Allakaket Village
Biomass Heat Pre-Feasibility Study

Prepared for Interior Regional Housing Authority

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Prepared by:

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With Support from:

The Alaska Energy Authority

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Acknowledgements

Energy Action thanks the following representatives for their assistance with this assessment:

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Summary of Findings

The Yukon-Koyukuk School District (YKSD) may be interested in a biomass heat sales agreement with a third-party owner and operator. This is a revenue-generating opportunity for a third-party, such as the Allakaket Village Council, the City of Allakaket, the Alatna Village Council, or a private entity.

The project building is the future Allakaket School, planned for construction in 5 – 10 years. The biomass project would use an estimated 93 cords per year to displace about 85% of the future school's assumed heat load of 10,875 gallons of fuel oil. The project is considered marginally pre-feasible at this time.

If the project owner can source fuel at $265 per cord, as the Tanana Chiefs Conference reconnaissance-level biomass resource assessment suggests, the project is considered pre-feasible.

Under the current market prices of $400 per cord and $5.69 per gallon, the project is considered unfeasible. Sensitivity analysis indicates the project would be financially pre-feasible with the input price of $400 per cord if the price of fuel oil rises to $6.85 per gallon or more.

When YKSD begins to actively plan the new Allakaket School, it is recommended that they review this pre-feasibility study to consider whether assumptions have significantly changed which would impact the pre-feasibility of the biomass heat project. It is also recommended that YKSD discuss the possibility for third-party ownership and operation of a biomass heat project with local organizations. The project may be an opportunity for these organizations to create revenues and community benefits consistent with their organizational missions.

Statement of Purpose

Since 2008, the Alaska State Legislature has supported renewable electric and thermal energy projects through the Renewable Energy Grant Recommendation Program, administered by the Alaska Energy Authority. In Round 6 of the Program, Interior Regional Housing Authority, which seeks opportunities to promote community self-sufficiency through energy projects, received money to complete pre-feasibility studies of biomass heat in community buildings in seven villages. The following pre-feasibility study has been funded through that grant.

Community & Facility Information

Allakaket Village (population 105) is an Alaska Native Village located on the south bank of the Koyukuk River, southwest of its junction with the Alatna River, approximately 190 air miles northwest of Fairbanks. Allakaket Village also provides the airport, electric utility, postal, and school services to Alatna Village (population 26), which is located just west of Allakaket Village across the Koyukuk River.

The Yukon-Koyukuk School District (YKSD) will construct a new school in Allakaket in 5 – 10 years. This new school is the project building, as explained below. YKSD is managed by a Superintendent and Board of Education. The current Director of Facilities & Maintenance is Gale Bourne.

YKSD purchases fuel oil in Allakaket for $5.69 per gallon. Delivery is by plane only.

The current going rate for cordwood is $400 per cord (Allakaket Village Council meeting, personal conversation, February 5, 2013). The Allakaket Village Council and City of Allakaket offices both contain wood stoves, which are actively used for heating.

Electricity averages 92 cents per kWh (email correspondence, Gale Bourne, February 11, 2014).

Much of the town, including the existing Allakaket School, is below the 100-year flood mark of 497'. New construction is often located on high ground in the New Allakaket Subdivision.

The project building is the future Allakaket School. This building will have the largest heat load in the community, and new construction will offer the potential to minimize project costs by through shared overhead expenses with the future School construction. Mr. Bourne expressed that he is interested in a biomass energy project that meets the following standards:

- Lower cost per Btu than oil
- No increased maintenance costs
- No inherent risk that is out of YKSD's ability to control

It appears that a heat sales project, owned and operated by a third-party, which is separate from the School's energy system, may satisfy Mr. Bourne's interest. However, the interest of a third-party to own and operate such a system remains to be determined, as discussed in the "Recommendations" section of this report.

The existing Allakaket School uses about 14,500 gallons of fuel oil per year (Appendix B). For the purpose of this report, the future School is anticipated to use 75% of the existing School's fuel usage, a total of10,875 gallons of fuel oil. It is also assumed to be designed to heat with warm water at 120°F.

Several buildings were considered not suitable for biomass energy assessment, including the Tribal office, City office, and Washateria / Water Plant. The Tribal office and City office have relatively low fuel oil consumption (<1,200 gal/ yr.), and already have operating cordwood stoves. The Washateria / Water Plant fuel oil consumption (about 1,160 gal/ yr.) is too low to justify evaluation for biomass heat. The Washateria /Water Plant benefits from recovered heat from the nearby AP&T power plant.

Biomass Resource Availability

This pre-feasibility study was completed simultaneous to a reconnaissance-level biomass resource assessment by Tanana Chiefs Conference, which will be complete in fall 2014. The draft biomass resource assessment takes account of biomass stocking by ownership, resource distance from Allakaket Village, and other factors. In summary, within a 5-mile radius of Allakaket Village, there are approximately 144,000 cords of biomass, with nearly 82% of this material located on K'oyitl'ots'ina, Limited lands. The average cost for biomass within a 5-mile radius of Allakaket Village is about $121 per cord. This figure includes harvest, stumpage, administration, and transport costs, but does not include the cost of processing logs into cordwood or profit.

Site Control

The proposed biomass project is hypothetical, and no project location has been determined. Site control has not been evaluated for this project.

Permitting

Applicable project permitting is considered below:

- The Alaska Department of Public Safety, Division of Fire and Life Safety must approve the project plans before construction is started. Mechanical and electrical review is limited to that which is necessary to confirm compliance with fire and life safety requirements.
- Commercial harvests associated with the project may or may not be required to comply with the Alaska Forest Practices and Resources Act. While most commercial operations are required to comply, commercial operations of minor or small scale are sometimes exempted. The Act addresses forest management along water bodies, erosion mitigation, and reforestation.
- The 40CFR63 NESHAP Rule does not apply to the project. The Rule does not apply to a hot water heater, which is defined in Subpart 6J as a boiler with a heat input capacity is less than 1.6 million Btu/hr and that does not generate steam.
- If State or Federal money is used to construct the project, the Alaska Department of Natural Resources Office of History and Archaeology, State Historic Preservation Office should review project plans to determine whether historic, prehistoric, or archaeological resources are likely to be affected. The Office also offers suggestions for to mitigate potential effects on resources.

Proposed Biomass System

For the purpose of this report, the new school building is anticipated to use 75% of the current school's fuel usage. The new school building is assumed to use 10,875 gallons of fuel oil per year. It is also assumed to be designed to heat with warm water at 120°F.

The project equipment must be suitable for delivery by plane. Contact was made with several air carriers to identify suitable aircraft for the project, which includes the ability to accommodate the project equipment and land at the Allakaket airport. Please see Appendix C.

The requirement to deliver the project equipment by plane limits the size of the boiler. The limited boiler size increases stoking requirements, which is a major component of operating costs. The proposed biomass system is three (3) 180,000 Btu cordwood boilers. The project would be more cost effective with fewer, larger boilers.

The following assumptions were made for the purpose of completing the pre-feasibility assessment, and are not a substitute for heat load calculations and boiler sizing to be completed by the project engineer during project development:

- Annual consumption of 10,875 gallons of fuel oil per year, 95% of which serves space heat load, 5% of which serves domestic hot water
- Three (3) 180,000 Btu cordwood boilers with 2,940 gallons of storage total, delta T = 80°F
- Maximum 4 firings per day per boiler, with additional heat demand served by oil. Each firing requires 20 minutes labor
- Annual inflation
    - Biomass O&M and scheduled repairs – 1.5%
    - Cordwood – 3%
    - Oil O&M and scheduled repairs – 1.5%
    - Oil – 4.8%
- Input prices, year 1
    - Cordwood -- $400/ cord
    - Oil -- $5.69/ gal
    - Labor -- $20.17/ hr

Alternatives Considered

There were no alternatives considered for this project.

Heat Load & Biomass Requirements

Figure 1: Fuel Energy Values

	Gross Btu/unit	System efficiency	Delivered Btu/unit	Gross $/unit	Delivered $/MMBtu
Oil (gal)	134,500	80%	107,600	$ 5.69	$ 52.88
Biomass, 20% MC* (cord)	16,400,000	65%	10,660,000	$ 400	$ 37.52

*MC is Moisture Content. Moisture in biomass fuel evaporates and absorbs energy in combustion, thereby decreasing the net energy value of the fuel.

Figure 2: Projected Annual Fuel Use & Cost

Facility	Fuel Oil (gal)	$ / gal	Annual Fuel Cost
future school	10,875	$ 5.69	$ 61,879
		Total	**$ 61,879**

Figure 3: Project Annual Fuel Use & Cost, Biomass Project

15%	Oil
85%	Biomass
9244	gallons displaced

Facility	Fuel Type	Units	$ / unit	Annual Fuel Cost
future school	Biomass, 20% MC* (cord)	93.3	$ 400	$ 37,322
future school	Oil (gal)	1631	$ 5.69	$ 9,282
			Total	**$ 46,604**

Figure 4: Biomass Stoking Requirements & Cost

Facility	Total Stokings per Yr	Stoking Hrs Per Yr	$ / hr	Annual Stoking Cost
future school	1893	631	$ 20.17	**$ 12,726**

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Figure 5: Biomass O&M Costs (non-stoking)

Biomass size (btu)		540,000
Biomass fuel		Biomass, 20% MC* (cord)
Cost of Labor	$	20.17
Cost of Electricity	$	0.83
Number of Stokings		1893

MATERIALS			Yrs to replacement		Replacement Cost per lifetime
Lower Gasket	$	23	5	$	92
Motor mount	$	27	10	$	54
Rear cleanout gasket kit	$	46	10	$	92
Manway cover gasket	$	19	10	$	38
5" cleaning brush	$	24	5	$	96
Motor assembly	$	518	12	$	863
1/2 HP motor	$	331	12	$	552
Motor mount kit	$	87	12	$	145
Motor mount ring & screws	$	17	12	$	28
Misc.	$	250	5	$	1,000
Anode Rod	$	98	5	$	392
Chemicals	$	250	1	$	5,000
			Cost per Lifetime	$	8,352
			Straight-line Average Cost per Yr.	$	418

LABOR	Hours labor	Yrs to labor		Cost of Labor over Lifetime
Water test and replace	0.50	1	$	170
Cleanout covers and heat xger	2	1	$	807
Clean blower motor	0.75	0.5	$	605
Clean Ash & Combustion Air Intake	0.08	0.05	$	614
Check & replace gaskets	3	5	$	242
		Cost per Lifetime	$	2,437
		Straight-line Average Cost per Yr.	$	122

OTHER			Yrs. To Cost		Cost over Lifetime
Electricity 1/2 HP fan	$	97	1	$	1,949
			Straight-line Average Cost per Yr.	$	97
			O&M Cost per Yr. per Boiler	**$**	**637**
			Number of Boilers		3
			Total O&M per Yr.	**$**	**1,911**
Electricity -- pump				$	367
			Total Annual Biomass O&M (non-stoking)	**$**	**2,278**

Opinion of Probable Cost

Figure 6: Force Account Summary

Site & Foundation Work	$9,973
Biomass boiler building	$45,068
Biomass heat system	$119,440
End-user building integration	$8,374
Miscellaneous	$8,700
Overhead	$34,730
Freight	$51,859
CONSTRUCTION SUB-TOTAL	**$278,143**
Design & Construction Admin	$22,628
Construction Management	$11,314
PROJECT SUB-TOTAL	**$312,086**
Contingency @ 20%	$62,417
Admin @ 4%	$12,483
TOTAL PROJECT COST	**$386,986**

Figure 7: Force Account Detail

ITEM	QUAN	UNIT	UNIT COST	MATL COST	UNIT HRS	LAB HRS	LAB RATE	LABOR COST	CONTR COST	FREIGHT COST	TOTAL COST	UNIT WT	TOTAL WT(#)
SITE & FOUNDATION WORK													
Site prep (layout, excavation, backfill, compaction, grading)	1	lump							$5,000		$5,000	0.00	0
Wood timbers -- 8" x 8" x 8'	45	ea	$63.00	$2,835	0.50	22.50	$95	$2,138			$4,973	70.00	3150
BIOMASS BOILER BUILDING W/ WOOD STORAGE													
Sill plate - 2" x 6" x 20' PT	5	ea.	$20	$100	0.25	1.3	$95	$119			$219	51	255
SIP exterior walls -- 4' x 10'	22	ea.	$350	$7,700	0.3	7	$95	$627			$8,327	4	88
SIP roof -- 4' x 10' pkg	13	ea.	$350	$4,550	0.75	10	$95	$926			$5,476	4	52
SIP fasteners / hardware / framing anchors	2	lump	$400	$800	0	0	$95	$0			$800	500	1000
SIP caulk, sealant, expanding foam	2	lump	$250	$500	4	8	$95	$760			$1,260	150	300
Roof, frame	1	lump	$900	$900	18.00	18	$95	$1,710			$2,610	400	400
Roof, Metal -- 3' x 10' Delta rib roofing	17	ea.	$175	$2,975	1.00	17	$95	$1,615			$4,590	96	1632
Floor Insulation, Rigid (2"x24"x96")	30	ea.	$28.00	$840	0.25	8	$95	$713			$1,553	1	30
Floor system, metal	1	lump	$2,400	$2,400	20.00	20	$95	$1,900			$4,300	1600	1600
Siding, Metal, plus trim -- 3' x 10' Delta rib roofing	30	ea.	$175	$5,250	1.00	30	$95	$2,850			$8,100	96	2880
Fasteners	2	lump	$250	$500	0	0	$95	$0			$500	100	200
Man-door w/ hardware	1	lump	$780	$780	6	6	$95	$570			$1,350	75	75
Overhead garage door (10' x 10')	1	lump	$1,350	$1,350	6	6	$95	$570			$1,920	250	250
Drywall -- 4' x 10' + tape	22	ea.	$27	$594	0.33	7	$95	$690			$1,284	50	1100
Interior paint -- 5 gal	6	ea.	$40	$240	4	24	$95	$2,280			$2,520	42	249
Fire protection	1	lump	$250	$250	0.1	0.1	$95	$10			$260	150	150
BIOMASS HEAT SYSTEM													
Boiler -- GARN 1000	3	ea.	$11,000	$33,000	16	48	$95	$4,560			$37,560	2200	6600
Pipe/Valves/Ftgs/Gauges	3	lump	$5,000	$15,000	54	162	$100	$16,200			$31,200	800	2400
Circ pump	4	ea.	$500	$2,000	4	16	$100	$1,600			$3,600	60	240
Plate HXR, (600 MBH)	2	ea.	$5,000	$10,000	10	20	$100	$2,000			$12,000	250	500
Misc Strut & Pipe Hangers	1	lump	$1,000	$1,000	20	20	$95	$1,900			$2,900	500	500
Tank Insulation	3	lump	$1,200	$3,600	3	9	$95	$855			$4,455	50	150
Stack -- 6" dia double wall UL listed + supporting infrastructure	3	lump	$1,700	$5,100	4	12	$95	$1,140			$6,240	3.8	11
Ventilation & Combustion Air Intake	1	lump	$1,200	$1,200	3	3	$95	$285			$1,485	50	50
BTU meter	0	ea.	$2,500	$0	18	0	$95	$0			$0	0	0
Electrical	1	lump	$10,000	$10,000	100	100	$100	$10,000			$20,000	750	750
INTEGRATION													
PEX Piping -- 2" Arctic	60	lf	$25	$1,500	0.27	16	$95	$1,539			$3,039	1	78
PEX accessories --	60	1/ft	$5	$300	0.00	0	$95	$0			$300	1	60
Pipe penetration exclosure	1	lump	$750	$750	3	3	$95	$285			$1,035	200	200
Temp controls	1	lump	$750	$750	8	8	$100	$800			$1,550	200	200
Electrical work	1	lump	$1,250	$1,250	12	12	$100	$1,200			$2,450	200	200
MISCELLANEOUS													
Misc Hardware	1	lump	$2,500	$2,500	0	0	$95	$0			$2,500	500	500
Misc Tools & Safety Gear	1	lump	$1,500	$1,500	0	0	$95	$0			$1,500	1446	1446
Consumables, Gases, Etc.	1	lump	$2,000	$2,000	0	0	$95	$0			$2,000	1500	1500
Wood splitter	1	ea	$2,700	$2,700	0	0	$95	$0			$2,700	657	657
OVERHEAD													
ROW Legal Work	0	lump							$0		$0		0
Rent Heavy Equip	1	lump							$1,500		$1,500		0
Misc Tool Rent	1	lump							$1,250		$1,250		0
Commission System & Training	20	hr			1	20	$90	$1,800			$1,800		0
Superintendent Overhd Off-Site	40	hr			1	40	$90	$3,600			$3,600		0
Superintendent Overhd On-Site	80	hr			1	80	$90	$7,200			$7,200		0
Crew Travel Time	10	hr			1	10	$90	$900			$900		0
Crew Airfares	2	trips	$540						$1,080		$1,080		0
Crew Per Diem	240	mn.dy.	$60						$14,400		$14,400		0
Housing Rent	2	mo.	$1,500						$3,000		$3,000		0
FREIGHT													**29,453**
Ground Freight	6,600	lb.	$0.41							$2,733			
Air Freight	29,453	lb.	$1.40							$41,126			
Air Freight Tool Mob & Demob	2	lump	$2,500							$5,000			
Misc Small Freight & Gold Streaks	1	lump	$3,000							$3,000			
CONSTRUCTION SUB-TOTAL				$126,714		763		$73,340	$26,230	$51,859	$278,143		
Engineering (Design & CCA)	10	%							$22,628				
Construction Management	5	%							$11,314				
PROJECT SUB-TOTAL				$126,714				$73,340	$60,173	$51,859	$312,086		
Contingency	20	%									$62,417		
Admin Fee	4	%									$12,483		
CONSTRUCTION TOTAL											**$386,986**		

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Financial Analysis

Financial Summary

The project is considered marginally feasible at this time.

- Benefit/ Cost: 0.60
- Simple Payback Period: n/a
- Net present value: ($146,029)

Benefit / Cost Model

The following model was designed by University of Alaska Anchorage Institute of Social and Economic Research, for use by the Alaska Energy Authority. The model has been adapted for the project and completed according to the aforementioned assumptions.

AEA B/C Model (adapted)

Project Description		
Community	Allakaket	
Nearest Fuel Community	Allakaket, Alatna	
Region	Rural	
RE Technology	Biomass	
Project ID		
Applicant Name	Allakaket Village	
Project Title	Allakaket future school_biomass	
Category		

Results	
NPV Benefits	$218,743
NPV Capital Costs	$364,772
B/C Ratio	0.60
NPV Net Benefit	($146,029)

Performance	**Unit**	**Value**
Displaced Petroleum Fuel	gallons per year	9,244
Displaced Petroleum Fuel	total lifetime gallons	184,875
Avoided CO2	tonnes per year	94
Avoided CO2	total lifetime tonnes	1,876

Proposed System	**Unit**	**Value**
Capital Costs	$	$386,986
Project Start	year	2015
Project Life	years	20
Displaced Heat	gallons displaced per year	9,244
Heating Capacity	Btu/hr	540,000
Heating Capacity Factor	%	85%

Parameters	**Unit**	**Value**
Heating Fuel Premium	$ per gallon	
Discount Rate	% per year	3%
Crude Oil	$ per barrel	

Annual Savings (Costs)	Units	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Project Capital Cost	$ per year	$ 386,986	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Electric Savings (Costs)	$ per year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Heating Saving (Costs)	$ per year	$ 271	$ 1,451	$2,715	$4,069	$5,516	$271	$8,713	$10,475	$12,353	$14,355	$16,487	$18,756	$21,169	$23,735	$26,462	$29,358	$32,433	$35,696	$39,157	$42,828
Transportation Savings (Costs)	$ per year	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Savings (Costs)	**$ per year**	$271	$1,451	$2,715	$4,069	$5,516	$271	$8,713	$10,475	$12,353	$14,355	$16,487	$18,756	$21,169	$23,735	$26,462	$29,358	$32,433	$35,696	$39,157	$42,828
Net Benefit	**$ per year**	**($386,715)**	**$1,451**	**$2,715**	**$4,069**	**$5,516**	**$271**	**$8,713**	**$10,475**	**$12,353**	**$14,355**	**$16,487**	**$18,756**	**$21,169**	**$23,735**	**$26,462**	**$29,358**	**$32,433**	**$35,696**	**$39,157**	**$42,828**
Heating	**Units**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
Proposed																					
Renewable Heat	gal. disp./ yr.	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244	9,244
Renewable Heat O&M (non-stoking)	$ per yr.	$ 2,278	$ 2,312	$ 2,347	$ 2,382	$ 2,418	$ 2,454	$ 2,491	$ 2,528	$ 2,566	$ 2,604	$ 2,644	$ 2,683	$ 2,723	$ 2,764	$ 2,806	$ 2,848	$ 2,891	$ 2,934	$ 2,978	$ 3,023
Renewable Heat Stoking	$ per yr.	$ 12,726	$ 12,917	$ 13,111	$ 13,307	$ 13,507	$ 13,709	$ 13,915	$ 14,124	$ 14,336	$ 14,551	$ 14,769	$ 14,991	$ 15,215	$ 15,444	$ 15,675	$ 15,910	$ 16,149	$ 16,391	$ 16,637	$ 16,887
Renewable Fuel Use Qty (Biomass)	cords	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3
Renewable Fuel Cost	$ per unit	$ 400	$ 412	$ 424	$ 437	$ 450	$ 464	$ 478	$ 492	$ 507	$ 522	$ 538	$ 554	$ 570	$ 587	$ 605	$ 623	$ 642	$ 661	$ 681	$ 701
Total Renewable Fuel Cost	$ per yr.	$ 37,322	$ 38,442	$ 39,595	$ 40,783	$ 42,006	$ 43,266	$ 44,564	$ 45,901	$ 47,278	$ 48,697	$ 50,157	$ 51,662	$ 53,212	$ 54,808	$ 56,453	$ 58,146	$ 59,891	$ 61,687	$ 63,538	$ 65,444
Supplemental Fuel Qty (Oil)	gal.	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631	1631
Fuel Cost	$ per gal.	$ 5.69	$ 5.96	$ 6.25	$ 6.55	$ 6.86	$ 7.19	$ 7.54	$ 7.90	$ 8.28	$ 8.68	$ 9.09	$ 9.53	$ 9.99	$ 10.47	$ 10.97	$ 11.50	$ 12.05	$ 12.63	$ 13.23	$ 13.87
Supplemental Fuel Cost	$ per yr.	$ 9,282	$ 9,726	$ 10,193	$ 10,682	$ 11,195	$ 11,732	$ 12,295	$ 12,885	$ 13,504	$ 14,152	$ 14,831	$ 15,543	$ 16,289	$ 17,071	$ 17,891	$ 18,749	$ 19,649	$ 20,592	$ 21,581	$ 22,617
Proposed Heat Cost	**$ per yr.**	**$ 61,607**	**$ 63,396**	**$ 65,245**	**$ 67,154**	**$ 69,125**	**$ 71,162**	**$ 73,265**	**$ 75,438**	**$ 77,684**	**$ 80,004**	**$ 82,401**	**$ 84,879**	**$ 87,440**	**$ 90,087**	**$ 92,824**	**$ 95,654**	**$ 98,580**	**$101,605**	**$104,734**	**$107,970**
Base																					
Fuel Use	gal. per yr.	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875	10,875
Fuel Cost	$ per gal.	$ 5.69	$ 5.96	$ 6.25	$ 6.55	$ 6.86	$ 7.19	$ 7.54	$ 7.90	$ 8.28	$ 8.68	$ 9.09	$ 9.53	$ 9.99	$ 10.47	$ 10.97	$ 11.50	$ 12.05	$ 12.63	$ 13.23	$ 13.87
Fuel Cost	$ per yr.	$ 61,879	$ 64,847	$ 67,960	$ 71,222	$ 74,641	$ 78,224	$ 81,978	$ 85,913	$ 90,037	$ 94,359	$ 98,888	$103,635	$108,609	$113,823	$119,286	$125,012	$131,012	$137,301	$143,891	$150,798
Base Heating Cost	**$ per yr.**	**$ 61,879**	**$ 64,847**	**$ 67,960**	**$ 71,222**	**$ 74,641**	**$ 78,224**	**$ 81,978**	**$ 85,913**	**$ 90,037**	**$ 94,359**	**$ 98,888**	**$103,635**	**$108,609**	**$113,823**	**$119,286**	**$125,012**	**$131,012**	**$137,301**	**$143,891**	**$150,798**

Sensitivity Analysis

Sensitivity analysis was also performed. All other variables remaining equal, the following fuel variable results in an economically feasible project.

Variable	*Fuel Oil Price per Gal, Yr. 1*	$	6.85
Results	Benefit / Cost		1.25
	NPV Net Benefit		$91,168

Sensitivity analysis was also performed for the price of cordwood. If the project owner can source fuel at $170 per cord, as the Tanana Chiefs Conference reconnaissance-level biomass resource assessment suggests, the project has the following economic results.

Variable	*Cordwood, $ / cord, Yr. 1*	$	265
Results	Benefit / Cost		1.25
	NPV Net Benefit		$89,801

Recommendations

The biomass project for a future school is considered marginally feasible at this time. Sensitivity analysis indicates the project will be financially pre-feasible under current assumptions if the price of fuel oil price is $6.85 per gallon or more, or if a project owner can reliably source wood at $265 per cord or less. Sourcing wood at $265 per cord would result in about $25,000 of revenues per year for the supplier.

When YKSD begins to actively design the future Allakaket School, it is recommended that they review this pre-feasibility study to consider whether assumptions have significantly changed which would impact the feasibility of the biomass project. Additionally, if YKSD anticipates reduced construction cost through shared overhead expenses, including the ability to charter much larger plane(s), an update is recommended.

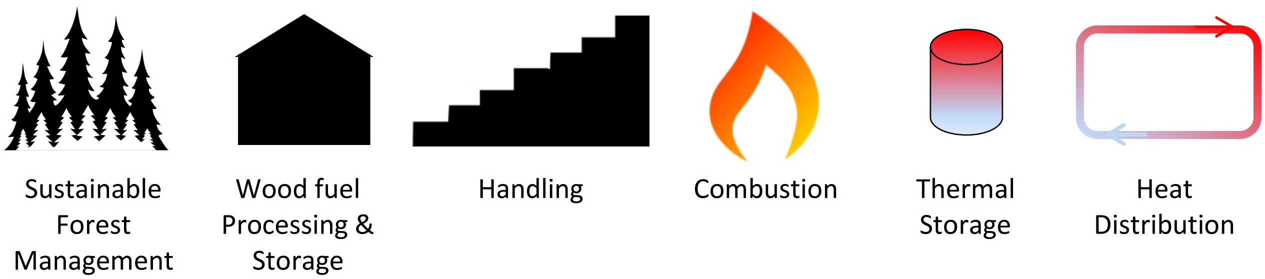
It is also recommended that YKSD discuss the possibility for the development and operation of a biomass heat sales project with a third-party, such as the Allakaket Village Council, the City of Allakaket, and the Alatna Village Council. The project may be an opportunity for these organizations to create revenues and community benefits consistent with their organizational missions.

Appendix

A—Biomass Technology
B – Utility Information
C—Aircraft Information

A – Biomass Technology

Although humans have used wood for heat for millennia, modern high-efficiency biomass boilers have only been in use for a few decades. Biomass boilers may use wood fuels such as cordwood, wood chips, or wood pellets, to heat commercial buildings. Biomass boiler projects depend on sustainable forest management, quality biomass fuel sourcing, processing, and storage, and reliable fuel handling. Biomass boilers frequently integrate with conventional hydronic heat systems, which use water to move heat from where it is produced to where it is needed. Small-scale biomass systems often incorporate a hot water storage tank, which promotes efficient combustion and improves the availability of biomass heat. To provide reliable heat, the biomass boiler, building heat distribution system, controls, and heat emitters must be properly matched.



The Nature of Wood Fuels

Composition

All wood is made primarily of cellulose, hemi-cellulose, and lignin. It is about 50% Carbon, 44% Oxygen, and 6% Hydrogen. Theoretically, complete combustion (100% efficient) would result in only two products: carbon dioxide and water. In practice, biomass boilers range from about 77 -- 83% efficient. Wood that is not completely burned become carbon monoxide and hydrocarbons, often in the form of smoke and ash.[1]

Combustion

Biomass fuel undergoes fascinating changes as it burns. Pyrolysis occurs at 500 – 600°F, in which organic gasses leave behind charcoal solids. Primary combustion is burning of charcoal solids.[2] Secondary combustion is burning of organic gasses. Because about 60% of the heating value is contained in gasses, secondary combustion is essential to high efficiency wood burning.

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[1] Rick Curkeet, PE, *Wood Combustion Basics,* EPA Burnwise Workshop 2011, http://www.epa.gov/burnwise/workshop2011/WoodCombustion-Curkeet.pdf (June 19, 2014).
[2] Curkeet, Rick.

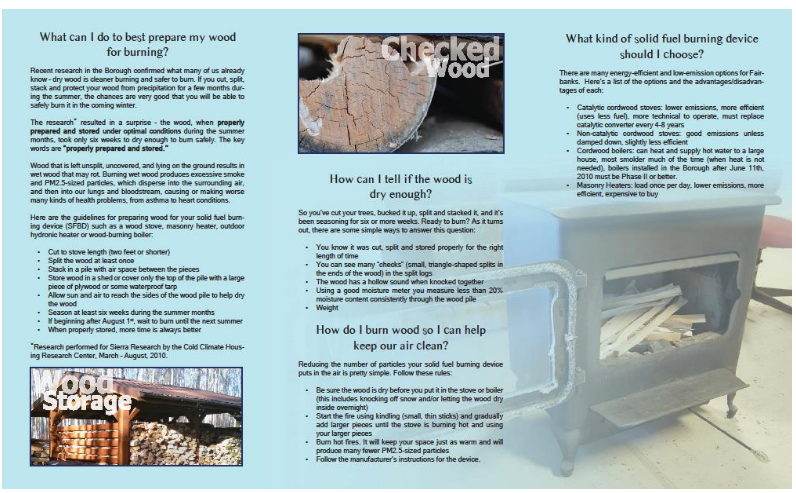
Emissions

In wood burning, the primary emissions concern is particulate matter 2.5 microns or less in size (“PM 2.5”), which is hazardous to human health. Additionally, unburned wood signifies lost heat and potential creosote formation. Creosote formation results in higher fuel costs, shortens the life of the boiler, and increases other maintenance costs. Boiler manufacturers have certified emissions tests conducted according to the ASTM E2618-13 standard that document boiler efficiency. High efficiency wood boilers emit about 0.07 – 0.3 lbs of PM 10 per million BTU in test conditions.

Boiler manufacturers specify operating conditions for the field. One important condition is wood fuel specifications, which include moisture content and fuel dimensions. Other important conditions for efficient operation include proper fuel storage, routine operations and maintenance, and system design (such as proper boiler sizing and incorporating a hot water storage tank).

One valuable source of information for seasoning cordwood in Interior Alaska is available at the Cold Climate Housing Research Center’s (CCHRC) website.[3] “Properly prepared and stored” cordwood can be dry enough to burn safely within six weeks during the summer. In regions other than the Interior, similar storage principles would apply, but recommended storage durations may be different. Below is a summary of how to properly prepare and store cordwood:

- Cut to stove length (two feet or shorter)
- Split the wood at least once
- Stack in a pile with air space between the pieces
- Store wood in a shed or cover only the top of the pile with a large piece of plywood or some waterproof tarp
- Allow sun and air to reach the sides of the wood pile to help dry the wood
- Season at least six weeks during the summer months
- If beginning after August 1st, wait to burn until the next summer
- When properly stored, more time is always better



What can I do to best prepare my wood for burning?

Recent research in the Borough confirmed what many of us already know - dry wood is cleaner burning and safer to burn. If you cut, split, stack and protect your wood from precipitation for a few months during the summer, the chances are very good that you will be able to safely burn it in the coming winter.

The research* resulted in a surprise - the wood, when **properly prepared and stored under optimal conditions** during the summer months, took only six weeks to dry enough to burn safely. The key words are **"properly prepared and stored."**

Wood that is left unsplit, uncovered, and lying on the ground results in wet wood that may rot. Burning wet wood produces excessive smoke and PM2.5-sized particles, which disperse into the surrounding air, and then into our lungs and bloodstream, causing or making worse many kinds of health problems, from asthma to heart conditions.

Here are the guidelines for preparing wood for your solid fuel burning device (SFBD) such as a wood stove, masonry heater, outdoor hydronic heater or wood-burning boiler:

- Cut to stove length (two feet or shorter)
- Split the wood at least once
- Stack in a pile with air space between the pieces
- Store wood in a shed or cover only the top of the pile with a large piece of plywood or some waterproof tarp
- Allow sun and air to reach the sides of the wood pile to help dry the wood
- Season at least six weeks during the summer months
- If beginning after August 1st, wait to burn until the next summer
- When properly stored, more time is always better

*Research performed for Sierra Research by the Cold Climate Housing Research Center, March - August, 2010.

Wood Storage

Checked Wood

How can I tell if the wood is dry enough?

So you've cut your trees, bucked it up, split and stacked it, and it's been seasoning for six or more weeks. Ready to burn? As it turns out, there are some simple ways to answer this question:

- You know it was cut, split and stored properly for the right length of time
- You can see many "checks" (small, triangle-shaped splits in the ends of the wood) in the split logs
- The wood has a hollow sound when knocked together
- Using a good moisture meter you measure less than 20% moisture content consistently through the wood pile
- Weight

How do I burn wood so I can help keep our air clean?

Reducing the number of particles your solid fuel burning device puts in the air is pretty simple. Follow these rules:

- Be sure the wood is dry before you put it in the stove or boiler (this includes knocking off snow and/or letting the wood dry inside overnight)
- Start the fire using kindling (small, thin sticks) and gradually add larger pieces until the stove is burning hot and using your larger pieces
- Burn hot fires. It will keep your space just as warm and will produce many fewer PM2.5-sized particles
- Follow the manufacturer's instructions for the device.

What kind of solid fuel burning device should I choose?

There are many energy-efficient and low-emission options for Fairbanks. Here's a list of the options and the advantages/disadvantages of each:

- Catalytic cordwood stoves: lower emissions, more efficient (uses less fuel), more technical to operate, must replace catalytic converter every 4-8 years
- Non-catalytic cordwood stoves: good emissions unless damped down, slightly less efficient
- Cordwood boilers: can heat and supply hot water to a large house, most smolder much of the time (when heat is not needed), boilers installed in the Borough after June 11th, 2010 must be Phase II or better.
- Masonry Heaters: load once per day, lower emissions, more efficient, expensive to buy

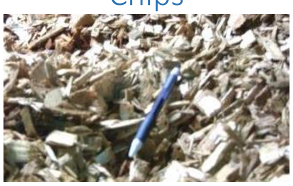
Figure 1: Excerpt from CCHRC's Cordwood Handling Brochure

[3] http://www.cchrc.org/docs/best_practices/Cordwood_Handling_Brochure.pdf

ENERGY ACTION

Wood Fueled Heating Systems

Below are the characteristics of cordwood, wood chip, and wood pellet boiler systems.

<table>
<tr><th></th><th>Advantages</th><th>Disadvantages</th></tr>
<tr><td>Cordwood
</td><td>• Local wood resource
• Small size (less than 1 MMBTU)
• Simple to operate</td><td>• Higher labor costs, including hand-feeding the boiler, manual ash removal, and manual grate cleaning
• Labor is needed intermittently, so someone must be available "on site"
• Typically non-pressurized, which may require more frequent boiler chemical additions</td></tr>
<tr><td>Pellets
</td><td>• Can operate unattended, and automatically match heat load
• Scalable from small to large sizes (generally 100,000 btu – 1 MMBTU)
• Relatively small footprint
• Typically the most efficient biomass combustion</td><td>• Pellet fuel is typically not locally produced, and therefore depends on "imports"
• Shipping pellets is very costly; even a freight rate of $0.05 per lb. results in an additional cost of $100 per ton.
• Relatively expensive wood fuel
• Ash removal and grate cleaning may be automated or manual</td></tr>
<tr><td>Chips
</td><td>• Can operate unattended, and automatically match heat load
• Wood chips may be the lowest cost fuel
• Local wood resource may be available or produced
• Large projects achieve economies of scale
• Creates jobs in the woods and at the boiler plant</td><td>• Large systems are expensive
• Typically large sizes > 1,000,000 MMBTU
• Wood chip fuel can be diverse, which can make it difficult to meet fuel specifications. Screens and other devices can improve fuel quality.</td></tr>
</table>

ENERGY ACTION

Appendix B – Utility Receipt

Wynne,

I have quite a bit of historical fuel data. Fuel is not typically the highest cost utility however. Electricity is the highest cost.

Allakaket school currently uses an average of 52 gallons per day (total campus) or 14,500 gallons per year. The cost is $5,69/gallon (air delivery only). Electricity runs approximately 10,398 Kwh per month (total campus). The cost averages .92/kwh.

Gale

From: Wynne Auld [mailto:wynne@energyaction.info]
Sent: Monday, February 10, 2014 12:21 PM
To: Gale Bourne
Cc: Russell Snyder
Subject: Re: Allakaket School biomass

Hi Gale,

Thank you for the information. You can help me by helping me figure out the energy use of the future school. Have you built other schools recently in the area? How many gallons of fuel oil would you anticipate the future school using?

My assessment will focus on a biomass system serving this hypothetical heat load, at current market prices.

Thanks,

Wynne

Appendix C – Aircraft Information

For the purpose of this feasibility study, all project equipment should fit within a Shorts 330 Sherpa, with a maximum cargo length of 29’, width of 75”, and height of 76”. Ravn Alaska charters the Sherpa to Allakaket for an estimated $6,315 with a 4,800 lb. maximum payload. Up to 5,400 lbs. can be accommodated for an additional cost.

No cordwood boilers larger than 180,000 btu were identified that would be able to fit into a Shorts 330 Sherpa, McDonnell Douglas DC 6, or Casa 212. No other aircraft that could potentially accommodate the project equipment and land at the Allakaket Airport were identified.