of uncertainty. Unfortunately, it may be one of the most important and least known of your assumptions. But, looking backward can help. Heating oil prices have closely mirrored crude oil prices. Over the past 20 years, oil prices have escalated at an annual compounded rate exceeding 7 percent; from 2002 to 2012, it increased 13 percent annually. Wood pellet prices over the same period increased by about 3 percent in the lower 48 states.

C. **Cost sensitivity.** Small changes in assumptions can matter. Financial return can vary greatly based upon a 5 percent over- or underestimation of boiler capital cost, a small change in the annual cost of fossil fuel, or a few minutes more or less each day for maintenance extrapolated over the project lifespan.

D. **Verify assumptions.** Verify assumptions using credible sources. Because the technology and fuel can be unfamiliar, it is easy to take oft-quoted assumptions as gospel, which may not be relevant to modern systems. Vendors and other sources may have motivations that are undisclosed.

Step 5: Compare Financial Results (cont.)

Rapid Assessment

- ☑ Current Heat Demand
- ☑ Biomass System Design
- ☑ Fuel Cost Savings
- ☑ Estimate Project Finances
- ☑ ***Compare Financial Results***

E. **Consultant experience.** If a third party consultant performs a feasibility analysis, ensure that they have strong, direct experience in biomass design, installation, and operation. Modern biomass systems are complex. Many professionals lack the technical expertise to properly size boilers and ensure their proper installation and maintenance.

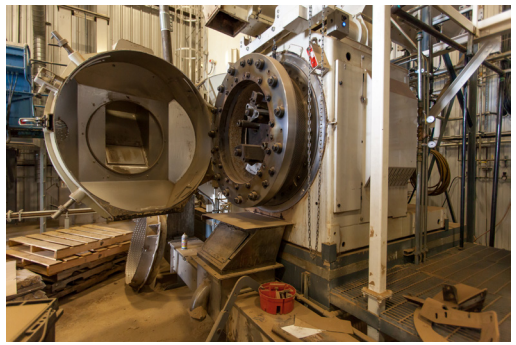
F. **Transparency.** If financial analysis is provided by a third party, require that all spreadsheets and calculations be provided electronically for complete review, not just a written report with "black box" calculations.

G. **Interpreting results.** A quick way to assess financial viability is using simple payback analysis, which is the ratio of the total capital costs divided by the annual fuel cost savings, stated in years. But it should not be the sole determination of project viability. Simple payback treats all costs and savings in present dollars, ignoring the time-value of money for future transactions. It has no provision for dealing with nonlinear or sporadic transactions that may occur at infrequent or varying intervals. Most importantly for biomass projects, simple payback fails to account for the differential rates of inflation between oil and biomass, which in recent history have been significant.

In Alaska, with its unique geography, logistics, and dispersed population, it is commonly understood that the "standard approach" to solving a challenge may not be the best approach. Biomass projects can be financially promising but are often challenged by that one factor that causes the economics to "blow up." That might be the shipping cost of biomass, or the cost of the fuel itself. Look for creative alternatives. Find alternative means of transportation, or different sources of fuel, for instance. Third party consultants and analysts may be unmotivated to seek solutions that make a biomass option the best one for your location.

Promising Technologies for Alaska

Large-Scale Pellet Production in Southeast Alaska



Large-scale wood pellet production is not new to Alaska. Superior Pellet Fuels, Inc. opened its doors in August 2010. (See "Superior Pellet Fuels.")

Southeast Alaska could be different, but in the lower 48, making wood pellets is not a cottage industry. Production by commercially viable wood pellet mills in the United States and Canada ranges from less than 10,000 to over a million tons per year. About half those factories each produce more than 50,000 tons per year. That's a lot of pellets.

Potential. Southeast Alaska consumes an estimated 22 million gallons of heating oil annually. It would take around 55,000 tons of wood pellets a year to replace 30 percent of that demand—the output of a medium-size pellet mill. The current demand is very small, but the potential is there.

Benefits. Developing this market and supplying it locally would help keep heating fuel dollars from leaving the region—through jobs manufacturing and delivering pellets, and through potential energy savings. Locally producing pellets could also provide a destination for local forest treatment residual material.

Creating demand. One of the greatest challenges is how to build demand without inviting imports from the south. A Canadian pellet producer in British Columbia (BC) can produce more than a million tons per year. Pellets are routinely exported out of Prince Rupert, BC, on ships capable of holding more than 50,000 tons. The distance from Prince Rupert to Juneau is less than half the distance from Prince Rupert to Seattle, Washington, making southeast Alaska an easy market to access.

Creating local supply and demand requires balance. If demand grows faster than supply, outside suppliers could dominate the local market. If supply grows faster than demand, local pellet mills might not be able to stay in business. Community and public support are likely needed to make this work until the market matures.

Transportation. High transportation costs—especially to small communities—might actually benefit an appropriate-scale pellet mill. When you factor in transportation costs, locally produced pellets might prove competitive. On the other hand, those same transportation costs limit how far those local pellets can be economically shipped. And that limits the size and efficiency of a local pellet mill. So it is a balance.

Large-Scale Pellet Production in Southeast Alaska (cont.)

Electricity. Electricity is needed to make pellets—around 100 kWh per ton. Electric rates in southeast Alaska are generally between $0.10 and $0.20 per kWh. That works out to between $10 and $20 per ton of pellets that might sell for $300. So the cost of electricity does have some effect on the cost of making pellets.

A more significant challenge is just having enough electricity. Many communities in southeast Alaska have limited peak generation capacity from their hydroelectric generators. Some hours a year there might not be enough electricity to run a pellet factory without the utilities having to run additional, more costly diesel-powered generators. This is most likely to happen during the peak heating hours of the day during the winter when some of the hydropower facilities are frozen. Fortunately, this problem can be managed if the factory has the flexibility to alter its daily production schedule to avoid those hours.

Global market. The international demand for wood pellets is growing because pellets can be used as a renewable substitute for coal. But this global market is very competitive.

Many of the smaller communities in southeast Alaska get their electricity from neighboring communities through submarine cables, like this one leaving Douglas Island for smaller islands to the west.

Microchips offer the convenience of wood pellets and low-cost, locally manufactured supply. The challenge is chip quality.

Dave Frederick (above) put a Bio-Burner 100 into a trailer and is showing it around Alaska. Microchips are very promising.

Increased pellet production has a promising but complicated development cycle that depends upon factors beyond local control. But a different opportunity for expansion exists with small chip systems using "microchips."

Microchips are clean chips (i.e., no bark or needles) that are manufactured from a variety of feedstock—unutilized materials from timber operations, mill residuals, clearings from road and power line maintenance or land conversion, and whole trees. They are basically a smaller version (1/4 to 3/8 inch) of the traditional wood chip, and can be used in modern small-scale chip-fired biomass systems (Steiner and Robinson 2011). Typically, the feedstock is screened to size, and oversized material is reprocessed to meet the specified microchip size. The green chips are then dried to about 25 percent moisture content, usually with a dryer system (that can be fueled by wood chips or sawdust). Finally, the microchips are stored in a dry, covered area, similar to wood pellets.

The chipping technology is readily available. The boiler technology exists and is substantially less expensive than previous models. Some pellet boiler models are even capable of using microchips.

Microchips offer some advantages over pellets:

- ✓ The most important advantage microchips have over other energy forms is a very substantial price reduction. Typically, as seen with the Tongass Forest Enterprises mill in Ketchikan, which is manufacturing both pellets and microchips, microchips will yield energy costs at about one-half the cost of pellets.
- ✓ The capital cost of the equipment is substantially lower, providing a lower barrier to entry into the market.
- ✓ The energy needed to produce a microchip is far lower than that to produce pellets. Chips do not need to be dried as much as pellet feedstock, nor does the chip need to be pulverized into small particles, which is an energy-intensive process. The pelleting process demands a large amount of electricity, which in much of Alaska is very expensive.

Microchips (cont.)

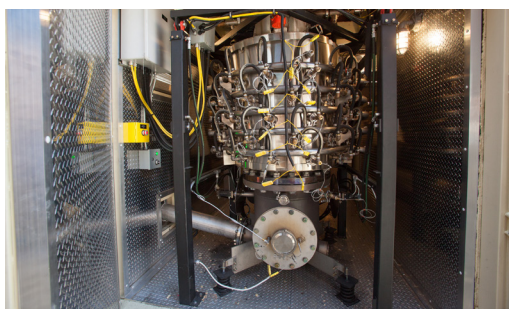
So why isn't everyone converting to microchips?

- ✓ Pellets or cordwood are generally more suitable for smaller residential heating units. No chip boiler technology is commercially available at the residential scale.
- ✓ Pellets flow more easily than chips, allowing for greater flexibility in fuel storage, handling, and placement, which is a key consideration in some facility configurations.
- ✓ Pellets are a more energy-dense fuel and thus more suitable for transporting long distances. Pellets may be the more competitive choice when produced regionally.

But microchips and pellet production do not have to be mutually exclusive. Microchip production can position businesses for possible future pellet production given that the steps to producing quality microchips are on the same path as those for pellets.

Microchips also open up the possibility for future electrical power production. The technology for small-scale power production is advancing rapidly, and it is anticipated that these technologies will be sufficiently mature in the foreseeable future for widespread deployment in remote locations, hopefully producing electricity at costs substantially lower than from diesel generation in remote Alaska communities. By establishing microchip production now, that fuel source and supply chain will be established for follow-on markets and technologies.

Combined Heat and Power



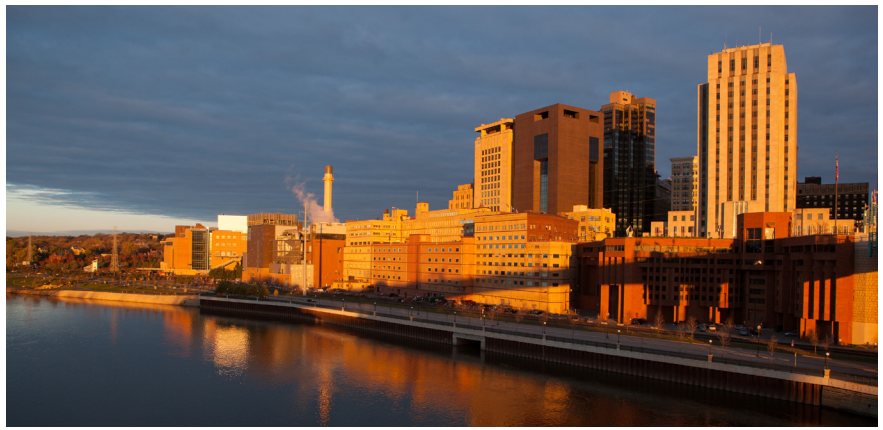
Combined heat and power (CHP) is a technological innovation that utilizes biomass to simultaneously produce heat and electricity at small- to large-scale applications. The standard technology for producing power is the steam turbine, where biomass is combusted in a boiler to produce steam, which then powers a turbine connected to an electrical generator. About 25 percent of the energy in the wood is converted to electricity, with the remainder being converted to heat. If a community has a district heating system installed, it is ideally positioned to harvest the heat and electricity, assuming a favorable electricity power purchase agreement can be negotiated or there is sufficient internal electricity and heat demand.

Rural communities in Alaska that generate all of their power with diesel might be able to take advantage of small-scale CHP if they also have or can install a sufficient heat distribution system. Aligning system outputs with community demands is critical. Establishing a highly trained workforce to operate the system is also essential.

Gasification power generation is an emerging technology that shows great promise for Alaska. Rather than combusting wood to make steam, wood is “gasified” or heated in an oxygen-deprived environment until it produces combustible gases. These combustible gases are then cleaned of impurities and fed into an internal combustion engine as fuel. The basic technology predates World War II, but the latest developments are showing real promise for remote communities in Alaska.

The advantage of gasification is that it eliminates several complex and expensive stages with steam turbines and generators, and relies primarily on a technology that is abundantly familiar to rural Alaskans: the internal combustion engine. Though not quite ready for remote locations in Alaska, developments are pointing towards a mature technology within the next decade.

City-Scale District Energy



An energy district features a central heating plant that delivers heat to buildings through a heat distribution system. Typically these are buried, insulated pipes conveying hot water. The district may be as small as a few buildings or a campus, or as large as an entire city. Many of the buildings in downtown Seattle, Washington, and St. Paul, Minnesota (shown in these photos), for example, are connected to an energy district fueled by biomass. Many cities in Europe are heated likewise. A single heating plant benefits from economies of scale, which allows greater flexibility in technology selection and subsequent factors like biomass fuel sources. A district heating system consolidates capital and operation and maintenance expenses across a variety of facilities, thus relieving the individual burden.

Ownership of the district can take many forms, from a city utility like water or sewer, to a privately operated service. The heat delivered to individual buildings can be measured with a Btu meter, much like electricity is metered, which allows for accurate invoicing.

Southeast Island Schools

Ketchikan

Haines

Tanana Village

Daisy Huang

Southeast Island Schools

Southeast Island School District

Lauren Burch, the superintendent for the Southeast Island School District (SISD), which covers nine remote schools on Prince of Wales, Baranof, and Kosciusko Islands, viewed his cordwood boilers as providing far more than low-cost energy for his schools. He saw them as the platform on which to build programs that other school administrators only dream of.

From the beginning, Mr. Burch insisted upon cordwood boilers even though others suggested that perhaps chip or pellet boilers might be a better fit for some of his facilities. His reasoning was absolutely clear: cordwood is a fuel that can be supplied by any members in the local community. Anyone with a chainsaw (most households in rural Alaska) is a potential "fuel refinery." Additional wood fuel can be provided by regional commercial cordwood processors with mechanized cordwood processing equipment. This was essential to Burch's vision of maintaining a connection between the community and the school. As a result, the funding that goes into heating the school flows into the local economy. But the benefits do not stop there.

Another positive impact is that the students play an active role in heating their school. The sports teams split and stack firewood after school or on weekends. Students and their parents engage in firewood cutting and splitting to help pay for extracurricular activities and cover their travel expenses to events and field trips. Some students were hired by the school to manage the boilers, and took great pride in their responsibilities.

In addition, the low-cost excess heat from the boilers allowed Mr. Burch to implement large, commercial-scale greenhouses at three schools, along with the cordwood boiler installation. These greenhouses provide numerous benefits. The schools have fresh salad ingredients—a rare commodity in rural Alaska villages—for their lunch programs, providing significantly improved nutrition. The excess vegetables are sold to local residents and restaurants to raise revenue for extracurricular activities. And the students do this by electing to take a class that has them making the business decisions for the operation of the greenhouse.

Converted from oil to cordwood in 2009, the Howard Valentine School located in Coffman Cove on Prince of Wales Island occupies approximately 10,000 square feet. Heat is distributed via air handlers in the gymnasium, cabinet heaters at entrances, and radiant heat floors in the classrooms. The school district expected to spend about $45,000 per year for fuel oil. Now they're spending about $15,000 to $20,000 on cordwood and associated labor.

In 2010, two GARN WHS 2000 cordwood boilers were installed, and have substantially reduced the amount of fuel oil that was used for heat at the school. A small amount of diesel oil is used during winter break or long holiday weekends when school is not in session. Two teacher housing units are being built and will be heated by the GARN system starting in 2015. On the weekends, the teachers can load the boiler in exchange for free heat.

The Thorne Bay School on Prince of Wales Island occupies 41,650 square feet and had four 20-year-old oil-fired boilers each rated at 266,000 Btu/hr. Fuel oil consumption ranged from 15,000 to 20,000 gallons per year. SISD received Alaska Renewable Energy Fund grants in 2010 and 2011 to design and construct a cordwood-fired heating system. Two GARN PAK prototype boilers were installed during the winter of 2013-14. The school now uses about 120 cords of wood per year, saving more than $25,000 in fuel costs. The greenhouse became operational in 2014.

The Thorne Bay School took it a step further: they recently purchased a local restaurant where, in addition to managing the greenhouse, students are responsible for much of the operation and decision-making. From garden to plate, the students are eating better and learning valuable, real-world, marketable skills that you can't learn from a textbook.

The Kasaan School, also located on Prince of Wales Island, is the latest school in the SISD to be converted to wood heat. A GARN WHS 2000 was installed in 2014 to heat the school, teacher housing, the City of Kasaan Public Library, and soon a greenhouse.

All of these developments fit Mr. Burch's philosophy that schools should be educating students to be functioning members of their communities and society as well as learning the three "Rs." He's a firm believer in work and responsibility, and connecting the results of students' efforts to tangible outcomes, such as splitting and stacking firewood with a warm school, and planting the seeds in a greenhouse that ultimately end up being served on a plate in the cafeteria and restaurant. His wood boilers enable all of this. And it didn't happen by accident.

Lauren Burch's vision for cordwood heating has surpassed most people's expectations. And, he aims to repeat this model at all of his schools. The school district is saving significant money, heating fuel dollars are reinvested into the local economy, and a successful curriculum has been built around wood energy that provides students with the nutrition, skills, and experience to apply in life beyond the school walls. It all began with a simple pile of firewood and a vision.

Ketchikan Federal Building

Larry Jackson had a problem. Larry owns a small sawmill, Tongass Forest Enterprises, in Ketchikan's Ward Cove, the site of a former pulp mill. He manufactures high-end mouldings, cabin kits, and other custom-milled products from Tongass National Forest timber for the local market. For years, Larry was the only tenant on the property and could freely burn the piles of sawmill residue that quickly accumulated from his milling operations. But when new tenants began to occupy the adjacent property a few years ago, the smoke Larry's sawmill was generating became a problem. He had to come up with another disposal solution, and hauling it off for landfilling or burning elsewhere was going to be very expensive. What to do?

Fortunately, a solution was at hand. Just as he encountered his disposal conundrum, a major federal property owner in Ketchikan, the General Services Administration (GSA), announced plans to convert the Ketchikan Federal Building to wood pellet heating to offset its nearly 9,000 gallons of annual heating oil consumption and to comply with federal mandates to reduce fossil fuel usage and shift to renewables. This was the first-ever pellet boiler in GSA's 1,500-building inventory. The timing couldn't have been better! Partnering with local engineer and entrepreneur, Trevor Sande, Larry acquired a small, used pellet mill and proceeded to turn an expensive waste problem into an energy business opportunity.

The GSA, using funding from the American Recovery and Reinvestment Act (ARRA), invested $4.7 million in the Ketchikan Federal Building to upgrade the energy system and install a modern pellet boiler. The bulk of this investment went towards converting the building's antiquated and inefficient steam heat distribution system to hot water including a new oil-fired backup boiler. The pellet boiler system itself cost about $450,000.

The boiler chosen was a 1-MMBtu/hr Advanced Climate Technologies (ACT) Bioenergy boiler—a European-designed system built in upstate New York. By all accounts the system has functioned well. A June 2014 report (NREL 2014) by the National Renewable Energy Lab documented detailed and meticulous onsite testing of the boiler that confirmed the system was meeting manufacturer's performance claims. The report concluded that: "The biomass system works well, needs very little maintenance or attention of any kind, and performs well within the efficiencies put forth by the vendor. These biomass hot water heating systems are efficient, clean burning, and provide a reliable source of renewable energy."

The report also states that the Ketchikan system "does not have an attractive payback period" on account of the boiler being oversized and the cost of imported pellets being very expensive at over $350 per ton. However, the report shows that as the price of pellets decreases, the economics (simple payback) of the project dramatically improve. Once Larry's local pellet mill came online, the cost of pellets dropped significantly, and the economics of the project became very attractive.

The report also found that the boiler was significantly larger—and therefore more expensive—than it needed to be. This often happens when the unique characteristics of biomass boilers are not understood and they are treated like conventional gas or oil

boilers. Generally, biomass boilers do not perform well when they are started and stopped frequently. They should be sized smaller than conventional boilers to allow them to run more consistently and efficiently. That requires maintaining a conventional boiler to meet peak heating demand. On the coldest days, both the biomass boiler and the conventional boiler may be needed. On warmer days when heat is only briefly needed in the morning, it may be more efficient to just use the conventional boiler. The conventional boiler usually serves as a backup to the entire system.

The good news is that the GSA study showed that their boiler was operating at a very high efficiency despite being large, a testament to the advanced design of the boiler that allowed it to effectively modulate its output to meet the low heating demand.

At about the same time that the GSA project managers were planning their Ketchikan project, Forest Service engineers were planning a biomass conversion project for their Southeast Alaska Discovery Center. This visitor center is a 21,000-square-foot facility located in downtown Ketchikan, across the parking lot from the federal building. This was also an ARRA-funded project.

The boiler that was installed in the Southeast Alaska Discovery Center was a first-of-its kind system by Hurst Boilers. Hurst is well regarded for its large biomass boilers for commercial and industrial customers, but this was one of its first forays into the small building pellet boiler market.

The boiler was sized at 900,000 Btu/hr to meet the building's peak demand, comparable to the building's oil-fired boilers. However, biomass boilers should generally be sized smaller to meet typical winter days rather than the infrequent peaks. As a result, the boiler was oversized and unable to efficiently modulate its output to meet the lower, more typical heating demand. The system contained no thermal storage, so when the boiler could no longer throttle down its output, it simply shut down. This particular biomass boiler lacked an auto-ignition feature, so once the boiler shut down, it had to be restarted manually, creating a significant burden for facility personnel.

An October 2013 test by the Forest Service indicated that an attempt to increase the heating load on the oversized boiler by disabling the building's energy conservation systems resulted in the building consuming 50 percent more heat than in years past. Even though the heat from the pellets cost less, the differential was not great enough to account for the very significant increase in energy usage. The study indicated that a more appropriate size for the boiler would have been closer to 300,000 Btu/hr rather than the boiler's 900,000 Btu/hr.

While oversizing a conventional gas or oil boiler doesn't usually cause problems, boilers that use solid fuel like biomass are different. Solid fuel boilers take time to start up and to shut down, and the output heat can only be adjusted over a fairly narrow range. They work best when they stay on for hours, even days. If the system is too big for the load, it will cycle on and off frequently, which can

cause performance and maintenance problems. That's what happened at the Discovery Center.

Immediately adjacent to the Discovery Center, the city of Ketchikan built a new fire station and preplumbed it to accept heat from an external biomass boiler at some later date. The Forest Service studied the possibility of connecting the Discovery Center's biomass boiler to the fire station. The economics of the project appeared promising, but previous performance and maintenance problems led to uncertainties that kept the project from going forward.

The pellet boiler in the Discovery Center has been since idled. The Forest Service remains committed to biomass heating at the Discovery Center, but the current configuration is not economically viable. Many lessons have been learned as a result of this experience that will be carried over to the next system.

The Ketchikan GSA and Forest Service pellet boiler experiences present educational case studies on how these types of projects can succeed or fail individually. But, looking at all three of these neighboring buildings, there was a lost opportunity to connect all of them together and use a single, appropriately sized system—reducing capital and operating costs for all.

The take-away lesson from this experience is that coordination and communication need to occur at the local levels continuously so that when funding opportunities present themselves, they can be utilized to the maximum effect.

The efforts by GSA and the Forest Service were recognized in Ketchikan, which now had its very own fuel refinery in the form of Larry's pellet mill. It was manufacturing pellets at a very competitive price. Heating oil was selling for around $4.00 per gallon while Larry's pellets were selling for around $275 per ton, even less in bulk purchases. That made heat from Larry's pellets equivalent to oil at around $2.30 per gallon, a price that hadn't been seen for years and isn't likely to be seen again. Additionally, locals appreciated the fact that Larry's pellets used local waste resources and created local jobs.

The next new building "on-deck" for conversion in Ketchikan was the new library. It was built with an ACT Bioenergy pellet boiler, similar to the GSA boiler. In addition, the airport terminal and high school recently received a Forest Service grant to pay for the design of biomass conversions followed by an Alaska Renewable Energy Fund grant to pay for the construction costs for the airport conversion. These projects are currently underway.

Ketchikan has a strong foundation as a "pellet community" with its own pellet mill, a solid base of large customers, competitively priced pellets, ample feedstock, and receptive community leaders. Now it only needs to build upon its many advantages.

Haines Borough

Pellet Communities: Haines Borough

The small community of Haines, Alaska, became a "pellet community" following their own path. It started with a Forest Service "Jump-starting Wood Energy" grant in 2007. This $10,000 grant (with a $10,000 match from Haines) funded the specifications and cost estimate for a cordwood boiler system for their school. Though the cordwood boiler was never ultimately installed in the school, the process of going through the analysis infected the community with the wood energy bug.

The Chilkoot Indian Association (CIA) was one of the earliest pellet adopters in town. It was largely unintentional. The CIA owns an inventory of housing units for members, and Scott Hansen, the energy manager, was seeking ways to reduce heating costs on one of their fourplexes. They had received an Alaska Renewable Energy Fund Grant to install a GARN cordwood boiler system, but soon realized that the size and weight of the system would require extensive filling of wetlands underneath it, which was going to exceed their available budget. They decided to shift over to a pellet boiler, which was more compact and lighter, and avoided the expensive filling operation.

Their first boiler was an oil boiler conversion unit from Pellergy Boilers. While not as low-maintenance and efficient as a purpose-built pellet boiler, the CIA found the system to be successful and proceeded to install additional purpose-built pellet boilers in other family housing units. Recently, they completed their new headquarters building, where they installed a Maine Energy System pellet boiler.

Because the CIA's boilers are all of the residential/small commercial scale, they've elected to fill their hoppers from 40-pound bags of pellets, shipped in from the lower 48. This has led them to establish more efficient supply channels, which in turn has led other residents to source their pellets from the CIA. Currently, the CIA supplies over 60 tons of pellets to local residents, including Olerud's Market Center and Alaska Sport Shop, one of the main stores in town that has converted to pellet heat.

In their quest for greater self-determination, the CIA has explored the construction of a local pellet mill. The State Forester has been strongly supportive of using the local biomass resource from the Haines State Forest, and there is ample beetle-killed Canadian timber nearby across the border. The Forest Service provided the CIA with a grant for the design of a pellet mill, but so far, the cost of a small mill has proven prohibitive.

Pellet Communities: Haines Borough (cont.)

Stephanie Scott, the former mayor of Haines Borough, was determined to put her community on a more sustainable energy path from her involvement in the Haines Peak Oil Task Force nearly a decade ago, which was formed to guide the community through a potential decline in the availability of fossil fuels and the corresponding increase in costs. The task force received a wood energy feasibility study by the Alaska Wood Energy Development Task Group for the conversion of their old school from oil heat to a cordwood-based system, sparking Stephanie's interest in wood energy. Scott Hansen of the CIA and other residents who had converted to wood pellets provided powerful examples for the community to model. According to Mayor Scott, "The Energy Sustainability Commission was formed upon the recommendation of the Peak Oil Task Force, which went away with the publication of its final report. The energy commission championed biomass; it held workshops, presentations, etc. The borough acquired feasibility funds, which resulted in questionable economics. Big discussions ensued. Meanwhile, a small building needed a new heat system. Why not buy a pellet fired boiler and test it?"

A consultant's initial study indicated that converting borough facilities to biomass simply wasn't feasible: too expensive, too maintenance intensive, best just to stick with oil until the way forward was clearer. After hearing strong rebuttals from Forest Service and Alaska Energy Authority engineers, Mayor Scott decided to move forward with the test boiler. Haines converted their Senior Center that provides meals and other services to the community's senior citizens to a hot water hydronic system heated with a Maine Energy System boiler. In the first year of operation, the boiler yielded a 47-percent reduction in heating costs and proved to be reliable, user-friendly, and low maintenance. The borough was convinced.

One unanticipated challenge with the Senior Center has been the silo. It was too tall. Owing to the height of the silo, there was only one means of filling it in the region, a pellet delivery truck out of Juneau. This significantly increased the price of pellets by eliminating delivery options and competition.

In 2013, the borough began the design of the high school conversion, initiated by their Biomass Champion, Darsie Culbeck. Darsie also spearheaded the effort that succeeded in winning an Alaska Renewable Energy Fund Grant in the amount of $1.3 million to convert most of the borough facility inventory to biomass heat. These projects are commencing now.

Pellet Communities: Haines Borough (cont.)

The biggest challenge Haines has faced is the high cost of imported pellets. Barging pellets up from the lower 48 to Haines more than doubles their price. While still competitive with oil, the differential in the cost of using pellets has not been significant enough to drive a rapid transformation to a pellet economy. A local pellet mill such as what the CIA has been exploring would have the potential to drive prices significantly downward, but the small potential demand for pellets in Haines makes the economics of a pellet mill challenging. They are continuing to explore ideas for reducing pellet costs and sourcing local biomass, and the prospects for solutions appear promising.

Haines has demonstrated that with enlightened leadership and a few strong champions, an entire community can shift its course. Clearly, this is just one step for Haines on their path to sustainability.

Tanana Village

Daisy Huang

Imagine living where you could only come and go by air and river. Tanana is located in interior Alaska at the confluence of the Tanana and Yukon Rivers, about 130 air miles west of Fairbanks. The city experiences a cold, continental climate with temperature extremes. Daily maximum temperatures in July range from 64 to 70 degrees Fahrenheit; daily minimum temperatures in January are –48 to +14 degrees Fahrenheit. Extremes have been measured from –71 to +94 degrees Fahrenheit. The Yukon River, which is a locally important water highway for transporting goods, is only ice-free from mid-May through mid-October, thus limiting supply deliveries.

Tanana was a traditional trading settlement for Koyukon and Tanana Athabascans long before European contact. During World War II, an air base was established near Tanana as a refueling stop. A new hospital facility was built in 1949 and was a major employer until it closed in 1982. That same year, Tanana incorporated as a city to assume control of the local school system.

In 2006, the city of Tanana applied for a feasibility assessment through the Alaska Wood Energy Development Task Group. That first seed has led to installation of eight GARN and four Econoburn cordwood boilers that heat their city washeteria/water plant, fire station, 25,000-square-foot school, the city shop, and teacher housing. Recognizing the need for technical expertise to keep the systems operating smoothly, Tanana is putting together a curriculum for training its operators and those in six other villages.

What makes Tanana unique is their main source of wood—the Tanana River—and the way they purchase wood. The Tanana and Yukon Rivers transport thousands of cords of wood from eroded riverbanks every year. Up to 60 percent of Tanana's wood comes from the harvest of driftwood in the summer months when the river is ice free. The remaining firewood is sustainably harvested by local wood cutters, from forest thinnings that reduce the city's risk to wildfire, and from road clearings. Tanana partnered with the Alaska Department of Transportation and the former governor on a new road project and the wood from the road easement will supply its boilers for years to come.

While most of the wood is supplied by "commercial firewood dealers" who have contracts with the city, local residents can also deliver small quantities of wood without a contract. With limited opportunities to generate cash in a predominantly subsistence economy, driftwood collection and firewood cutting are important sources of revenue. Quality of supply is monitored to meet system specifications.

Also unique to the city of Tanana are incentive programs that ensure a steady supply of wood. New chainsaws are available at a reduced upfront cost, and delivery of two cords of wood within 6 months completes payment. The city also purchased a firewood processor that cutters can rent for a reasonable rate. And teachers living in cordwood-heated housing are motivated by reduced rent if they use the cordwood boilers.

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Appendix 1: Residential Heating Challenges

After performing energy audits on about 30 percent of the housing units in Alaska, the Alaska Housing Finance Corporation amassed an impressive database of information (NCSHA 2014) around the challenges of residential home heating:

- ✓ Outside of Anchorage, houses in Alaska are smaller and more rural, with the majority having been constructed during the oil pipeline boom years of the 1970s and 1980s. Houses in the Anchorage urban area are nearly twice as large as corresponding rural homes.
- ✓ Alaska houses are twice as likely to be overcrowded (based on national standards) than lower 48 houses, and some of the more rural regions see overcrowding levels 12 times the national average. This can lead to adverse outcomes for health and childhood education. High home construction and energy costs are the primary reasons for this overcrowding.
- ✓ The average Alaska housing unit uses twice as much energy as houses located in lower 48 regions classified as "cold" or "very cold" by the U.S. Department of Energy, and uses three times as much energy per square foot as the national average. Houses in interior Alaska and the Far North use even more energy owing to their colder climates.
- ✓ On average, Alaskans are burdened with energy costs that are higher than those for the rest of the Nation. Compared to energy costs in the "cold"/"very cold" regions of the lower 48, annual residential energy costs in Alaska range from approximately 50 percent higher in the Anchorage area to nearly 400 percent higher in the interior region.
- ✓ On a per-square-foot basis, some areas of Alaska stand out even more for their high energy costs. In the northwest region, average households spend $9.15 per square foot per year for home energy, which is more than nine times higher than the $0.97 per square foot national "cold" climate average.
- ✓ Coupled with the cold climate and high cost of energy, the poorer quality of home construction in Alaska means that most homes rate "moderate" to "very poor" in their home heating index, a measure of the energy used for space heating in a building normalized by square footage and climate.
- ✓ In homes that operate inefficient wood stoves, indoor air quality can be unhealthy. Converting to newer high-efficiency devices can improve indoor air quality as well as reduce fuel usage.

General Information

Biomass Energy Resource Center (BERC): www.biomasscenter.org

Biomass Thermal Energy Council (BTEC): www.biomassthermal.org

Wood2Energy: www.wood2energy.org

Pellet Fuels Institute: www.pelletheat.org

National Renewable Energy Laboratory: www.nrel.gov/biomass/

U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy: www.energy.gov/eere/office-energy-efficiency-renewable-energy

Alaska Wood Energy Development Task Group: www.akenergyauthority.org/AEEE/Biomass/AWEDTG

Financial Incentives

The national interest in renewable energy and energy efficiency has led to the creation of financial incentives to promote renewable fuels, from feasibility studies through facility construction. Various programs are available at both the federal and state level, in addition to other nonprofit organizations and partnerships with for-profit interests.

In Alaska, the primary federal agencies involved in biomass energy development include the USDA Forest Service and Rural Development. Others may include the Farm Service Agency, Natural Resources Conservation Service, Economic Development Administration, Bureau of Land Management, and Bureau of Indian Affairs. Working with partners, the Forest Service is supporting development of wood energy projects that promote sound forest management, expand regional economies, and create new jobs in rural locations.

USDA Renewable Energy and Energy Efficiency Programs

The U.S. Department of Agriculture (USDA) offers programs focused on rural communities including housing, energy efficiency, and conservation assistance. Rural development loan assistance can include direct or guaranteed loans, grants, and technical assistance, see:

www.rd.usda.gov/programs-services/all-programs/energy-programs

Environmental Protection Agency

For information about the Environmental Protection Agency's financing options for wood-burning appliance changeout, see:

www.epa.gov/burnwise/pdfs/financing.pdf

State Programs

The primary state agencies include Alaska Energy Authority, Department of Natural Resources, Division of Forestry, University of Alaska-Fairbanks (UAF) Cooperative Extension Service and UAF Alaska Center for Energy and Power. Municipalities and tribal councils often have some resources to bring to a project or can access them through special government programs.

Information on Alaska Energy Authority can be found at:

www.akenergyauthority.org/Programs/AEEE/Biomass

Information on Alaska Industrial Development and Export Authority can be found at:

www.aidea.org

Energy Savings Performance Contracts (ESPC) and Energy Service Company (ESCO)

Various procurement vehicles fall under the general description of "Energy Service Company." Often used for energy-efficiency improvement projects, these contracts have one thing in common in that they rely on a third party who arranges both the capital for the project as well as the execution of the project. Typically, they offer the following services:

- ✓ Develop, design, and arrange financing for energy efficiency projects.
- ✓ Install and maintain the energy-efficient equipment involved.
- ✓ Measure, monitor, and verify the project's energy savings.
- ✓ Assume the risk that the project will save the amount of energy guaranteed.

These services are bundled into the project's cost and are repaid through the dollar savings generated.

Biomass projects are often good candidates for ESPC contracts owing to their often-strong positive cash flow. They can be structured to include only the initial installation of the system, the complete operation and management of the system, or any variation in between.

A special form of ESCO is a "Heat Sales Contract" where a third party contractor installs a biomass system on the client's property and connects it to the client's facility at the contractor's expense. The contractor owns, operates, fuels, and maintains the system. The client purchases heat that is measured with a British thermal unit meter. A contract like this allows the client to outsource the capital and operations and maintenance costs of heat generation with minimal risk. The contractor must charge enough to cover capital and operating costs, as well as profit, but if this is the contractor's primary line of work, chances are good that they can achieve superior pricing and operating efficiencies to offer the client a significant savings in energy costs.

Federal agencies have special authorities to enter into two different types of ESCO-type contracts:

ESPCs are a special contract administered by the Department of Energy. Sixteen firms have been awarded ESPC indefinite-delivery, indefinite-quantity contracts, to which any federal agency may issue task orders. www.energy.gov/eere/femp/articles/energy-savings-performance-contracts-0

Utility Energy Services Contracts are similar to ESPCs except that there is only one qualified contractor for a given project, the utility in whose service area the agency's project lies. In these sole-source contracts, the agency can finance the project through the utility, pay for the project with appropriated funds, or any combination of the two. www.energy.gov/eere/femp/articles/utility-energy-service-contracts-0