Pre-Feasibility Assessment for Integration of Biomass Energy Systems

in

Cascade, Idaho

February 7, 2005

Presented by

CTA Architects Engineers
Dan Stevenson

For

United Stated Department of Agriculture
Forest Service
Region One

In partnership with:

Cascade School District, Valley County & Cascade Medical Center & Clinic

Bitter Root Resource and Conservation Development Area, Incorporated

CTA Project: BIOMASPFA-CASC

Executive Summary

The following assessment was commissioned to determine the technical and economic feasibility of integrating a biomass heating system with four existing facilities in Cascade, Idaho. The existing facilities considered include the Cascade School, the Valley County Courthouse & Criminal Justice Facility and the Cascade Medical Center & Clinic. This assessment is funded through the USDA Forest Service, Region One, as part of the Fuels for Schools program. Based on a review of the pre-feasibility assessment forms and recent energy records, the sites had potential as biomass projects. The field investigation took place in August, 2004 and identified the following information:

Valley County Courthouse & Criminal Justice Facility

The existing courthouse building is two stories, originally constructed in 1917, with a later addition. A second addition to the courthouse is currently under construction. The original courthouse is made up of concrete wall with brick façade and a membrane roof system. Total area of this building is approximately 22,000 square feet. The criminal justice facility (housing the jail and sheriff's offices) was built adjacent to the courthouse in 1995. The jail is CMU walls with a metal roof. Some sides of the jail are covered with a brick façade and others have an exterior finish and insulation system (EFIS). Total building area is 22,541 square feet.

The heating system in the 1917 portion of the courthouse consists of a single oil-fired boiler that generates low-pressure steam. The steam is distributed to radiators in the rooms by the original piping system, which should not be re-used due to age. Cooling was added to this area by means of packaged rooftop units. The first courthouse addition is heated by means of electric resistance heaters in a forced air system. This same duct system is equipped with DX cooling to provide air conditioning to the spaces as well.

The jail utilizes a heat pump system (boiler and tower) to provide both heating and cooling to all spaces. This heat pump loop is being expanded to supply the brand new courthouse addition with heating and cooling as well. The heat source is a single propane fired boiler.

The courthouse uses three different water heaters, scattered throughout the facility, to generate domestic water. Each water heater is electric. There is one located in the boiler room, one on the fan platform in the addition, and one in the women's restroom as a point of use heater.
For the jail, a single propane fired water heater fills a 400-gallon storage tank to supply the facility's domestic water needs.

In the courthouse, the existing boiler room has no headroom and no space for accommodating additional equipment. The room has been assimilated into the computer and phone network room and often overheats.

For the jail, the boiler room is located on a mechanical platform over the center of the building. This platform could not accommodate a biomass boiler because of a lack of headroom and floor space. Vehicle access to either of the buildings on this site could be reasonably accomplished.

The County owns several properties adjacent to the site that may be more suitable to a biomass boiler building with chip storage bin. With any of the adjacent properties, however, they would have to be cleared of the houses currently occupying them and the piping would have to be routed around/behind the jail to get to the boiler room.

The varied heating systems, integration costs and lack of physical space indicate further investigation into this facility is not warranted.

Cascade Medical Center & Clinic

Cascade Medical Center was originally constructed in 1977, with the clinic addition in 1997. It is a single story building constructed of stud walls with brick façade. The building also has asphalt shingles on a sloped roof. There is a basement fan room, but otherwise the building has crawlspace access. Total area of this building is 7,861 square feet for the hospital and 4,450 square feet in the clinic.

The heating system in the hospital consists of a three forced-air units, 2 in the basement fan room and one in the attic. They are equipped with electric resistance heaters in the supply ducts. Electric PTAC (hotel style) heaters serve the perimeter rooms. In the clinic, 3 residential style heat pumps and their duct systems serve all the spaces.

The facility uses two different water heaters, one in the hospital, and one in the clinic, to generate domestic water. Both water heaters are electric.

The basement fan room has no headroom and no space for accommodating additional equipment. Vehicle access to either side of the building on this site could be reasonably accomplished.

The Hospital owns a vacant adjacent property, but it would probably not be suitable to a biomass boiler building because of its proximity to the helipad. The tall boiler building and flue would most likely interfere with the approach pattern of the helicopters using the landing site.

The varied heating systems and integration costs indicate further investigation into this facility is not warranted.

Cascade Schools

The existing building is a single story, originally constructed as an elementary school in 1972, with additions in 1979 for the high school portion and 1992 for the middle school. It is constructed of CMU walls with brick façade and a metal roof. The Elementary School gymnasium has metal siding covering the CMU. Overall size of the facility is 92,000 square feet.

A pair of hot water boilers serves most of the existing school, with one boiler able to provide the load for the entire heated area, and the other as a 100% redundant standby. Both boilers are oil-fired with propane ignition and served by a pair of 5,000-gallon storage tanks. The boilers generate hot water, which is circulated to the terminal heating devices by means of pumps in the boiler room. In the 1972 portion, 3 oil-fired forced air furnaces serve the kitchen and cafeteria.

Three different water heaters, scattered throughout the facility, generate domestic water. In the elementary school, an electric water heater serves those spaces. An oil-fired water heater is located near and serves the cafeteria, and a propane-fired heater located in the boiler room serves the high school, middle school, main gymnasium and lockers. Only the water heater in the boiler room has a separate storage tank.

The existing boiler room has ample headroom but no space for accommodating additional equipment. The boiler room is located near the middle of the building, on the rear side of the site. Vehicle access to this room would be very difficult.

The School District owns properties adjacent to the school site that may be more suitable to a biomass boiler building with chip storage bin. With any of the adjacent properties, however, piping would have to be routed around/behind the school to get to the boiler room.

Three options were explored in greater detail.

Option A – Biomass Plant Near Elementary Gym
Install a 2 MMBTUH hot water wood chip heating plant at the end of the access road serving the Elementary School Gymnasium. This Option provides a base-load heating plant for the entire **School Facility** and assumes that the existing boilers would be used for peak loads and as back up. The biomass system would be a less than automated system similar to the Chiptec "A" Series, Grovewood Heat or Messersmith Dragon systems that require day bins to be filled with wood chips. A small tractor would be used to transfer the chips from the chip storage building to the day bin. The main advantage is that piping runs to the existing mechanical room will be short. At this location, the biggest disadvantage is that access for a semi trailer would be difficult due to a sloping and narrow service road. The scope of this project would be similar to Thompson Falls with approximately $80,000 additional underground piping infrastructure. Estimated cost: $450,000.

Option B – Pellet Plant Near Elementary Gym
Install a 2 MMBTUH hot water wood pellet heating plant at the end of the access road serving the Elementary School Gymnasium. This Option provides a base-load heating plant for the entire **School Facility** and assumes that the existing boilers would be used for peak loads and as back up. The biomass system would require an exterior silo to be filled with wood pellets. The main advantage is that piping runs to the existing mechanical room will be short. At this location, the biggest disadvantage is that access for a semi trailer would be difficult due to a sloping and narrow service road. Estimated cost: $350,000.

Option C – Biomass Plant On Vacant Lot
Install a 2 MMBTUH hot water wood chip heating plant in the vacant lot at the northwest corner of School and Spring Streets. This Option provides a base-load heating plant for the entire **School Facility** and assumes that the existing boilers would be used for peak loads and as back up. The biomass system would be a less than automated system similar to the Chiptec "A" Series, Grovewood Heat or Messersmith Dragon systems that require day bins to be filled with wood chips. A small tractor would be used to transfer the chips from the chip storage building to the day bin. The main advantage of this site is that access for a semi trailer is easy, as the lot is fairly level and the streets are wider. The biggest disadvantage is that piping runs to the existing mechanical room will be quite long (approximately 450 feet each way). The scope of this project would be similar to Thompson Falls with approximately $350,000 additional underground piping infrastructure. Estimated cost: $725,000.

Biomass boiler system budget estimates are based upon recent biomass assessments and project costs for completed systems.

<u>Results of Evaluation</u>

The results of this analysis are summarized below. The cost estimate is representative of the scope of this project. A Cash Flow Analysis is provided at the end of the report. The cash flow analysis assumes availability of green chips at a price of $35 per green ton.

Option A- Wood Chip School Site achieves a positive accumulated cashflow (PAC) in 10 years with a subsidy of $225,000 and in 18 years with no subsidy.

Option B- Wood Pellet School Site never achieves a positive accumulated cash flow (PAC). The pellet fuel cost exceeds the current fuel cost.

Option C-Wood Chip Vacant Site achieves a positive accumulated cashflow (PAC) in 10 years with a subsidy of $500,000 and in 24 years with no subsidy. This site may be considered for a central plant for the school would be (1 block away); the courthouse (2 blocks away) and the hospital (2 ½ blocks away). Piping would then need to be routed to each facility.

Accumulated cash flow is the primary evaluation measure that is implemented in this report and is similar to simple payback with the exception that accumulated cash flow takes the cost of financing and fuel escalation into account. For many building owners, a positive accumulated cash flow of about 10 years maximum is considered necessary for implementation. Based on this standard, the amount of project subsidy required to achieve a 10-year PAC was calculated and is indicated above. If the School District chooses to further pursue a biomass heating system, it is recommended that each of the options be investigated in further detail.

The approach in analyzing this option has been to remain conservative, yet realistic about the performance of biomass heating plants and the cost of their installation. Due to the preliminary nature of this assessment, it is possible that the construction cost estimates can be reduced as additional information relative to the construction is gathered, favorably affecting the economic analysis.

Other factors should be considered when evaluating the viability of this project. The first is that although the current fuel oil cost of approximately $1/gallon is $7.14/decatherm, fuel oil contracts have recently seen dramatic increases in cost. The cash flow analysis assumes a 4% inflation rate in fuel oil. Individual years may fluctuate beyond that average. The cost of transporting wood pellet fuel to the site should be considered. Wood pellets currently sell for $130/ton, or $7.90/decatherm. Wood chips sell for $29/ton or $2.70/decatherm. Finally, air quality permit requirements in the State of Idaho should be reviewed in greater detail.

As individual projects, probably only the school would be viable, with the courthouse/jail being marginal and the medical center being undesirable. If these three locations were to merge into a single biomass plant, the likelihood of a successful project increases. In the latter case, the hospital becomes a large energy saver that could be used to help finance the improvements. A Performance Contractor should be involved further to see if energy savings and installation costs for all three sites together would make a viable project.

Option C: Cascade School Biomass Heating Economic Analysis- Wood Chips- Vacant Site

Conversion Proforma for Cascade School District - 4.6% APR - 10 Year Term

February 7, 2005
Revision:
Analyst: Salmon-CTA

Total Project Cost	**-$725,000**

Project Financing Information	
Percent Financed	31%
Amount Financed	-$225,000
Amount of Grants	$500,000
Interest Rate	4.60%
Term	10
Annual Finance Cost (years)	-$28,575

Escalation factors	
Elec. Escalation factor	1.04
Propane Escalation factor	1.04
Fuel Oil Escalation factor	1.04
Pellet Escalation factor	1.03
Green Chip Escalation factor	1.02
Maint. Escalation factor	1.03

Cashflow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Existing Heating System Operating Costs																			
Displaced fuel oil heating costs	$1.04		40,000	Gallons	41,600	43,264	44,995	46,794	48,666	50,613	52,637	54,743	56,932	59,210	61,578	64,041	66,603	69,267	72,038
Displaced Operation and Maintenance Costs					570	587	605	623	642	661	681	701	722	744	766	789	813	837	862
Biomass System Operating Costs																			
Green Chip Fuel ($/ton, delivered to boiler site, btu/lb) (90% of total heat rqmnt)	$29.00	90%	638	tons	18,507	18,877	19,255	19,640	20,033	20,433	20,842	21,259	21,684	22,118	22,560	23,011	23,472	23,941	24,420
Small load fuel oil (10% of total heat rqmnt)	$1.14	10%	2000	Gallons	2,280	2,371	2,466	2,565	2,667	2,774	2,885	3,000	3,120	3,245	3,375	3,510	3,650	3,796	3,948
Operation and Maintenance Costs					1,710	1,761	1,814	1,869	1,925	1,982	2,042	2,103	2,166	2,231	2,298	2,367	2,438	2,511	2,587
Annual Operating Cost Savings					***19,673***	***20,841***	***22,064***	***23,344***	***24,683***	***26,084***	***27,549***	***29,082***	***30,684***	***32,359***	***34,111***	***35,942***	***37,856***	***39,856***	***41,945***
Financed Project Costs - Principal and Interest					*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*					
Displaced System Replacement Costs																			
Special financing																			
	$0.00		0		0	0	0	0	0	0	0	0	0	0					
Net Annual Cash Flow					*(8,902)*	*(7,734)*	*(6,511)*	*(5,231)*	*(3,892)*	*(2,491)*	*(1,026)*	***506***	***2,109***	***3,784***	***34,111***	***35,942***	***37,856***	***39,856***	***41,945***
Cumulative Cash Flow					*(8,902)*	*(16,636)*	*(23,147)*	*(28,378)*	*(32,270)*	*(34,762)*	*(35,788)*	*(35,282)*	*(33,173)*	*(29,389)*	***4,722***	***40,664***	***78,520***	***118,376***	***160,321***

Cashflow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Existing Heating System Operating Costs																			
Displaced fuel oil heating costs	$1.04		40,000	Gallons	74,919	77,916	81,033	84,274	87,645	91,151	94,797	98,589	102,532	106,633	110,899	115,335	119,948	124,746	129,736
Displaced Operation and Maintenance Costs					888	915	942	970	999	1,029	1,060	1,092	1,125	1,159	1,193	1,229	1,266	1,304	1,343
Biomass System Operating Costs																			
Green Chip Fuel ($/ton, delivered to boiler site, btu/lb) (90% of total heat rqmnt)	$29.00	90%	638	tons	24,908	25,406	25,914	26,433	26,961	27,501	28,051	28,612	29,184	29,768	30,363	30,970	31,590	32,221	32,866
Small load fuel oil (10% of total heat rqmnt)	$1.14	10%	2000	full load MMBtu	4,106	4,270	4,441	4,619	4,804	4,996	5,196	5,403	5,620	5,844	6,078	6,321	6,574	6,837	7,111
Operation and Maintenance Costs					2,664	2,744	2,826	2,911	2,998	3,088	3,181	3,277	3,375	3,476	3,580	3,688	3,798	3,912	4,030
Annual Operating Cost Savings					***44,129***	***46,410***	***48,793***	***51,282***	***53,881***	***56,595***	***59,430***	***62,389***	***65,479***	***68,704***	***72,071***	***75,585***	***79,252***	***83,079***	***87,073***
Financed Project Costs - Principal and Interest																			
Displaced System Replacement Costs																			
Special financing																			
	$0.00																		
Net Annual Cash Flow					***44,129***	***46,410***	***48,793***	***51,282***	***53,881***	***56,595***	***59,430***	***62,389***	***65,479***	***68,704***	***72,071***	***75,585***	***79,252***	***83,079***	***87,073***
Cumulative Cash Flow					***204,450***	***250,860***	***299,653***	***350,934***	***404,815***	***461,411***	***520,840***	***583,230***	***648,709***	***717,413***	***789,484***	***865,068***	***944,321***	***1,027,400***	***1,114,473***

Option A: Cascade School Biomass Heating Economic Analysis- Wood Chips- School Site

Conversion Proforma for Cascade School District - 4.6% APR - 10 Year Term

February 7, 2005
Revision:
Analyst: Salmon-CTA

Total Project Cost	**-$450,000**

Project Financing Information	
Percent Financed	50%
Amount Financed	-$225,000
Amount of Grants	$225,000
Interest Rate	4.60%
Term	10
Annual Finance Cost (years)	-$28,575

Escalation factors	
Elec. Escalation factor	1.04
Propane Escalation factor	1.04
Fuel Oil Escalation factor	1.04
Pellet Escalation factor	1.03
Green Chip Escalation factor	1.02
Maint. Escalation factor	1.03

Cashflow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Existing Heating System Operating Costs																			
Displaced fuel oil heating costs	$1.04		40,000	Gallons	41,600	43,264	44,995	46,794	48,666	50,613	52,637	54,743	56,932	59,210	61,578	64,041	66,603	69,267	72,038
Displaced Operation and Maintenance Costs					570	587	605	623	642	661	681	701	722	744	766	789	813	837	862
Biomass System Operating Costs																			
Green Chip Fuel ($/ton, delivered to boiler site, btu/lb) (90% of total heat rqmnt)	$29.00	90%	638	tons	18,507	18,877	19,255	19,640	20,033	20,433	20,842	21,259	21,684	22,118	22,560	23,011	23,472	23,941	24,420
Small load fuel oil (10% of total heat rqmnt)	$1.14	10%	2000	Gallons	2,280	2,371	2,466	2,565	2,667	2,774	2,885	3,000	3,120	3,245	3,375	3,510	3,650	3,796	3,948
Operation and Maintenance Costs					1,710	1,761	1,814	1,869	1,925	1,982	2,042	2,103	2,166	2,231	2,298	2,367	2,438	2,511	2,587
Annual Operating Cost Savings					***19,673***	***20,841***	***22,064***	***23,344***	***24,683***	***26,084***	***27,549***	***29,082***	***30,684***	***32,359***	***34,111***	***35,942***	***37,856***	***39,856***	***41,945***
Financed Project Costs - Principal and Interest					*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*	*(28,575)*					
Displaced System Replacement Costs																			
Special financing																			
	$0.00		0		0	0	0	0	0	0	0	0	0	0					
Net Annual Cash Flow					*(8,902)*	*(7,734)*	*(6,511)*	*(5,231)*	*(3,892)*	*(2,491)*	*(1,026)*	***506***	***2,109***	***3,784***	***34,111***	***35,942***	***37,856***	***39,856***	***41,945***
Cumulative Cash Flow					*(8,902)*	*(16,636)*	*(23,147)*	*(28,378)*	*(32,270)*	*(34,762)*	*(35,788)*	*(35,282)*	*(33,173)*	*(29,389)*	***4,722***	***40,664***	***78,520***	***118,376***	***160,321***

Cashflow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Existing Heating System Operating Costs																			
Displaced fuel oil heating costs	$1.04		40,000	Gallons	74,919	77,916	81,033	84,274	87,645	91,151	94,797	98,589	102,532	106,633	110,899	115,335	119,948	124,746	129,736
Displaced Operation and Maintenance Costs					888	915	942	970	999	1,029	1,060	1,092	1,125	1,159	1,193	1,229	1,266	1,304	1,343
Biomass System Operating Costs																			
Green Chip Fuel ($/ton, delivered to boiler site, btu/lb) (90% of total heat rqmnt)	$29.00	90%	638	tons	24,908	25,406	25,914	26,433	26,961	27,501	28,051	28,612	29,184	29,768	30,363	30,970	31,590	32,221	32,866
Small load fuel oil (10% of total heat rqmnt)	$1.14	10%	2000	full load MMBtu	4,106	4,270	4,441	4,619	4,804	4,996	5,196	5,403	5,620	5,844	6,078	6,321	6,574	6,837	7,111
Operation and Maintenance Costs					2,664	2,744	2,826	2,911	2,998	3,088	3,181	3,277	3,375	3,476	3,580	3,688	3,798	3,912	4,030
Annual Operating Cost Savings					***44,129***	***46,410***	***48,793***	***51,282***	***53,881***	***56,595***	***59,430***	***62,389***	***65,479***	***68,704***	***72,071***	***75,585***	***79,252***	***83,079***	***87,073***
Financed Project Costs - Principal and Interest																			
Displaced System Replacement Costs																			
Special financing																			
	$0.00																		
Net Annual Cash Flow					***44,129***	***46,410***	***48,793***	***51,282***	***53,881***	***56,595***	***59,430***	***62,389***	***65,479***	***68,704***	***72,071***	***75,585***	***79,252***	***83,079***	***87,073***
Cumulative Cash Flow					***204,450***	***250,860***	***299,653***	***350,934***	***404,815***	***461,411***	***520,840***	***583,230***	***648,709***	***717,413***	***789,484***	***865,068***	***944,321***	***1,027,400***	***1,114,473***

Option B: Cascade School Bioı..ss Heating Economic Analysis- \..od Pellets

Conversion Proforma for Cascade School District - 4.6% APR - 10 Year Term

February 7, 2005
Revision:
Analyst: Salmon-CTA

Total Project Cost	-$350,000

Project Financing Information	
Percent Financed	0%
Amount Financed	$0
Amount of Grants	$350,000
Interest Rate	4.60%
Term	10
Annual Finance Cost (years)	$0

Escalation factors	
Elec. Escalation factor	1.04
Propane Escalation factor	1.04
Fuel Oil Escalation factor	1.04
Pellet Escalation factor	1.03
Green Chip Escalation factor	1.02
Maint. Escalation factor	1.03

Cashflow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15
Existing Heating System Operating Costs																			
Displaced fuel oil heating costs	$1.04		40,000	Gallons	41,600	43,264	44,995	46,794	48,666	50,613	52,637	54,743	56,932	59,210	61,578	64,041	66,603	69,267	72,038
Displaced Operation and Maintenance Costs					570	587	605	623	642	661	681	701	722	744	766	789	813	837	862
Biomass System Operating Costs																			
Wood Pellet Fuel ($/ton, delivered to boiler site, btu/lb) (90% of total heat rqmnt)	$130.00	90%	420	tons	54,634	56,273	57,961	59,700	61,491	63,336	65,236	67,193	69,209	71,285	73,424	75,626	77,895	80,232	82,639
Small load fuel oil (10% of total heat rqmnt)	$1.14	10%	2000	Gallons	2,280	2,371	2,466	2,565	2,667	2,774	2,885	3,000	3,120	3,245	3,375	3,510	3,650	3,796	3,948
Operation and Maintenance Costs					1,710	1,761	1,814	1,869	1,925	1,982	2,042	2,103	2,166	2,231	2,298	2,367	2,438	2,511	2,587
Annual Operating Cost Savings					***-16,454***	***-16,555***	***-16,642***	***-16,716***	***-16,775***	***-16,819***	***-16,845***	***-16,853***	***-16,841***	***-16,808***	***-16,753***	***-16,673***	***-16,568***	***-16,436***	***-16,274***
Financed Project Costs - Principal and Interest					***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***					
Displaced System Replacement Costs																			
Special financing																			
	$0.00		0		0	0	0	0	0	0	0	0	0	0					
Net Annual Cash Flow					*(16,454)*	*(16,555)*	*(16,642)*	*(16,716)*	*(16,775)*	*(16,819)*	*(16,845)*	*(16,853)*	*(16,841)*	*(16,808)*	*(16,753)*	*(16,673)*	*(16,568)*	*(16,436)*	*(16,274)*
Cumulative Cash Flow					*(16,454)*	*(33,009)*	*(49,651)*	*(66,367)*	*(83,143)*	*(99,961)*	*(116,806)*	*(133,659)*	*(150,500)*	*(167,308)*	*(184,061)*	*(200,734)*	*(217,302)*	*(233,737)*	*(250,011)*

Cashflow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Existing Heating System Operating Costs																			
Displaced fuel oil heating costs	$1.04		40,000	Gallons	74,919	77,916	81,033	84,274	87,645	91,151	94,797	98,589	102,532	106,633	110,899	115,335	119,948	124,746	129,736
Displaced Operation and Maintenance Costs					888	915	942	970	999	1,029	1,060	1,092	1,125	1,159	1,193	1,229	1,266	1,304	1,343
Biomass System Operating Costs																			
Wood Pellet Fuel ($/ton, delivered to boiler site, btu/lb) (90% of total heat rqmnt)	$130.00	90%	420	tons	85,118	87,672	90,302	93,011	95,801	98,675	101,636	104,685	107,825	111,060	114,392	117,824	121,358	124,999	128,749
Small load fuel oil (10% of total heat rqmnt)	$1.14	10%	2000	full load MMBtu	4,106	4,270	4,441	4,619	4,804	4,996	5,196	5,403	5,620	5,844	6,078	6,321	6,574	6,837	7,111
Operation and Maintenance Costs					2,664	2,744	2,826	2,911	2,998	3,088	3,181	3,277	3,375	3,476	3,580	3,688	3,798	3,912	4,030
Annual Operating Cost Savings					***-16,081***	***-15,856***	***-15,595***	***-15,297***	***-14,959***	***-14,579***	***-14,155***	***-13,684***	***-13,162***	***-12,588***	***-11,958***	***-11,269***	***-10,516***	***-9,698***	***-8,810***
Financed Project Costs - Principal and Interest																			
Displaced System Replacement Costs																			
Net Annual Cash Flow					*(16,081)*	*(15,856)*	*(15,595)*	*(15,297)*	*(14,959)*	*(14,579)*	*(14,155)*	*(13,684)*	*(13,162)*	*(12,588)*	*(11,958)*	*(11,269)*	*(10,516)*	*(9,698)*	*(8,810)*
Cumulative Cash Flow					*(266,092)*	*(281,948)*	*(297,543)*	*(312,839)*	*(327,798)*	*(342,377)*	*(356,533)*	*(370,217)*	*(383,379)*	*(395,967)*	*(407,925)*	*(419,194)*	*(429,710)*	*(439,408)*	*(448,218)*