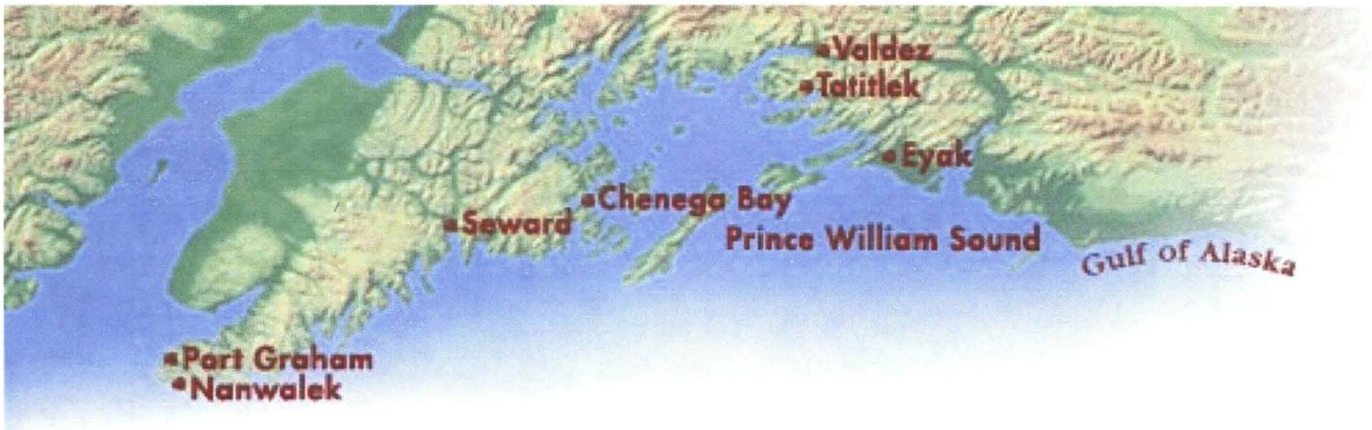
DE-FG36-06GO16023, A000



U. S. Department of Energy Tribal Energy Program

The Potential for Biomass District Energy Production in Port Graham, Alaska—Final Report

May 5, 2008

Prepared by:

Fran Norman, Project Coordinator

Charles Sink, Technical Representative

Kerryanne Leroux, Technical Consultant for EERC

There are no distribution limitations or patentable material protected data.

Tribal Renewable Energy–Final Report

Project Title:	The Potential for Biomass District Energy Production in Port Graham, Alaska (Project)
Covering Period:	Close of Period October 31, 2007
Date of Report:	May 5, 2008
Recipient Organization:	Port Graham Village Council
Award Number:	DE-FG36-06GO16023
Partners:	Port Graham Village Council Members: Fran Norman, Tribal Administrator Patrick Norman, First Chief Olga Fomin, Second Chief Chugachmiut as Cost-Share Partner that includes using Charles Sink as Technical Assistance Representative Energy and Environmental Research Center (EERC) as Technical Study Sub-Contractor
Technical Contact:	Charles Sink, Chugachmiut 1840 S. Bragaw Street, Suite 110 Anchorage, Alaska 99508 907.562.4155; Fax 907.563.2891 charlie@chugachmiut.org Kerryanne Leroux for Darren D. Schmidt, Research Manager Energy & Environmental Research Center University of North Dakota P. O. Box 9018 Grand Forks, North Dakota 58202-9018 701.777.5000; Fax 701.777.5181 dschmidt@undeerc.org
Business Contact:	Fran Norman, Chair Port Graham Village Council P. O. Box 5509 Port Graham, Alaska 99603 907.284.2227; Fax 907.284.2222 Francis907@hotmail.com
DOE Project Officer:	**Lizana K. Pierce**, lizana.pierce@go.doe.gov

I. Executive Summary

A collaboration between The Energy & Environmental Research Center (EERC), Chugachmiut – A Tribal Organization Serving the Chugach Native People of Alaska, and Port Graham Village Council – A Federally Recognized Tribe Serving the People of Port Graham, Alaska through the U.S. Department of Energy (DOE) Tribal Energy Program, this project was conducted to determine the economic and technical feasibility for implementing a biomass energy system to service the Chugachmiut community of Port Graham, Alaska. The forest timber surrounding the village and the established salmon industry are seen as potential biomass fuel resources to reduce energy costs and reliance on imports and support subsistence in the Chugachmiut community. Other benefits of implementing a biomass fuel include economic development and environmental improvement. To satisfy the project goal, the EERC performed load evaluation, resource data analysis, energy and cogeneration technology evaluation, and economic analyses for the Port Graham village.

How research adds to understanding of the area

An ample supply of biomass can be procured from underutilized forest region surrounding Port Graham and from fishery activities to satisfy the energy needs of Port Graham. About 5,000 tons (71,000 MMBtu) per year is available within ¼-mile of existing timber roadways. Salmon oil can also be processed from whole fish or generated waste for use as fuel and is available depending on annual harvesting or processing yields. Currently, about 78,000 gallons diesel are imported to supply an average of 6 MMBtu/hr heat to community buildings and residences and 560 kW for industrial energy via diesel generators. Homer Electric Association provides 260 kW for all village structures and partial industrial operations. About 9,000 MMBtu and 2,000 MWh (16,000 MMBtu combined) in heat and electricity, respectively, are consumed by the village annually, costing the community an estimated $470,000[1] for energy per year.

Technical effectiveness and economic feasibility of the methods or techniques investigated or demonstrated

The most economically viable options for Port Graham are utilization of a fish oil–diesel fuel and the installation of indoor wood boilers. Estimated capital investments are about $260,000 for fish oil-processing equipment and for the delivered and installed boilers. Annual savings and the simple payback periods are about $80,000 and 2–3 years, respectively. User savings could be up to 50% current heating expenses. Fish oil can be blended up to 50% with diesel for use in the existing boilers and furnaces. Approximately 42,000 gallons of fish oil or 630 tons fish/waste annually would be required to provide fish oil blended fuel to the entire village. An average 630 tons of logs would be needed annually for installed indoor wood boilers serving individual village buildings or homes. Differences in the implementation of a indoor wood boiler scenario include enhanced economy, 70% diesel displacement, and potential for increased particulate emissions.

[1] Wholesale diesel costs in Port Graham for the fall, winter, and spring of 2008-2009 is $4.95 per gallon. HEA recently implement kWhr costs from approximately $0.12 kWhr to $0.13 kWhr for community power.

Other economically feasible biomass technology applications include individual, shared, and full-scale wood combustion systems for heat and industrial processing, wood gasification electricity production and cogeneration, and a fish oil–diesel fuel without change to the current infrastructure. Exceptions were distributive heat supplied by steam or syngas and the generation of electric heat and power.

A biomass energy scenario should be discussed by the community to ensure acceptance of the chosen technology. Potential issues beyond economics are manual operation for wood systems and the ability to sustain equipment maintenance. An approach plan should then be derived. Recommended steps for implementation of a biomass energy system include a formal engineering design and quote, including guarantee or proof of emissions compliance for wood systems, secured financing, equipment procurement and installation, personnel hire and training, coordination of feedstock storage and delivery, and blending equipment for fish oil fuel or an ash disposal plan for wood systems. The community of Port Graham must remain diligent in the execution of a biomass energy plan to reduce diesel imports and support subsistence.[2]

How project is otherwise of benefit to the public

This feasibility study follows a format that makes a broad assessment of how an Alaska Native community that does not lie on a road system or on the conventional power grid could utilize a renewable energy source for heat and or power. Other remote Alaskan communities could reference this study so that they may develop an assessment of their potential to use biomass for renewable energy needs. There is an estimated 50 other remote communities in Alaska that have a similar source of biomass. These other communities also have less than 1 Mw power requirements where this study looks at possible variations of utilizing biomass power.

From the time of this study where wholesale delivered diesel fuel to Port Graham, Alaska the cost has risen dramatically. At the start of this study in 2006, the price of diesel was $3.00 per gallon for the 2006-2007 heating season where wholesale fuel is purchased and delivered at the end of each summer. The price rose to $4.07 per gallon for diesel fuel for the 2007-2008 heating season and to $4.95 per gallon for the 2008-2009 heating season. The are price increases 36% and 65% increases from the starting period of this study. These price increases have gotten the attention of the Port Graham community. Other remote communities in Alaska have experience more dramatic price increases in fuel costs. Port Graham and these other Alaska communities can greatly benefit from review of this feasibility study to jump start their study and implementation of their renewable energy options. Dramatic rises in heating costs need to be alleved is obvious. What is not obvious, are those small Alaskan communities off the power-grid system, like Port Graham, whose power consumption is as costly as their heating oil needs will become more affected because unlike Port Graham, their power comes from, for the most part, diesel-fired generators.

[2] Executive Summary taken from The Potential for Biomass District Energy Production in Chugachmiut Communities, Leroux, Kerryanne M. B.; et. al. Energy and Environmental Research Center; Page v and vi.

II. Comparison of Accomplishments with Goals and Objectives of the Project

Analyze biomass resource data The main source of biomass feedstock, Sitka spruce timber, was assumed available and of sufficient quantity to supply stock required for any of the scenarios of heat and power generation studied.	**Resource Data Analysis** Upon analysis it was determined that a sufficient supply was available for the term of any of the scenarios studied. Another source of biomass studied was fish oil from salmon stock that was not previously identified in the proposal. Use of such fish oil would help lessen the dependence on woody biomass but not replace its use. Between the two sources of biomass, it was determined sufficient supplies were available for any biomass renewable energy production scenario studied.
Evaluate site selection and load Site location was assumed to be in a location near the Port Graham Cannery Building because of the co-location of the diesel power generation building.	**Site Selection and Load Evaluation** Upon analysis the assumption was preferred since the modern diesel power plant built in 2000-2001 contained the power infrastructure switch and monitoring equipment to distribute power to the cannery and the communities of Port Graham and Nanwalek, Alaska. Electrical load for Port Graham Village was estimated to be 260 kW with a total 6 MMBtu/hr load for heat. Total yearly load was estimated at 2,000 MWh per year and 9,090 MMBtu/yr for the community. Electrical load is currently supplied by Homer Electrical Association supplying 260 kW. Heating oil in the form of diesel requires approximately 78,000 gallons per year. During the study, biomass generation to replace all or part of the heat and power needs were evaluated. The study narrowed down the number of biomass load generation combinations analyzed to seventeen combinations. The range of power and heat load scenarios ranged from individual residential application (65,000 Btu/hr) to cogeneration energy (6 MMBtu/h4, 600kW) or electrical power and heat (2 MW) supplied to the whole village.[3]
Evaluate biomass energy and cogeneration technologies	**Cogeneration Technology Evaluation** Combustion technologies considered included indoor wood boilers, outdoor wood furnaces, and full-scale systems. There were seventeen wood heat and wood heat and power systems studied. The additional use of fish oil as an additive to diesel and wood was included. The number and viability of these combinations can be reviewed in The Potential for Biomass District Energy Production in Chugachmiut Communities, Leroux, Kerryanne M. B.; et. al. Energy and Environmental Research Center; Pages 12-31.

[3] The Potential for Biomass District Energy Production in Chugachmiut Communities, Leroux, Kerryanne M. B.; et. al. Energy and Environmental Research Center; Page 9.

Determine engineering economics	Engineering Economic Analysis

Determine engineering economics

Engineering Economic Analysis

Biomass technologies, such as feedstock preparation, combustion, gasification, and utilization of a biomass fuel in existing equipment, are technically viable options for alternative energy in Port Graham. The layout of systems is bound by the energy system footprint required and the proximity needed to be maintained for safety measures and economics for distribution of energy. Feedstock preparation methods include production of logs, wood chips, and wood pellets; fish oil procurement and processing; and biomass storage requirements. Combustion systems suitable for the village include indoor wood boilers, outdoor wood furnaces, and full-scale combustion systems, which generate hot water for building heating. A gasification system is capable of providing a synthetic gas product or syngas which can be used to produce steam for heat or processing, combusted for building heat (forced air or hot water), fed to a turbine for electricity generation, or a combination for cogeneration. Fish oil can be used without further processing in a 50% diesel blend in the existing energy system. For all biomass technologies, the current systems can remain in place as a backup.

The layout of village structures is suitable for all scenarios proposed, from individual systems to larger, shared heating or cogeneration systems. Two examples are provided in Appendix C[4]. The first shows outdoor wood furnaces serving multiple homes and village buildings. The second shows distributive heat, electricity, or cogeneration to the entire village using a large combustion or gasification system. Outdoor wood furnaces must be located about 100 ft away from both the property line of the unit served and any structures for safety measures. Large-scale systems serving the whole village require the installation of a piping network to provide heat to village buildings. Electricity produced via gasification can be distributed by connecting to the existing power plant for access to village power lines. Thus proximity to other structures, connections to structures for shared systems, and existing infrastructure determine the applicability of scenarios to the Port Graham village.

All biomass energy scenarios studied were determined to be economically viable, with the exception of those proposing distributive steam or syngas (alone, without cogeneration) and electricity generation for heat and power. Economic calculations are shown in Appendix E. Feedstock, capital, and operating costs were estimated for each scenario and the annual cost, savings, and payback were calculated for determination of the most economical approach for the village. Each scenario also requires an array of additional equipment for implementation, e.g. piping, as well as operating considerations such as wood loading and ash management, which can have a significant effect on economics. A detailed table listing the necessary requirements for scenario implementation is given in Appendix B. Emissions from operation of a biomass energy system are not expected to exceed national or state standards.

[4] The Potential for Biomass District Energy Production in Chugachmiut Communities, Leroux, Kerryanne M. B.; et. al. Energy and Environmental Research Center; see Appendix B, C, and E.

III. Summary of Project Activities

Original hypotheses

The goal of the project was to determine the economic and technical feasibility for implementing a biomass energy system to serve the community of Port Graham. To accomplish this goal, an analysis was made of the biomass resource data, evaluating the site selection and energy load, evaluating cogeneration technology and determining engineering economics. Upon completion of the feasibility study, Port Graham Village Council would have a recommendation regarding the viability of local fuel resources and the application of fuel resources to energy loads. That is, the Council would be able to determine whether use of the biomass in an energy facility will provide an economical source to heat and power the Port Graham Cannery. From this feasibility study the Port Graham Village Council wished to be able to determine whether to utilize a biomass energy system and which type of biomass technology to invest.

Approaches used

Contractor EERC performed load evaluation, resource data analysis, energy and cogeneration technology evaluation, and economic analysis for the Port Graham Village. Specific matching of resources, technology, and energy loads provided information needed to compare options on an economic basis and determine the most viable options for Port Graham.

Members of the project team visited the village to obtain pertinent information concerning energy loads in the village. Community buildings were identified and energy systems were investigated and recorded. Tribal council members and Chugachmiut representatives provided information needed to perform load and economic calculations in the industry sector.

Data was assembled by Chugachmiut regarding the forested resource located in Port Graham, and fish oil information was provided by the Port Graham Hatchery. This data was analyzed to determine annual supply and cost of procurement. Densification of the wood into wood chips or pellets was considered for ease of use, transportation, and increased efficiency. Fish oil was also reviewed as a potential biomass resource because of the established salmon industry in Port Graham.

Several technologies (e.g., combustion, gasification, liquid biomass fuel) and a variety of size applications were considered for Port Graham energy production and cogeneration. Combustion systems are commercially available and vary in size from small indoor wood boilers for individual use to full-scale units capable of supplying heat to the entire village. Gasification is an alternative option that can be implemented to supply heat via syngas production, generate electricity using a microturbine, or provide both heat and electricity through cogeneration. Liquid biomass sources can be used to replace diesel and reduce consumption without modification of the existing infrastructure.

Finally, an engineering economic feasibility analysis was performed to evaluate the technologies and applications. The analysis was based on savings from current fossil fuel and electricity costs, including estimation of capital, operational, and feedstock costs. The estimated savings were used to calculate a simple payback period for financing expenses.

Sensitivity of the savings and payback were tested for changes in feedstock cost, petroleum fuel price, and capital investment. Emissions

Problems encountered and departure from planned methodology

Biomass feasibility was conducted as proposed except for the addition utilizing fish stock to render into fish oil that would be used for biofuel. As a result of touring the fish hatchery operation, the manager suggested using overstock of returning salmon to the hatchery operation. Subsequently, an analysis was conducted to assess the fish stock, estimate the amount of fish oil biofuel that could be utilized, and a technical analysis regarding how to optimally use this fuel.

Assessment of their impact on project results

Fish oil derived from simple pressing of fish stock could supply the most economic process. The fish oil would then be used as a fish oil-diesel blend to displace diesel consumption. The price of diesel and fish oil–diesel blend, followed by capital investment and wood procurement, are the most sensitive factors to the estimated savings and payback for the large fish oil and indoor wood boiler scenarios. From EERC's Feasibility Study starting on Page 21, "Diesel displacement is important to the economic feasibility of fish oil fuel, becoming unviable for blend containing less than 20% fish oil. Procurement of the wood resource could conceivably range $35–$75/ton. Savings and payback show a minor effect (up to "15%) with change in wood cost. Scenario economics could vary up to three times the baseline for both scenarios with change in diesel price, tested for the range of $2–$5/gal. The base diesel price of $3.00/gal is a conservative value, given the recent spikes in petroleum fuel costs. Although diesel price is historically volatile, the probability of a significant decrease in price is low. Figure 13 shows that the indoor wood boilers have the potential to generate greater savings than processing fish oil at higher diesel prices. Changes in estimated capital investment have a significant effect on savings and payback. Increasing the capital costs to $500,000 would generate an estimated savings of about $50,000 annually and a simple payback of 3 years, which would continue to be considered an economical investment."

Facts, figures, analyses, and assumptions used during life of project to support conclusions

See The Potential for Biomass District Energy Production in Chugachmiut Communities, Leroux, Kerryanne M. B.; et. al. Energy and Environmental Research Center, attached.

IV. Products Developed

Publications

i. EERC Study—The Potential for Biomass District Energy Production in Chugachmiut Communities, Leroux, Kerryanne M. B.; Williams, Kirk D.; Hanson, Sheila K.; Zacher, Erick J.; 2007-EERC-07-07; Energy and Environmental Research Center University of North Dakota, 15 North 23rd Street, Stop 9018; Grand Forks, North Dakota 58202-9018, July 2007.
ii. EERC PowerPoint

Data and databases—see EERC Study above