Pre-feasibility Assessment for Integration of Biomass Energy Systems

in

Idaho City, Idaho

July 26, 2005

Presented by

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For

United Stated Department of Agriculture
Forest Service
Region One

In partnership with:

Basin School District #72 & Idaho City Ranger District

Idaho Department of Lands: Fuels For Schools Program

Bitter Root Resource and Conservation Development Area, Incorporated

CTA Project: BIOMSPFA_IDSD

Executive Summary

The following assessment was commissioned to determine the technical and economic feasibility of integrating a biomass heating system with existing facilities in Idaho City, Idaho. The primary existing facilities considered for this assessment include the Idaho City High School and Basin Elementary School. It is worth noting that the Idaho City Forest Service operates a campus across the street from the school buildings and is very interested in participating in the biomass project. The information for the ranger district facilities is contained in Appendix A.

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 school sites had potential as biomass projects. The field investigation took place in July, 2005 and identified the following information:

Idaho City High School

The existing high school building is a single story with a mechanical mezzanine, constructed in 1995. The building is made up of concrete block walls and a standing seam metal roof system. Total area of this building is approximately 47,393 square feet.

The heating system consists of a combination of horizontal and vertical high-efficiency, propane-fired, residential-style furnaces that serve the classroom and office spaces. For the gymnasium and dining areas, single-zone, standard-efficiency, propane-fired air handlers provide comfort heating. Unoccupied and service areas are heated with propane-fired unit heaters.

The ventilation (fresh) air for the building is provided through a ducted make up air system. In the classroom wing, ventilation air is tempered by a propane-fired heater and then ducted directly into the spaces. In the gym/admin wing, the air is ducted to the return air side of the equipment serving the space without being tempered. The kitchen hoods receive make up air from the same ducts that serve ventilation air to the gym/admin wing.

Cooling is only provided to the administration areas of the High School. The furnaces serving these areas are equipped with DX coils and connected by refrigeration piping to an air-cooled condensing unit outside the building.

Temperature controls are accomplished by means of programmable wall thermostats, one per furnace, and low voltage control wiring.

Domestic hot water is provided by a single propane-fired boiler and stored in a 350 gallon storage tank in the mechanical room. There is a recirculation pump between the tank and heater and another one for the hot water distribution system.

Basin Elementary School

The existing elementary school building is a single story, originally constructed in 1962, with subsequent additions in 1966 and 1974. The 1974 addition also included a "daylight" basement. Total area of the facility is approximately 15,540 square feet. The building envelope is CMU walls with brick façade and a standing seam metal roof. Some limited areas of the building have metal siding with a brick wainscot.

The heating system consists of vertical standard-efficiency, propane-fired, residential-style furnaces that serve the classroom and office spaces. Corridors are heated with electric baseboard radiators and service areas are heated with electric unit heaters.

The ventilation (fresh) air for the building is provided through a ducted make up air system in which the air is routed to the return air side of the furnaces without being tempered.

No spaces are provided with cooling in the elementary school.

Temperature controls are accomplished by means of programmable wall thermostats, one per furnace, and low voltage control wiring.

Domestic hot water is provided by two separate water heaters, both of which are electric. One is in the original 1962 building, while the other is in the 1974 addition. There is no recirculation system on the hot water distribution piping.

Idaho City Schools Site

The existing site slopes down substantially from Southeast to Northwest, with the Elementary School being located at the high point on the Southeast side of the site, and the High School being at the bottom of the hill to the Northwest of the Elementary building. Between the two main buildings, the School District has erected five modular classrooms that essentially comprise the Middle School operations. These modular buildings make the South side of the site unusable for a biomass boiler building. To the West of the High School, the District maintains a parking lot, which is currently undersized to handle parking requirements. The East side of the site contains the playground equipment for the Elementary School, and the North side has the propane storage tank. There is a small part of green space in the Northeast corner of the site, but this location is not large enough for a biomass boiler building.

With the site being so utilized, the only real possibility for constructing a biomass building on school district property may be to locate it to the East-northeast side, between the playground equipment and the propane storage tank. There is an existing access gate for propane deliveries which could be used for wood chip deliveries too. Road access is good from this side of the site, and a wood chip delivery van should have no problems with turning requirements, provided the biomass building is not located on the property line. This location is in close proximity to the Elementary School, with a reasonable distance to the High School.

Schools Site Summary

Initially, the major drawback to the school project is the lack of an existing hydronic or steam system to integrate with. As such, the integration will involve replacement of major portions of the existing heating and ventilating systems. A Performance Contractor can be brought on board to provide some energy saving solutions to help finance the system overhaul and may make the investment more attractive.

Three options were explored in greater detail:

- Option A – Fully-automated Wood Chip Plant
- Option B – Semi-automated Wood Chip Plant
- Option C – Wood Pellet Plant

Option A – Fully-automated Wood Chip Plant
Install a 1.0 million BTUH hot water wood chip heating plant between the existing playground equipment and the existing propane storage tank. This Option provides a base-load heating plant for the entire school facility and incorporates a new propane-fired boiler to be used for supplemental heat during peak loads and as back up if the biomass boiler is offline. The biomass system would be a fully-automated system, requiring minimal interface by maintenance personnel.

The main advantages with this Option are that piping runs to each school will be reasonable and wood chip deliveries can be easily accommodated. The biggest disadvantage is integration costs will be high because major portions of the heating and ventilation systems will be replaced to accommodate a new hydronic system. Estimated cost: $950,000.

Option B – Semi-automated Wood Chip Plant
Install a 1.0 million BTUH hot water wood chip heating plant between the existing playground equipment and the existing propane storage tank. This Option provides a base-load heating plant for the entire school facility and incorporates a new propane-fired boiler to be used for peak loads and as back up. The biomass system would be a less 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 or bobcat is required to transfer chips from the chip storage building to the day bin.

The main advantages with this Option are that piping runs to each school will be reasonable and wood chip deliveries can be easily accommodated. The biggest disadvantages are high integration costs, similar to Option A and increased maintenance costs to fill the day bin. Estimated cost: $750,000.

Option C – Wood Pellet Plant
Install a 1.0 million BTUH hot water wood pellet heating plant between the existing playground equipment and the existing propane storage tank. This Option provides a base-load heating plant for the entire school facility and incorporates a new propane-fired boiler to 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 advantages with this Option are that piping runs to each school will be reasonable and wood chip deliveries can be easily accommodated. The biggest disadvantage is high integration costs, similar to the two Options above. Estimated cost: $700,000.

<u>Results of Evaluation</u>

Results of this analysis are summarized below and based on the following assumptions. Biomass boiler system budget estimates are based upon recent biomass assessments and project costs for completed systems, as noted below:

- Fully-automated Wood Chip System: $550,000.
- Semi-automated Wood Chip System: $350,000.
- Wood Pellet system: $300,000.

The integration costs are based on removing the existing propane furnaces and installing a heat pump system to utilize the biomass water. For all the options analyzed, the integration costs are about $400,000.

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, and Fuels For Schools grant money for 50% of the new biomass boiler and chip storage bin/silo costs only.

- Option A – Fully-automated Wood Chip System achieves a positive accumulated cash flow (PAC) in 20 years with a subsidy (Fuels For Schools grant) of $275,000 and in 25 years with no subsidy.
- Option B – Semi-automated Wood Chip System achieves PAC in 18 years with a subsidy of $175,000 and in 21 years with no subsidy.
- Option C - Wood Pellet System achieves PAC in 19 years with a subsidy of $150,000 and in 22 years with no subsidy.

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 below:

- Option A – $673,000 subsidy required.
- Option B – $473,000 subsidy required.
- Option C – $467,000 subsidy required.

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 the options 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. First, is the cost of propane. Although the current propane cost is approximately $1.499/gallon, propane contracts have recently seen dramatic increases in cost. As a result, $1.65/gallon was used in the analysis, with a 4% inflation rate. Individual years may fluctuate beyond that average. Second, the cost of fuel costs in transporting wood pellets or chips to the site should be considered. Finally, air quality permit requirements in the State of Idaho should be reviewed in greater detail.

As an individual project, the Idaho City Schools should probably be considered marginal. This is mostly due to the fact that there is not really any existing infrastructure to support a hydronic heating system and it would all need to be installed new. A Performance Contractor could be involved further to see what energy saving measures may exist at the site. If some measures could be implemented, it would probably help to make the schools a viable project.

As was stated before, if the Forest Service site across the street can utilize a co-generation plant, it would probably improve the economics, but the analysis is beyond the scope of this assessment. A detailed energy analysis should be commissioned to help with that evaluation.

APPENDIX A
Idaho City Forest Service Campus Evaluation

The Forest Service manages a firefighter/trail maintenance operation in Idaho City comprised of many buildings. There are 10 major buildings that were reviewed for this study.

Warehouse

Built in 1983, this 6020 square foot building provides space for equipment storage as well as three offices. It is occupied year-round and considered one of the main buildings of the campus. Heating is provided by electric unit heaters and electric duct furnaces. Domestic hot water is provided by a 40 gallon electric heater.

North Fork Bunkhouse

Built in 2003, this building is 3175 square feet and provides space for 12 occupants during the summer/fall seasons. Heating is provided by propane fired furnaces that have a DX cooling coil to supply cooling to the spaces as well. Domestic hot water is provided by 15 Kw instantaneous electric heaters.

Old Bunkhouse #1 & #2

Built in 1940 as military barracks, each of these 1000 square foot buildings provide space for 10 occupants during the summer/fall seasons. Heating is provided by propane fired unit heaters. There is neither cooling nor domestic water provided.

Duplex Bunkhouse

Another building constructed in 1940 as a military barracks, the duplex is 1400 square feet and provides space for 3 occupants during the summer/fall seasons. Heating is provided by electric unit heaters. No domestic hot water or cooling is provided.

Kitchen/Mess Hall

This building's area comprises 1000 square feet, with construction completed in 1940. It provides limited food preparation and dining facilities for the campus occupants. The mission of this building may change in the future, as most of the meal preparation is being accommodated in the new bunkhouse designs. The exact means of heating the space is unknown, as the building was locked during the site visit. It does have a propane water heater and cooktop ranges, so it would be logical to assume that a propane unit heater or duct furnace heats the building. A swamp cooler provides comfort cooling to the spaces.

Middle Fork Bunkhouse

Built in 1995, this building is 2656 square feet and provides space for 12 occupants during the summer/fall seasons. Heating is provided by electric unit heaters. Domestic hot water is provided by 15 Kw instantaneous electric heaters. No cooling is provided.

South Fork Bunkhouse

Built in 2003, this building is an exact duplicate of the North Fork Bunkhouse with regard to this survey. Together with the North Fork Bunkhouse, these two bunkhouses are considered to be some of the major buildings in the complex.

Idaho City Hotshots Building

This 1792 square foot building was constructed in 2003 and provides space for a training room, conference room and offices for use by 20 occupants year-round. The Hotshots office is also considered one of the major buildings at the site. The spaces are heated and cooled by wall mounted, packaged units using electricity for the energy source. No domestic hot water is provided.

Tree Cooler Building

Built in 1997, this building is 1600 square feet and provides space during the spring season for seedling tree storage. The remainder of the year the building sees only occasional use. It is essentially a walk-in cooler with a roof over it. No heating or domestic hot water is provided.

Gas House

Built in 1984, this building is 972 square feet of hazardous materials storage primarily gasoline, diesel fuel and paint. There is a carport attached that also figures into the square footage for this building, even though it is only a roof. Minimal heat from electric unit heaters keeps the materials from freezing. No cooling or domestic hot water is provided.

Forest Service Campus Summary

If this campus were evaluated by itself and based solely on the merits of integrating a biomass boiler plant to provide comfort heating and domestic hot water for the facilities, it would probably not be economically feasible. The primary reason for this is that none of the heating systems are hydronic (using steam or hot water), making the integration of a hydronic system very expensive. Essentially for each building to be included on the biomass heat plant, the heating systems would have to be removed and retrofitted. Also, the campus is relatively widespread when the individual building areas are considered. Any hydronic heating piping would probably be best installed in a loop to cover all the buildings.

One thing this campus has in its favor, unlike the school campus across the street, is underutilized land where a biomass plant could be placed. The access to a biomass plant on this site would be very accessible for the delivery vans and could be integrated into the campus without disturbing any current operational activities. If the biomass plant were located in such a manner to be near the schools, a loop could be routed to serve the schools and the Forest Service campus together. The most desirable location for the biomass plant on Forest Service property would be east of the North Fork Bunkhouse. From this position, piping could be extended under Placerville Road to service the school buildings, while being routed in a loop to supply the Forest Service buildings as well.

For a combined School and Forest Service project to be realistic, a performance contractor should probably be involved to help find energy saving methods to help offset the high costs. The costs are high for this project because the existing heating systems are not hydronic. But at the same time, most of the systems are using electricity to heat the buildings, which is not energy efficient. This should be a good combination for the performance contractor – the systems will be replaced with energy efficient ones and the savings can be used to help finance the improvements.

Finally, the Forest Service has expressed interest in a co-generation plant that would use biomass as a fuel source. The plant would ideally generate enough electricity to power the

Forest Service campus and the schools. Obviously, if the plant were large enough to sell excess power to the electric utility, that could help finance the project improvements. The idea of biomass cogeneration is beyond the scope of the Fuels For Schools program and other means would be required to evaluate its feasibility. Hopefully, the other avenues would result in some grants or other funding sources to help improve this project's viability.

Idaho City Schools - Option A, Fully-automated Wood Chip Plant
Idaho City, Idaho

Date (Revised): July 26 2005
Analyst: CTA-Architects Engineers- Scott Mackay

	Fuel Oil	Propane	Natural Gas	Notes:
EXISTING CONDITIONS				
Existing Fuel Type:	Fuel Oil	Propane	Natural Gas	Fuel type highlighted
Current Fuel Cost (USD/gallon):	$0.00	$1.65	$0.00	Current year average $/gallon or $/dka
3-year Average Fuel Usage:	0	25,822	0	3-year year average gallon or dka
Annual Heating Costs:	$0	$42,606	$0	Chart will automatically convert
ENERGY CONVERSION (to 1 mmbtu, or 1 dka)				
Current Annual Fuel Volume (dka):	0	2,336,942,644	0	Chart will automatically convert
Assumed efficiency of existing heating system (%):	70%	80%	80%	
Net Annual Fuel Usage (dka):	0	1,869,554,115	0	Chart will automatically convert

	Wood Chips	Wood Pellets	
WOOD FUEL COST			
USD/ton:	$35.00	$85.00	Modify for local conditions
Assumed efficiency of wood heating system (%):	65%	70%	
PROJECTED FUEL USAGE			
Assumed btu content of wood fuel	5400	8200	
Tons of wood fuel to create net equivalent of 100% annual heating load	266	163	=Net Annual Fuel Usage/10.8 or 16.4 mmbtu/Assumed efficiency of wood heating system

Project Capital Cost	-$950,000	nearest $50,000
Project Financing Information		
Percent Financed	71%	
Amount Financed	-$675,000	
Amount of Grants	$275,000	
Interest Rate	4.60%	Modify for local conditions
Term	10	
Annual Finance Cost (years)	-$85,726	
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-33 (years)	Represents a quick look at project viability

Inflation Factors	
O&M Inflation Rate	3%
Current Fuel Inflation Rate	4%
Wood Fuel Inflation Rate	2%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 10	Year 11	Year 20	Year 30
Existing Heating System Operating Costs									
Displaced heating costs	$1.65		25822	gallons	$42,606	$60,642	$63,068	$89,765	$132,874
Displaced Operation and Maintenance Costs					$500	$652	$672	$877	$1,178
Biomass System Operating Costs									
Wood Chips ($/ton, delivered to boiler site, 5400 btu/lb)	$35.00	90%	266	tons	$8,389	$10,026	$10,226	$12,221	$14,898
Small load existing fuel (Propane)	$1.82	10%	25822	gallons	$4,687	$6,671	$6,937	$9,874	$14,616
Operation and Maintenance Costs					$1,500	$1,957	$2,016	$2,630	$3,535
Annual Operating Cost Savings					***$28,531***	***$42,641***	***$44,560***	***$65,916***	***$101,004***
Financed Project Costs - Principal and Interest					*(85,726)*	*(85,726)*			
Displaced System Replacement Costs (year one only)									
Net Annual Cash Flow					*(57,195)*	*(43,085)*	***44,560***	***65,916***	***101,004***
Cumulative Cash Flow					*(57,195)*	*(505,311)*	*(460,751)*	***41,215***	***881,560***

Idaho City Schools - Option B, Semi-automated Wood Chip Plant

Idaho City, Idaho

Date (Revised): July 26 2005
Analyst: CTA-Architects Engineers- Scott Mackay

EXISTING CONDITIONS	Fuel Oil	Propane	Natural Gas	Notes:
Existing Fuel Type:				Fuel type highlighted
Current Fuel Cost (USD/gallon):	$0.00	$1.65	$0.00	Current year average $/gallon or $/dka
3-year Average Fuel Usage:	0	25,822	0	3-year year average gallon or dka
Annual Heating Costs:	$0	$42,606	$0	Chart will automatically convert
ENERGY CONVERSION (to 1 mmbtu, or 1 dka)				
Current Annual Fuel Volume (dka):	0	2,336,942,644	0	Chart will automatically convert
Assumed efficiency of existing heating system (%):	70%	80%	80%	
Net Annual Fuel Usage (dka):	0	1,869,554,115	0	Chart will automatically convert

WOOD FUEL COST	Wood Chips	Wood Pellets	
USD/ton:	$35.00	$85.00	Modify for local conditions
Assumed efficiency of wood heating system (%):	65%	70%	
PROJECTED FUEL USAGE			
Assumed btu content of wood fuel	5400	8200	
Tons of wood fuel to create net equivalent of 100% annual heating load	266	163	=Net Annual Fuel Usage/10.8 or 16.4 mmbtu/Assumed efficiency of wood heating system

Project Capital Cost	**-$750,000**	nearest $50,000
Project Financing Information		
Percent Financed	**77%**	
Amount Financed	-$575,000	
Amount of Grants	$175,000	
Interest Rate	4.60%	Modify for local conditions
Term	10	
Annual Finance Cost (years)	-$73,026	
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-26 (years)	Represents a quick look at project viability

Inflation Factors	
O&M Inflation Rate	3%
Current Fuel Inflation Rate	4%
Wood Fuel Inflation Rate	2%

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 10	Year 11	Year 20	Year 30
Existing Heating System Operating Costs									
Displaced heating costs	$1.65		25822	gallons	$42,606	$60,642	$63,068	$89,765	$132,874
Displaced Operation and Maintenance Costs					$500	$652	$672	$877	$1,178
Biomass System Operating Costs									
Wood Chips ($/ton, delivered to boiler site, 5400 btu/lb)	$35.00	90%	266	tons	$8,389	$10,026	$10,226	$12,221	$14,898
Small load existing fuel (Propane)	$1.82	10%	25822	gallons	$4,687	$6,671	$6,937	$9,874	$14,616
Operation and Maintenance Costs					$1,500	$1,957	$2,016	$2,630	$3,535
Annual Operating Cost Savings					***$28,531***	***$42,641***	***$44,560***	***$65,916***	***$101,004***
Financed Project Costs - Principal and Interest					*(73,026)*	*(73,026)*			
Displaced System Replacement Costs (year one only)									
Net Annual Cash Flow					*(44,495)*	*(30,385)*	***44,560***	***65,916***	***101,004***
Cumulative Cash Flow					*(44,495)*	*(378,310)*	*(333,750)*	***168,216***	***1,008,561***

Idaho City Schools - Option C, Wood Pellet Plant
Idaho City, Idaho

Date (Revised): July 26 2005
Analyst: CTA-Architects Engineers- Scott Mackay

	Fuel Oil	Propane	Natural Gas	Wood Chips	Wood Pellets	Notes:
EXISTING CONDITIONS						
Existing Fuel Type:	Fuel Oil	Propane	Natural Gas			Fuel type highlighted
Current Fuel Cost (USD/gallon):	$0.00	$1.65	$0.00			Current year average $/gallon or $/dka
3-year Average Fuel Usage:	0	25,822	0			3-year year average gallon or dka
Annual Heating Costs:	$0	$42,606	$0			Chart will automatically convert
ENERGY CONVERSION (to 1 mmbtu, or 1 dka)						
Current Annual Fuel Volume (dka):	0	2,336,942,644	0			Chart will automatically convert
Assumed efficiency of existing heating system (%):	70%	80%	80%			
Net Annual Fuel Usage (dka):	0	1,869,554,115	0			Chart will automatically convert
WOOD FUEL COST				Wood Chips	Wood Pellets	
USD/ton:				$35.00	$85.00	Modify for local conditions
Assumed efficiency of wood heating system (%):				65%	70%	
PROJECTED FUEL USAGE						
Assumed btu content of wood fuel				5400	8200	
Tons of wood fuel to create net equivalent of 100% annual heating load				266	163	=Net Annual Fuel Usage/10.8 or 16.4 mmbtu/Assumed efficiency of wood heating system

Project Capital Cost	-$700,000	nearest $50,000
Project Financing Information		
Percent Financed	79%	
Amount Financed	-$550,000	
Amount of Grants	$150,000	
Interest Rate	4.60%	Modify for local conditions
Term	10	
Annual Finance Cost (years)	-$69,851	
Simple Payback: Total Project Cost/Year One Operating Cost Savings:	-30 (years)	Represents a quick look at project viability
Inflation Factors		
O&M Inflation Rate	3%	
Current Fuel Inflation Rate	4%	
Wood Fuel Inflation Rate	2%	

Cash flow Descriptions	Unit Costs	Heating Source Proportion	Annual Heating Source Volumes	Heating Units	Year 1	Year 10	Year 11	Year 20	Year 30
Existing Heating System Operating Costs									
Displaced heating costs	$1.65		25822	gallons	$42,606	$60,642	$63,068	$89,765	$132,874
Displaced Operation and Maintenance Costs					$500	$652	$672	$877	$1,178
Biomass System Operating Costs									
Wood Pellets ($/ton, delivered to boiler site, 8200 btu/lb)	$85.00	90%	163	tons	$12,458	$14,889	$15,187	$18,149	$22,124
Small load existing fuel (Propane)	$1.82	10%	25822	gallons	$4,687	$6,671	$6,937	$9,874	$14,616
Operation and Maintenance Costs					$2,500	$3,262	$3,360	$4,384	$5,891
Annual Operating Cost Savings					***$23,461***	***$36,473***	***$38,256***	***$58,235***	***$91,421***
Financed Project Costs - Principal and Interest					*(69,851)*	*(69,851)*			
Displaced System Replacement Costs (year one only)									
Net Annual Cash Flow					*(46,389)*	*(33,377)*	***38,256***	***58,235***	***91,421***
Cumulative Cash Flow					*(46,389)*	*(402,581)*	*(364,325)*	***74,224***	***827,655***