Regional Housing Authority

Southeast Alaska Energy Efficiency Audit, Assessment, and Alternative Energy Study

Craig Moore
V.P. Planning and Development
Tlingit-Haida Regional Housing Authority

2015 Program Review
Tribal Energy Program (TEP) Denver CO. May 6, 2015

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SE Alaska Energy Efficiency Audit, Assessment, and Alternative Energy Study

Project Description: "The project will provide energy efficiency audits, energy monitoring, and energy conservation proposed upgrades for about 51 low-income, multifamily buildings in 14 southeast Alaska communities with extremely high energy costs.

THRHA will also provide home energy assessments, energy conservation education, and energy use monitoring for 400 families."

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Objectives: Identify efficiency measures to reduce energy costs by 30% for low-income multifamily housing by:

1. Decreasing energy demand by increasing multifamily housing energy efficiency.
2. Reducing household energy consumption through energy conservation education and installation of energy upgrades.
3. Projecting energy savings based on fossil fuel reduction to environmentally and economically benefit tribal southeast communities.

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Objective 2: Reducing household energy consumption through energy conservation education and installation of energy upgrades.

- Energy Cents Program
- Conducted by Tasha McCoy, THRHA
- Completed 2014
- Presented by Tasha at TEP Review March 26, 2014
  http://apps1.eere.energy.gov/tribalenergy/pdfs/2013_program_review/40_thrha_tasha_mckoy.pdf
- Household Energy Use Assessments, Monitoring and Energy Education

Objective 2: Energy Cents Program (sample)

Tlingit and Haida Regional Housing Authority

Energy Cents Program

Tribal DOE Review

March 26th, 2014

Tasha McKoy

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Objective 2: Energy Cents Program (sample)

Project Deliverables (PDs)

- 28 field assessors conduct home assessments

Objective 2: Energy Cents Program (sample)

400 Energy Usage Assessments (PDs)

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Objective 2: Energy Cents Program (sample)

Community Meetings & Energy Fairs (PDs)

Objective 2: Energy Cents Program (sample)

Statement of Project Objectives

5-c.)Home energy assessment results and recommendations:

Table 4. Secondary Household Heating Fuel Types, by Primary Fuel Type

			Secondary Fuel Counts				
	Fuel	**No Second-ary or NR**	**Electric**	**Oil**	**Wood**	**Other**	**Total**
Primary Fuel	Electricity	33	6	4	7		50
	Oil	70	9	6	22	4	111
	Wood	9	5	21	---	2	37
	Other	---	1	1	---	---	2
	Total	**112**	**21**	**32**	**29**	**6**	**200**

Of the homes reporting a primary fuel, 44 percent report secondary heating systems. The most common secondary heating system for respondents is oil (36 percent) and electric (24 percent). About two-thirds of homes heated primarily by electricity and oil did not report a secondary heating system.

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Objective 2: Energy Cents Program

RESULTS:

- Good data on close to 400 SE Alaska homes
- Increased homeowner awareness of energy efficiency household energy usage, and how to change habits.
- Increased youth awareness of energy efficiency
- Energy efficient light-bulbs, weather-stripping and watt meters deployed in many homes.

CONCLUSIONS:

- Household education helps save energy.
- Many homes need weatherization.
- Most homes in high-cost diesel-electric communities need renewable energy (non-fossil fuel) heating systems

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OTHER PROGRAM OBJECTIVES:

Decrease energy demand in SE Alaska multifamily housing and reduce dependency on fossil fuels.

METHODOLOGY:

Provide energy efficiency audits, energy monitoring, and energy conservation proposed upgrades for a 51 low- income, multifamily buildings in 14 southeast Alaska communities with extremely high energy costs.

ASSIGNED TO: Craig Moore, THRHA

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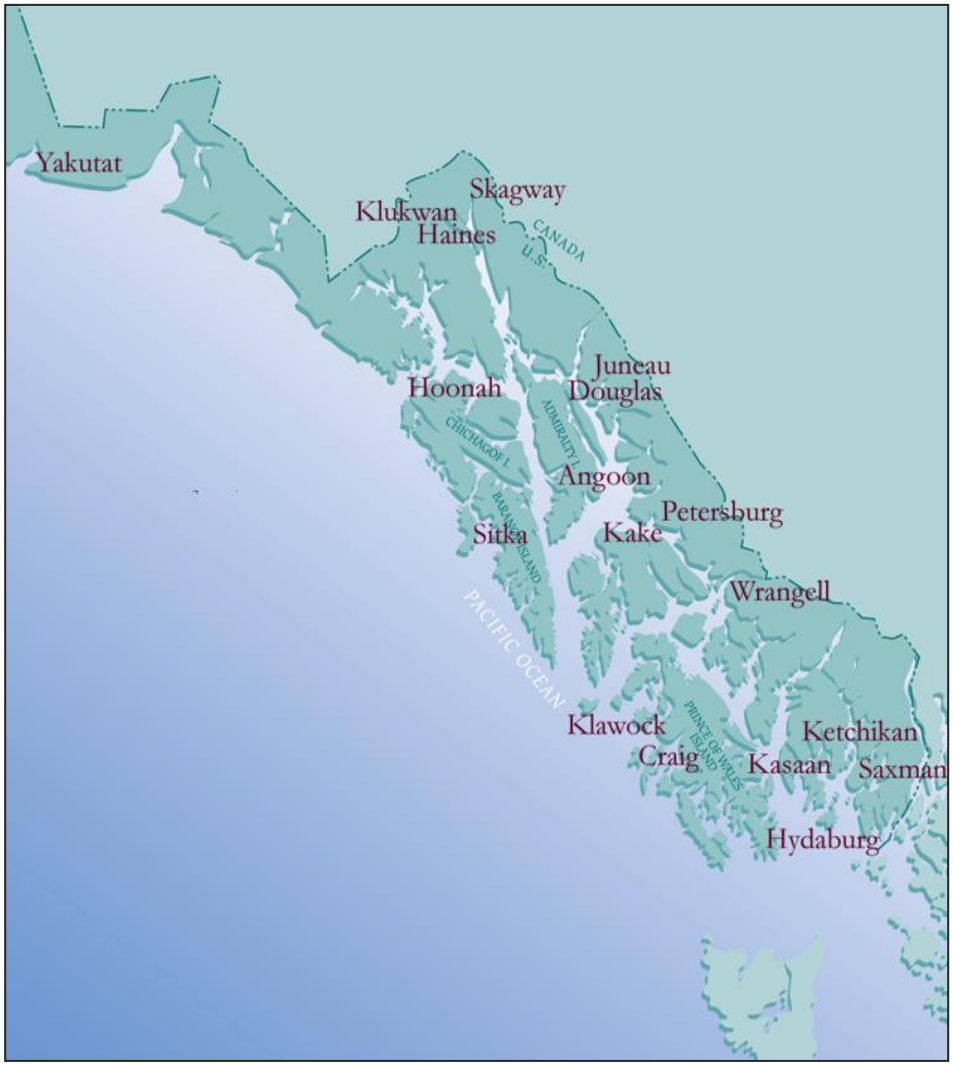

SE Alaska is an archipelago about 400 miles long, the temperate rainforest of the Tongass National Forest. Climate is wet, ranging from 7000 – 9000 HDD. Most communities are isolated on islands and are not connected by roads or electrical grids.

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While SE Alaska can get heavy snow, it seldom stays long due to the tempering influence of the Japanese currents in the nearby Gulf of Alaska.

The 12-unit Haines Low-Rent Building in Haines, Alaska is heated with oil. It is a good candidate for biomass heating.

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A typical SE village has limited economy and limited job opportunities. They have high shipping costs, and high energy costs.

The village of Angoon is a high-cost diesel-electric community where most homes are heated with oil or wood. At $0.65/kWh and $5.60/gallon oil, energy efficiency and alternate heating systems are important to sustainability.

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SE Alaska has no natural gas available. All fossil fuels are imported by barge from Seattle, resulting in high fuel costs.

Some of the larger communities have hydroelectric dams, which are very expensive to build, but provide relatively cheap, renewable hydro-electricity (between $0.08 to $0.17 kWh). In these hydroelectric communities, air-source heat pumps are proving to be a viable non-fossil fuel alternative to heating oil.

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A typical 82% AFUE oil boiler with hydronic distribution heating and boiler-fired indirect hot water maker.

Many homes in SE Alaska have heating systems like this, considered state-of-the-art in the 1990's. But with the high cost of fuel oil now, and the high maintenance repair costs, many homeowners can no longer afford to operate or maintain these systems.

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Many homeowners in SE Alaska are abandoning their oil boilers in favor of wood stoves. Most are not EPA certified, and are not safely installed. Wood is readily available for those fit enough to get it. However, the firewood is usually high moisture content and is seldom seasoned, causing inefficient burn. It's also common practice to keep an open pot of water on top.

Mold often becomes an issue when homeowners change heating systems without proper planning.

With most wood stove installations, there is usually inadequate movement of heat to back bedrooms, and very little air movement. High humidity in the home condenses on cold surfaces in bedrooms, causing mold and health issues.

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In addition, we often find that bathroom fans are not moving very much air, due primarily to improper duct installation.

In short, many homes in SE Alaska suffer from high energy costs, insufficient air-sealing and insulation, poorly functioning heating and ventilation systems, high indoor moisture and poor air quality. All these factors must be dealt with when considering energy efficiency improvements.

EXAMPLES OF MEASURES THRHA HAS BEEN TAKING TO IMPROVE ENERGY EFFICIENCY AND REDUCE DEPENDENCY ON FOSSIL FUELS:

- Weatherization Program
- Super-insulated building shells (outside insulation)
- Air Source Heat Pumps
- Biomass Heating
- Solar PV
- Improved ventilation systems
- Client education

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Dense-packing floors with cellulose

Since 2008, THRHA has trained a highly skilled local work force to perform weatherization on homes under the State of Alaska's Weatherization program, with an average cost per unit of $11,000.

This program has helped many homeowners immensely, yet is not adequate for installing new renewable energy heating systems.

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THRHA crew lead demonstrates proper window flashing on this house with outside insulation technique.

THRHA Crews have become proficient at building energy-efficient and durable buildings for our climate, with specialized training in cold-climate construction, proper weather-flashing, outside insulation technique, rain-screen siding, airtight construction, and proper ventilation.

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THRHA's newer subdivisions are highly energy efficient and durable construction.

Our new homes are 5 Star Plus energy rated, with non-fossil fuel heating systems and improved ventilation systems for good indoor air quality.

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Our new all-electric Saxman Senior Center is a state-of-the-art building with outside insulation technique and air-source heat pumps. It requires less than 5 BTU/square foot to heat.

This is a hydro-electric community at $0.10/kWh rates

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The new Yakutat Senior Center is highly energy efficient and is heated with a cord wood gasification boiler. It uses local cordwood, with a moisture content between 18 – 28%. It stores it's heat energy in large water-filled buffer tanks for heating both the building and domestic hot water.

This system provides local job and keeps fuel dollars in the community.

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The new energy efficient THRHA warehouse in Juneau is heated with a wood pellet boiler. It is clean burning, quiet and as maintenance free as any equipment we have used. It has a 10-ton silo. We do not have to worry about any fuel spills. It is saving us about $9,000/year over oil on heating costs.

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Kake Senior Center Modernization Project. Kake is a high-cost diesel electric community.

The newly modernized Kake Senior Center will be highly energy-efficient, and will be heated with a wood pellet boiler. It is ideally situated for solar PV, so we are looking into the feasibility of using solar PV to help displace some of the high cost ($0.65/kWh) electric rates.

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In some of our hydroelectric communities we are replacing electric resistance heat and oil heat with new “mini-split” ductless air-to-air heat pumps. With efficiencies to 300%, ranges down to -15 F, and installed costs of less than $5,000, they are a becoming a hot item in hydroelectric communities.

STATUS OF ENERGY EFFICIENCY AUDITS AND ALTERNATIVE ENERGY STUDIES ON MULTIFAMILY BUILDINGS IN SE ALASKA

- Over 50 Multifamily buildings have been assessed.
- AS-IS Energy Ratings conducted using AkWarm software.
- Improvement Options reports generated.
- Results are being compiled into final report.
- Additional studies being conducted on controls, real-time energy monitoring, and energy cost comparison in select communities.
- Final report due end of June 2015.

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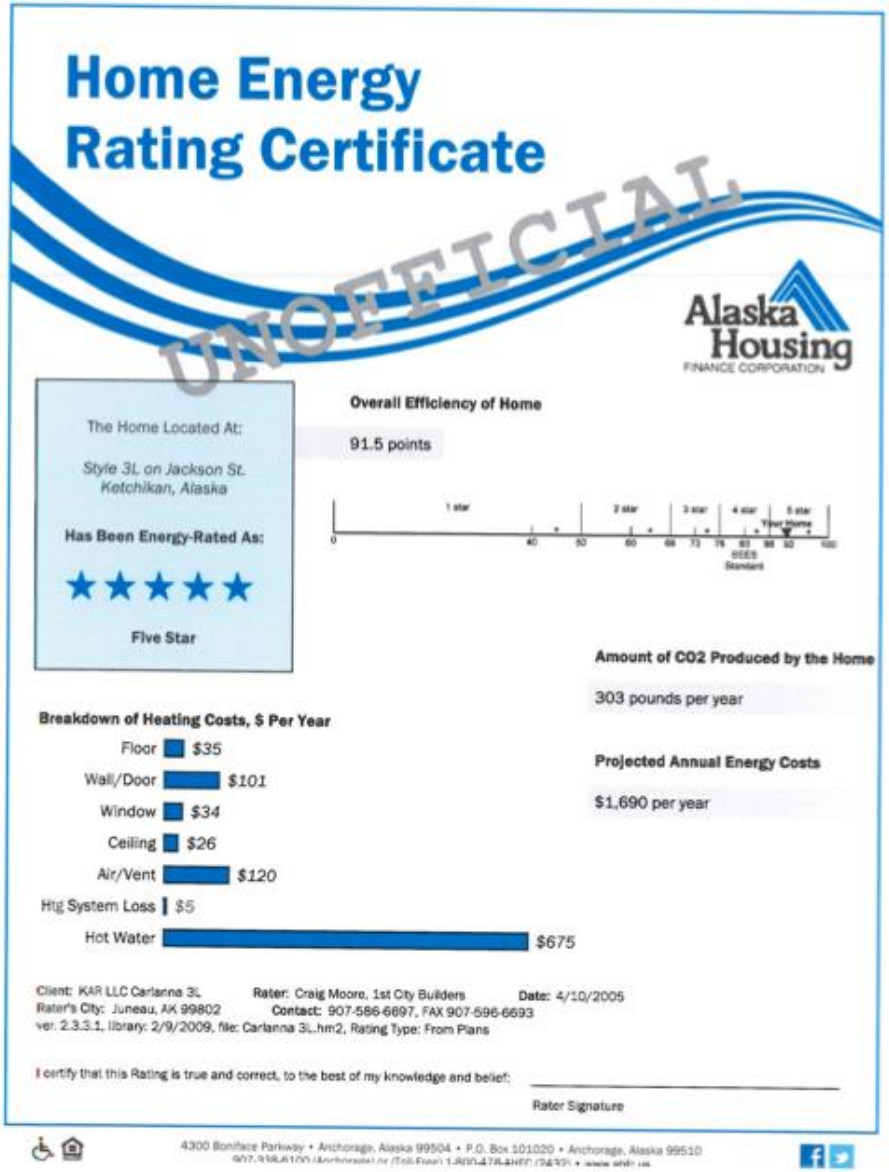

Sample AkWarm energy rating on a new building

AS-IS Energy Ratings were conducted by trained energy assessors on smaller multifamily buildings using AkWarm energy rating software. Improvement Options Reports were generated showing cost-effective improvements with a Savings to Investment Ratio (SIR) of 1 or better.

A typical AkWarm Improvement Options report for building shell improvements to a 12-unit multifamily building in Haines. Heating conversion is treated separately.

Table 2.3-4 : Haines Energy Conservation Measure Estimated Cost Benefit Summary

Energy Efficiency Measure	Estimated Total Savings	Estimated Total Cost	Simple Payback, Years	SIR Ratio
Replace 3 outside doors with U-0.16 insulation	$190	$1,467	7.7	3.0
Air Sealing to 4 ACH	$1,283	$5,000	3.9	3.0
Insulate floors with R-30 dense pack insulation	$666	$10,380	15.6	1.5
Replace windows with U-0.26	$2,323	$34,650	14.9	1.2
Increase Ceiling Insulation to R-60	$608	$16,945	27.9	0.9
Energy Star Refrigerators	$372	$12,000	32.3	0.5
Upgrade wall insulation to R-30 and replace siding	$367	$20,888	56.9	0.4
Totals	**$5,809**	**$101,330**	**17.4**	

Notes:

1 – Costs and savings values for air sealing, windows, and insulation are estimated using the AkWarm software from the 3/30/2015 library.

2 – Energy Star rated refrigerator savings are generated from www.energystar.gov savings calculator.

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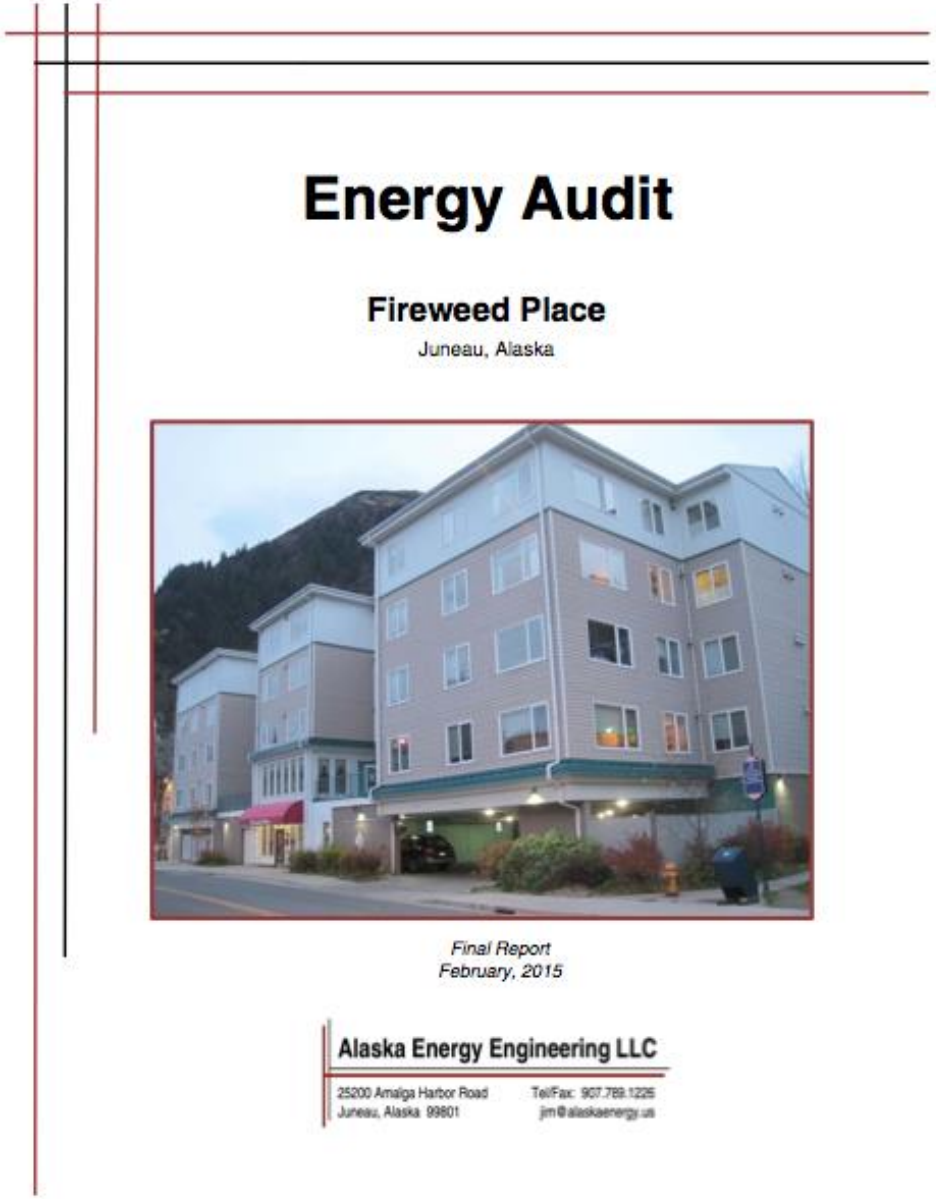

Professional energy audits were conducted on our larger multifamily buildings by energy engineers with experience in complex HVAC systems in multi-story buildings.

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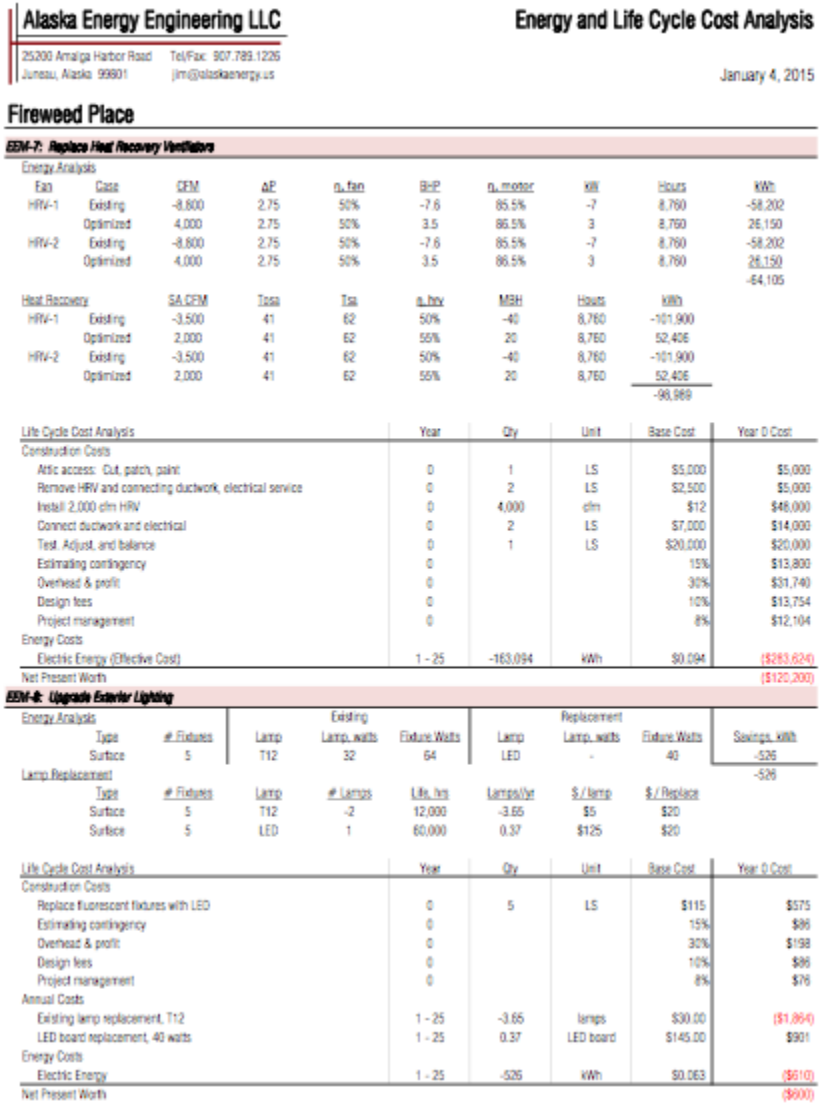

Alaska Energy Engineering LLC

25200 Amalga Harbor Road Tel/Fax: 907.789.1226
Juneau, Alaska 99801 jim@alaskaenergy.us

Energy and Life Cycle Cost Analysis

January 4, 2015

Fireweed Place

EEM-7: Replace Heat Recovery Ventilators

Energy Analysis

Fan	Case	CFM	ΔP	η, fan	BHP	η, motor	kW	Hours	kWh
HRV-1	Existing	-8,800	2.75	50%	-7.6	85.5%	-7	8,760	-58,202
	Optimized	4,000	2.75	50%	3.5	86.5%	3	8,760	26,150
HRV-2	Existing	-8,800	2.75	50%	-7.6	85.5%	-7	8,760	-58,202
	Optimized	4,000	2.75	50%	3.5	86.5%	3	8,760	26,150
									-64,105

Heat Recovery		SA CFM	Tosa	Tsa	η, hrv	MBH	Hours	kWh
HRV-1	Existing	-3,500	41	62	50%	-40	8,760	-101,900
	Optimized	2,000	41	62	55%	20	8,760	52,406
HRV-2	Existing	-3,500	41	62	50%	-40	8,760	-101,900
	Optimized	2,000	41	62	55%	20	8,760	52,406
								-98,989

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Attic access: Cut, patch, paint	0	1	LS	$5,000	$5,000
Remove HRV and connecting ductwork, electrical service	0	2	LS	$2,500	$5,000
Install 2,000 cfm HRV	0	4,000	cfm	$12	$48,000
Connect ductwork and electrical	0	2	LS	$7,000	$14,000
Test, Adjust, and balance	0	1	LS	$20,000	$20,000
Estimating contingency	0			15%	$13,800
Overhead & profit	0			30%	$31,740
Design fees	0			10%	$13,754
Project management	0			8%	$12,104
Energy Costs					
Electric Energy (Effective Cost)	1 - 25	-163,094	kWh	$0.094	($283,624)
Net Present Worth					($120,200)

EEM-8: Upgrade Exterior Lighting

Energy Analysis

		Existing			Replacement			
Type	# Fixtures	Lamp	Lamp, watts	Fixture Watts	Lamp	Lamp, watts	Fixture Watts	Savings, kWh
Surface	5	T12	32	64	LED	-	40	-526
								-526

Lamp Replacement

Type	# Fixtures	Lamp	# Lamps	Life, hrs	Lamps/Yr	$ / lamp	$ / Replace
Surface	5	T12	-2	12,000	-3.65	$5	$20
Surface	5	LED	1	60,000	0.37	$125	$20

Life Cycle Cost Analysis	Year	Qty	Unit	Base Cost	Year 0 Cost
Construction Costs					
Replace fluorescent fixtures with LED	0	5	LS	$115	$575
Estimating contingency	0			15%	$86
Overhead & profit	0			30%	$198
Design fees	0			10%	$86
Project management	0			8%	$76
Annual Costs					
Existing lamp replacement, T12	1 - 25	-3.65	lamps	$30.00	($1,864)
LED board replacement, 40 watts	1 - 25	0.37	LED board	$145.00	$901
Energy Costs					
Electric Energy	1 - 25	-526	kWh	$0.063	($610)
Net Present Worth					($600)

Energy and Life Cycle Cost Analyses were performed on proposed Energy Efficiency Measures (EEM's)

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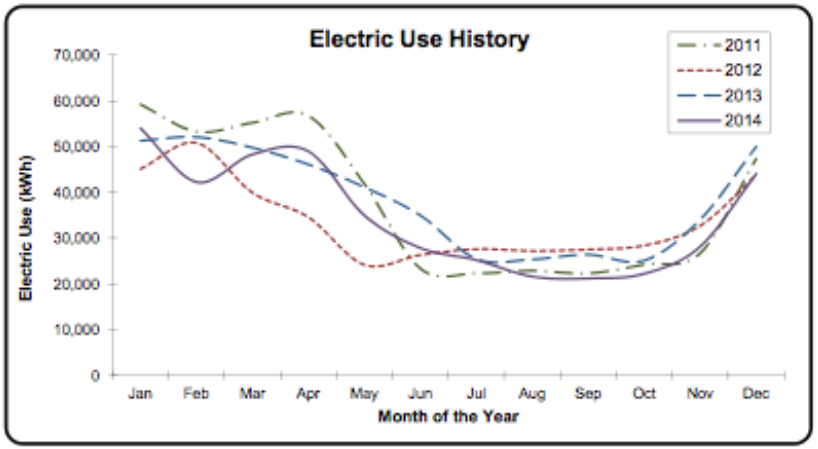
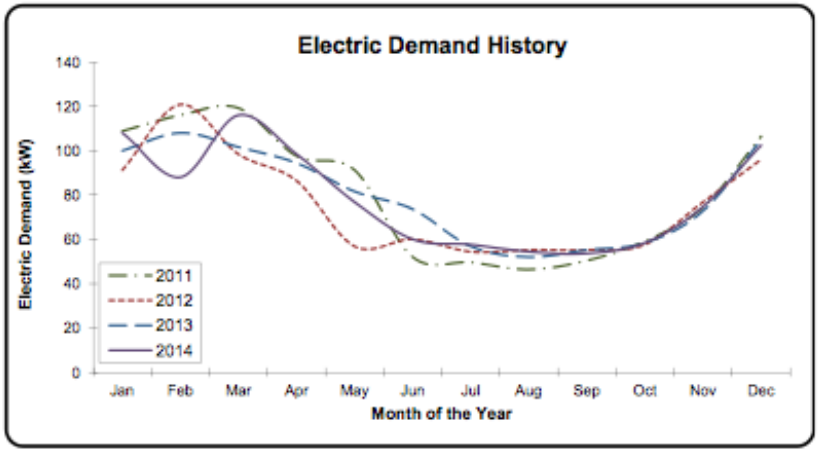
Annual Electric Consumption
January 4, 2015

Fireweed Place - Master Meter





Electrical use history is conducted on Multifamily buildings

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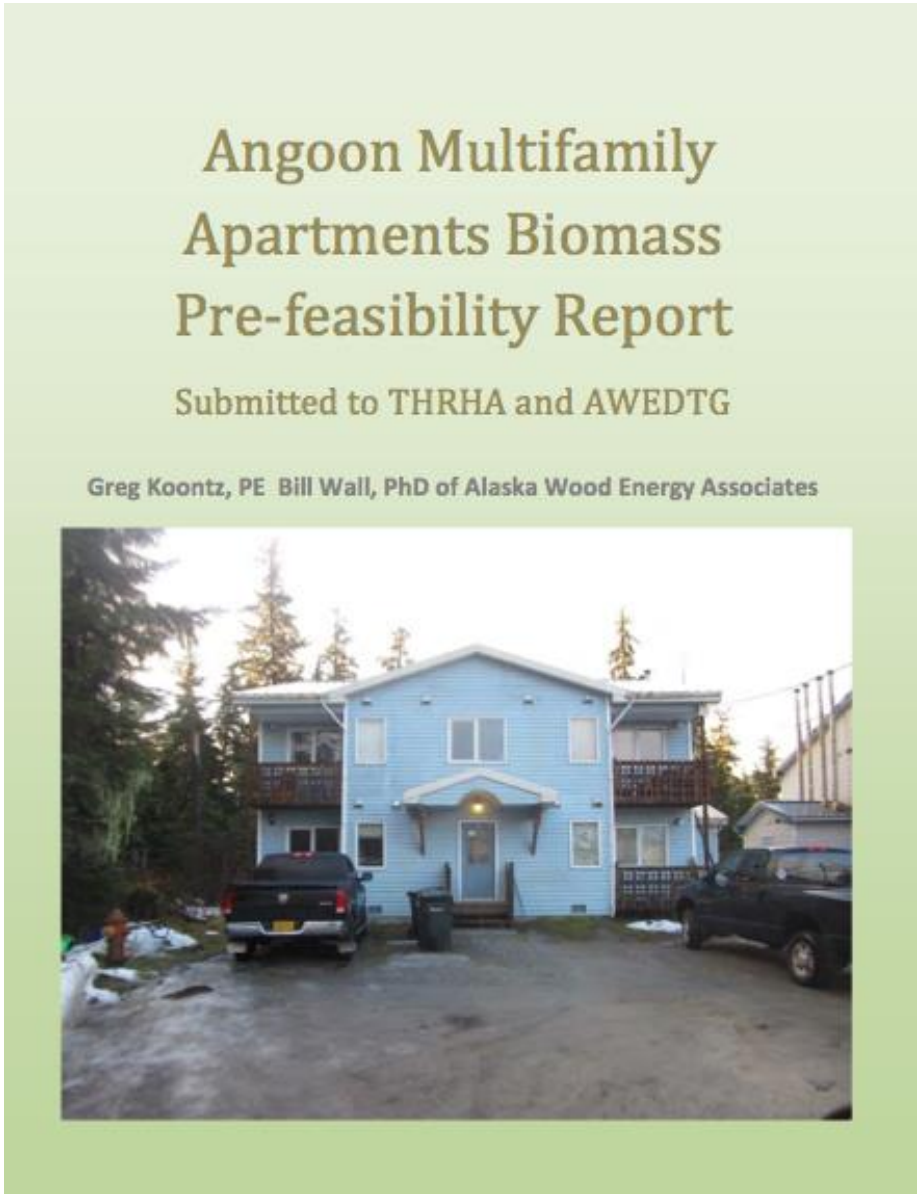

THRHA has received professional biomass feasibility studies on multifamily buildings in high-cost diesel electric communities.

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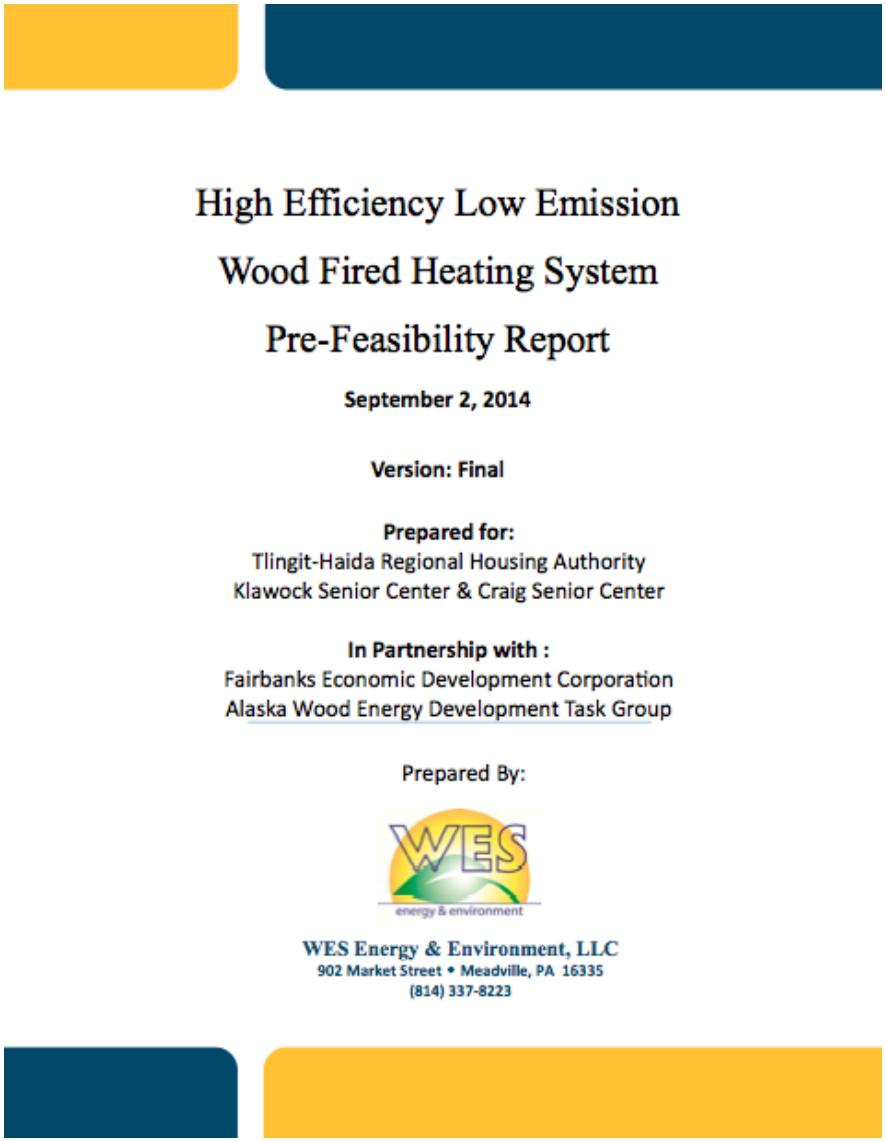

High Efficiency Low Emission

Wood Fired Heating System

Pre-Feasibility Report

September 2, 2014

Version: Final

Prepared for:
Tlingit-Haida Regional Housing Authority
Klawock Senior Center & Craig Senior Center

In Partnership with :
Fairbanks Economic Development Corporation
Alaska Wood Energy Development Task Group

Prepared By:

WES energy & environment

WES Energy & Environment, LLC
902 Market Street • Meadville, PA 16335
(814) 337-8223

THRHA is utilizing the cost-benefit analyses and energy savings projections from these biomass feasibility reports to help our communities lower energy costs and reduce dependency on imported, non-renewable fossil fuels.

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An Energy Cost Breakdown for a 4-plex in Angoon, modeled from AkWarm software. This will be compared to actual energy consumption records to see if tenants are operating according to normal usage.

Table 2.1-13 : Annual Fourplex Energy Cost Breakdown

Unit	Space Heating #1 Oil Use, Gallons	Space Heating #1 Oil Cost	Water Heating #1 Oil Use, Gallons	Water Heating #1 Oil Cost	Appliances / Lights Electric Use, kWh	Appliances / Lights Electric Cost	Total Annual Costs
1	428	$2,294	450	$2,412	24,407	$5,857	$10,563
2	428	$2,294	450	$2,412	24,407	$5,857	$10,563
3	428	$2,294	450	$2,412	24,407	$5,857	$10,563
4	428	$2,294	450	$2,412	24,407	$5,857	$10,563
Totals	**1,712**	**$9,176**	**1,800**	**$9,648**	**97,628**	**$23,428**	**$42,252**

Note: Fuel use and cost information provided by AkWarm software based on the 3/30/2015 library

A typical energy cost comparison chart, for the community of Craig. The cost of locally produced Bio Bricks is less than half the cost per mmBtu than oil.

Table 2.2-1 : Craig Cost of Energy Comparison

Technology, Unit	Input Btu/Unit	Cost/Unit	Assumed Efficiency	Output Btu/Unit	Cost/ mmBtu Output
#1 Fuel Oil, Gallon	134,000	$4.10	80%	107,200	$38.25
Electricity, kWh (Resistance)	3,412	$0.23	100%	3,412	$67.41
Electricity, kWh (Heat Pump)	3,412	$0.23	300%	10,236	$22.47
Wood Pellets, Ton	15,200,000	$330.00	80%	12,160,000	$27.14
Bio Bricks, Ton (Palletized Unboxed)	15,200,000	$200.00	75%	11,400,000	$17.54
Bio Bricks, Ton (Palletized Boxed)	15,200,000	$250.00	75%	11,400,000	$21.93
Seasoned Hemlock, Full Cord	18,100,000	$250.00	70%	12,670,000	$19.73

Note: Fossil fuel prices provided by AkWarm software based on the 3/30/2015 library. Biomass prices obtained from local providers.

A sample Cost of Energy Comparison for Ketchikan. Ketchikan is a hydroelectric community. Heat pumps (both air source and ground source) are far less costly per mmBtu output than oil or wood pellets

Table 2.7-1 : Ketchikan Cost of Energy Comparison

Technology, Unit	Input Btu/Unit	Cost/Unit	Assumed Efficiency	Output Btu/Unit	Cost/ mmBtu Output
#1 Fuel Oil, Gallon	134,000	$4.05	80%	107,200	$37.78
#2 Fuel Oil, Gallon	138,800	$4.05	80%	111,040	$36.47
Electricity, kWh (Resistance)	3,412	$0.11	100%	3,412	$32.24
Electricity, kWh (Air Source Heat Pump)	3,412	$0.11	300%	10,236	$10.75
Electricity, kWh (Ground Source Heat Pump)	3,412	$0.11	500%	17,060	$6.45
Wood Pellets, Ton	15,200,000	$400.00	80%	12,160,000	$32.89

Note: Fuel prices provided by AkWarm software based on the 3/30/2015 library

A typical Wood Pellet Heating System Financial Analysis for a Senior Center in Klawock. This shows a simple payback of 24.5 years.

Table 2.8-3 : Klawock Wood Pellet Heating System Financial Summary

Current #1 Fuel Oil Use, Gallons	Current Oil Cost	Estimated Wood Pellet Use, Tons	Estimated Wood Pellet Cost	Estimated O&M Costs	Estimated Oil Cost with Wood Pellet System	Estimated Savings	Estimated Capital Cost	Simple Payback, Years
5,000	$20,650	42	$13,860	$1,590	$1,033	$4,168	102,275	24.5

Note: Assumes 95% offset with wood pellet system. Remaining 5% is offset with existing oil fired system. Fuel prices used to generate economics are $4.13/gallon for #1 fuel oil and $330/ton of wood pellets. Annual oil use and wood pellet use values are from the September 2, 2014 report titled "High Efficiency Low Emission Wood Fired Heating System Pre-Feasibility Report" created by WES Energy & Environment.

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FINAL OUTCOMES will provide energy data, improvement options, and cost-effective recommendations for making our multifamily building in SE Alaska more energy efficient, and our communities more sustainable.

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