U.S. Department of Agriculture
Northeastern Area
State and Private Forestry

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Preliminary Feasibility Report

Biomass Heating Analysis for Alexandria Central School

Alexandria Bay, NY
October 2011

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TABLE OF CONTENTS

List of Figures

List of Tables

EXECUTIVE SUMMARY

Alexandria Central School serves grades K-12 in one large building in Alexandria Bay, New York. The School has approximately 141,000 square feet of conditioned space that is served by three relatively new steam boilers. The adjacent bus garage has an additional 19,000 square feet of conditioned space that is served by one hot water boiler. All four boilers use #2 fuel oil. The steam boilers were installed in 2007 and are in good condition. The hot water boiler was installed in 1968 and is in aging condition. The School is interested in upgrading from steam to hot water distribution. There are several Town and Village buildings (including the Town Alexandria Municipal Arena, Mascherry Library and the Alexandria Bay Village Offices and Fire Department) adjacent to the School that could potentially tie into a District Energy system.

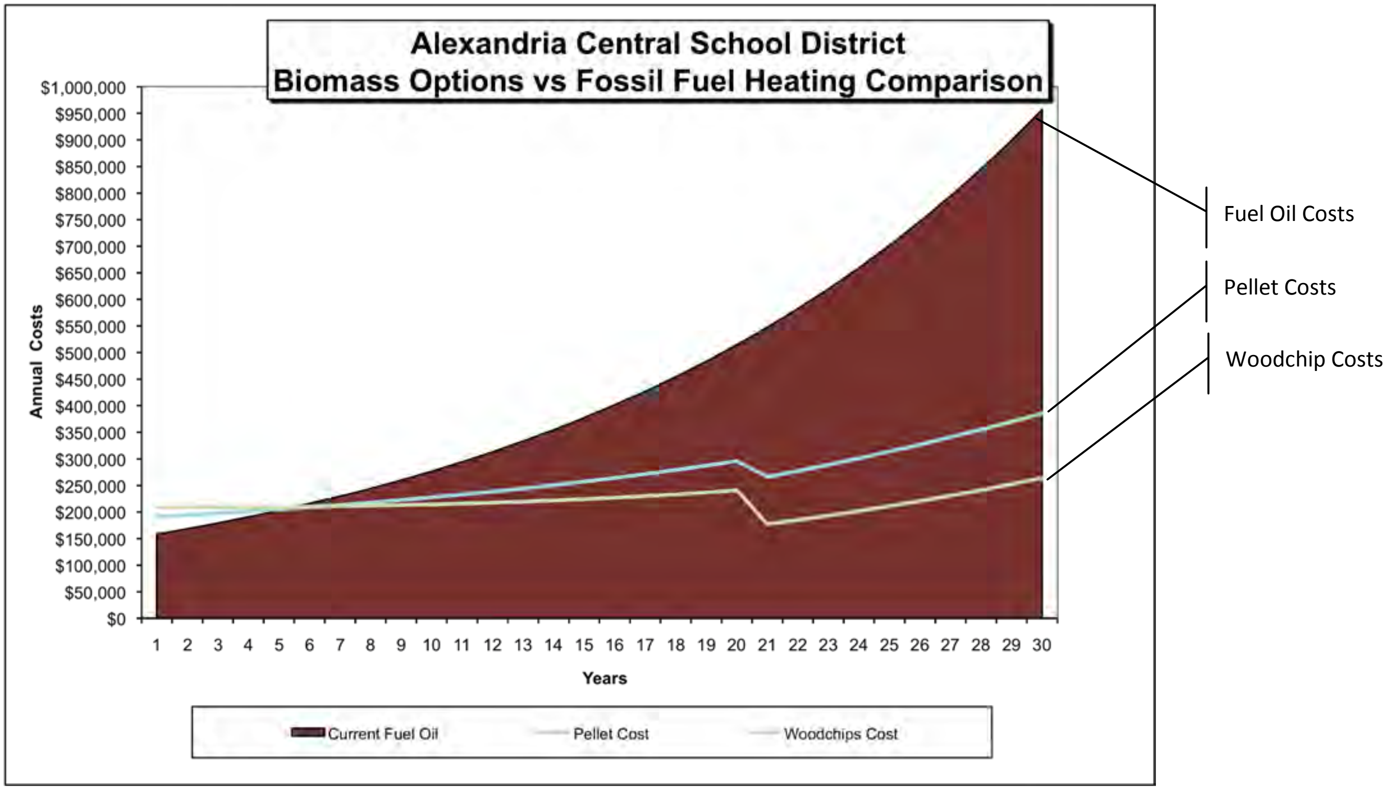
The School currently uses approximately 62,100 gallons of fuel oil on average each year. The average price paid by the School over the past two years was $2.55 per gallon. At that price Alexandria Central School will spend approximately $158,355 on oil for heat and hot water for the School this coming year.

This study analyzes two different biomass scenarios for heating the Alexandria Central School. One scenario analyzes the installation of a wood pellet boiler while the other scenario analyzes the installation of a woodchip system. Both analyses show significant savings and we recommend moving forward with a biomass project. The wood pellet scenario requires less of a capital investment but provides smaller annual fuel savings, while a woodchip system provides higher annual fuel savings and requires a larger capital expenditure. For Alexandria Central School the analysis shows savings of just over $2 million for a pellet system and $2.48 million for a woodchip system in operating costs over 30 years in today's dollars even when the cost of financing is included.

The analysis shows that Alexandria would need to spend approximately $775,700 for a pellet system and the required infrastructure (versus $1.36 million for a woodchip system) and the School would save $46,500 on fuel in the first year with a pellet system versus $89,700 with a woodchip system.

The Chart below compares annual heating costs over the next 30 years for Alexandria with the existing heating system, a wood pellet system and a biomass system. As you can see, the analysis predicts that both biomass systems will provide significant savings over the existing fuel oil system. The pellet and woodchip systems have similar annual costs because the larger fuel savings provided by the woodchip system are partly consumed by the debt of the capital expenditure.

Figure 1: Fuel Oil, Woodchip and Pellet Fuel Annual Cost Comparison



Alexandria Central School appears to be a very good candidate for a biomass heating system. The School is well sited for a biomass boiler house and the existing boiler systems could work well to provide back-up and supplemental heat in combination with a wood fired boiler. We recommend moving forward with a biomass project. We recommend the Alexandria Central School take the following steps to investigate this opportunity further:

1. Hire an engineering firm to help refine the project concept and to obtain firm local estimates on project costs. Further examination should help the School to determine whether a pellet system or woodchip system is more appropriate at this time. The US Forest Service may be able to provide some technical assistance from an engineering team with biomass experience. If the School move forward with this project, decision-makers should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area, to see what assistance can be provided. Contact Lew at (304)285-1538 or lmccreery@fs.fed.us

2. The School should identify any additional heating system improvements it plans to undertake and consider including those projects with the biomass project. It will be more cost effective to implement boiler room upgrades and heating distribution improvements at the same time a new boiler system is installed than it would be to postpone those improvements for a later time.

3. The School should consider energy efficiency improvements simultaneously with boiler upgrades. The efficiency of the building envelope and ventilation equipment need to be considered when sizing new boiler equipment. The New York State Energy Research and

Development Authority (NYSERDA) and/or the New York Power Authority (NYPA) should be engaged to develop comprehensive energy efficiency recommendations and proposals for incentives for efficiency upgrades before undertaking a major building project. This should be done regardless of whether or not the district moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives are included in the *Biomass and Green Building Resources* binder accompanying this report.

4. In order to effectively measure progress toward energy efficiency goals historical energy consumption data should be collected and updated frequently. There are many tools to help the School accomplish this. One such tool is the EPA Energy Star *Portfolio Manager* software. It is free public domain software that helps facility managers track energy and water use. This software can be downloaded at: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

5. Concurrent with the design of the project, the district should cultivate potential biomass fuel suppliers. There are two pellet manufacturers within 200 miles of Alexandria Bay that can provide the School with pellets if a pellet boiler is installed. If a woodchip boiler is installed, school staff should work with the State of New York Wood Utilization program staff to identify potential New York woodchip fuel suppliers. Sloane Crawford is the leader of that program. He can be reached at:

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This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates for the Alexandria Central School. Both Yellow Wood and Richmond Energy have extensive community economic development experience and Richmond Energy specializes in biomass energy projects. This study was funded by the Wood Education and Resource Center, Northeastern Area State and Private Forestry, U.S. Department of Agriculture.

INTRODUCTION

There is a significant volume of low-grade biomass in the United States that represents a valuable economic and environmental opportunity if it can be constructively used to produce energy. Commercially available biomass heating systems can provide heat cleanly and efficiently in many commercial applications. Biomass heating technologies are being used quite successfully in over 40 public schools in Vermont alone and the concept of heating institutions with wood is catching on in several other areas of the United States and Canada. Good candidate facilities for biomass energy systems include those that have high heating bills, those that have either steam or hot water heating distribution systems and those that have ready access to reasonably priced biomass fuel.

This report is a pre-feasibility assessment specifically tailored to Alexandria Central School outlining whether or not biomass heating makes sense for this facility from a practical perspective. In March 2011, staff from Yellow Wood Associates traveled to Alexandria Bay to tour the School. This assessment includes site specific fuel savings projections based on historic fuel consumption, and provides facility decision-makers suggestions and recommendations on next steps.

The study was funded by the U.S. Department of Agriculture Wood Education and Resource Center.

This preliminary feasibility study was prepared by Yellow Wood Associates and Richmond Energy Associates, LLC.

ANALYSIS ASSUMPTIONS

DESCRIPTION OF THE EXISTING HEATING SYSTEM

The Alexandria Central School serves grades K-12 in one large building complex with a centralized heating system. Located in Alexandria Bay, NY, the School serves 664 students in 141,000 square feet of conditioned space. The School is currently served by three 65 BHP steam boilers located in a central boiler room and a steam distribution system. The boilers were installed in 2007 and are in good condition. The School is interested in upgrading the steam distribution system to a hot water distribution system. The adjacent 19,000 square foot bus garage is heated by a hot water boiler that was installed in 1968.

LIFE CYCLE COST METHODOLOGY

Decision makers need practical methods for evaluating the economic performance of alternative choices for any given purchasing decision. When making a choice between mutually exclusive capital investments, it is prudent to compare all equipment and operating costs spent over the life of the longest lived alternative in order to determine the true least cost choice. The total cost of acquisition, fuel costs, operation and maintenance of an item throughout its useful life is known as its "life cycle cost." Life cycle costs that should be considered in a life cycle cost analysis include:

- Capital costs for purchasing and installing equipment
- Fuel costs
- Inflation for fuels, operational labor and major repairs
- Annual operation and maintenance costs including scheduled major repairs
- Salvage costs of equipment and buildings at the end of the analysis period

It is useful for decision makers to consider the impact of debt service if the project is to be financed in order to get a clearer picture of how a project might affect annual budgets. When viewed in this light, equipment with significant capital costs may still be the least-cost alternative. In some cases, a significant capital investment may actually lower annual expenses, if there are sufficient fuel savings to offset debt service and any incremental increases in operation and maintenance costs.

The analyses performed for this facility compare different scenarios over a 30-year horizon and takes into consideration life cycle cost factors. A 30-year time frame is used because it is the expected life of a new boiler.

The biomass scenarios analyzed in this report include ancillary equipment and interconnection costs. Under the biomass scenarios, the existing heating equipment would still be used to provide supplemental heat during the coldest days of the year if necessary, and potentially for the warmer shoulder season months when buildings only require minimal heating during chilly weather.

The analyses project current and future annual heating bills and compare that cost against the cost of operating a biomass system. Savings are presented in today's dollars using a net present value calculation. Net present value (NPV) is defined as the present dollar value of net cash flows over time. This is a standard method for using the time value of money to compare the cost effectiveness of long-term projects.

It is not the intent of this project, nor was it in the scope of work, to develop detailed cost estimates for a biomass system. It is recommended that for a project of this scale, the School hire a qualified design team to refine the project concept and to develop firm local cost estimates. Therefore the capital costs used for the biomass scenarios are generic estimates based on our experience with similar scale projects.

FUEL OIL COST ASSUMPTIONS

During the past two years Alexandria Central School used an estimated 62,100 gallons of fuel oil to heat the main school building and bus garage. The average price paid for fuel oil over the past two years was $2.55 per gallon according to the School. The analyses in this report use $2.55 per gallon for the first year of the analysis. At $2.55 per gallon, Alexandria Central School will spend more than $158,300 to heat the school next year.

WOOD PELLET FUEL COST ASSUMPTIONS

Pellet fuel is a manufactured product that competes directly with fossil fuels. Consequently pellet fuel prices track more closely to fossil fuels than other biomass fuel. Pellets prices also fluctuate more dramatically than woodchip prices. However, pellets are still a relatively local product so they won't likely have the same geopolitical pressures as fossil fuels. After consulting with local suppliers, we are projecting a first year cost of $200 per ton for pellets, which is equivalent to about $1.69 per gallon for fuel oil.

For the wood pellet scenario we are assuming the pellet boiler will meet 85% of the annual heating needs. The remaining 15% of the heating needs were then assumed to be provided by the existing fuel oil boilers consuming about 9,315 gallons of fuel oil. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.

WOODCHIP FUEL COST ASSUMPTIONS

Frequently, operators of institutional woodchip systems don't fire up their biomass boilers until there is constant demand for building heat. During the fall and spring, fossil fuel boilers are often used as they are easier to start up and turn down. Woodchip boilers are then typically used in place of fossil fuel boilers for the bulk of the winter heating season. In Vermont where there are well over 40 schools that heat with wood, the average annual wood utilization is about 85%.

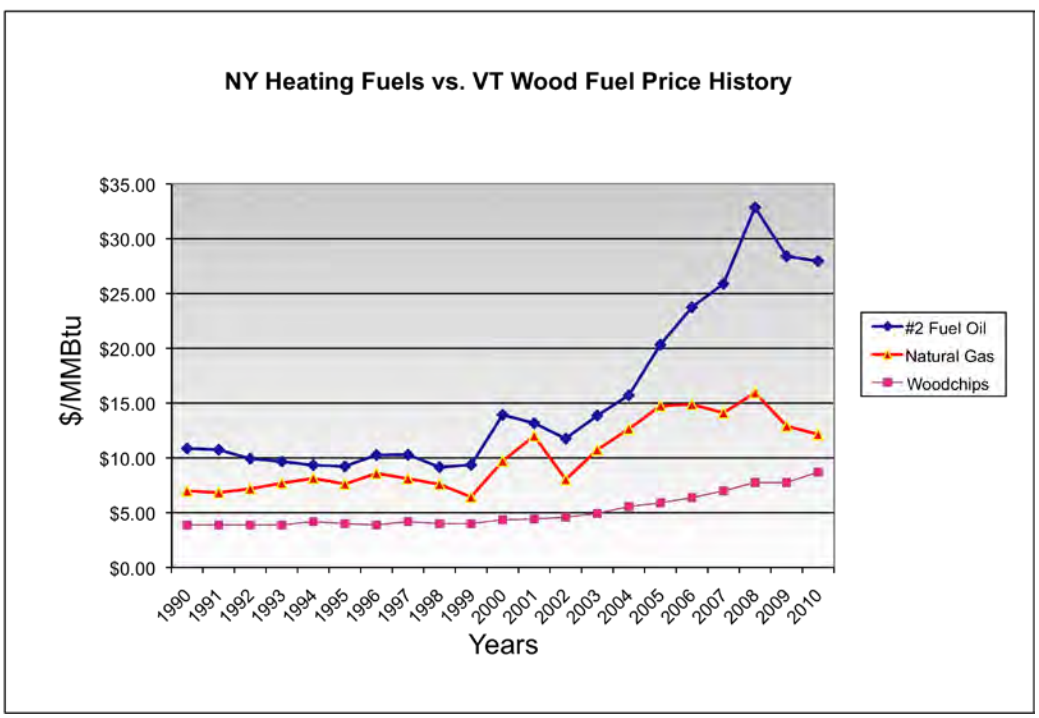
After consulting with other woodchip users in the region, we are projecting a first year cost of $50 per ton for woodchips which is equivalent to about $0.80 per gallon of fuel oil. The remaining 15% of the heating needs were then assumed to be provided by the existing fuel oil system consuming about 9,315 gallons of fuel oil. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.

INFLATION ASSUMPTIONS

Estimating future fuel costs over time is difficult at best. Over the past few years it has become even more difficult as fuel prices have fluctuated dramatically. Nevertheless, in order to more accurately reflect future costs in a thirty-year analysis, some rate of inflation needs to be applied to future fuel costs.

We looked retrospectively over the last 20 years (1990 – 2010) using US Energy Information Agency data and found that the average annual increase for fuel oil in New York was 6.4% per year. The analysis projects this average inflation rate for fuel oil forward over the thirty-year analysis period. Alexandria Central's fuel rate of $2.55 per gallon was used for the first year of the analysis and then inflated each year at 6.4%.

Figure 2: Woodchip and Fossil Fuel Inflation



The cost of woodchips used for heating fuel tends to increase more slowly and has historically been much more stable in price over the past two decades than fossil fuels. In Vermont for example, the statewide average woodchip fuel price for institutional biomass heating systems rose from $25/ton to $56/ton in the period between 1990 and 2010. The average annual increase during this period was about 3.6% annually[1] with the greatest increases happening recently. Because woodchip fuel is locally produced from what is generally considered a waste product from some other forest product business, it does not have the same geopolitical pressures that fossil fuels have. Over the past twenty years, woodchip fuel costs have been far less volatile than fossil fuels.

There is not good historical data on pellet prices. Anecdotal evidence suggests that pellet prices are more volatile than woodchips, but less so than fossil fuels. For the purposes of this analysis, it was assumed that pellet fuel will inflate at a higher rate than general inflation and less than the projected inflation rate for propane. A pellet fuel price inflation rate of 4.25% is halfway between the twenty year average Consumer Price Index and the twenty year average fuel oil price inflation. A 4.25% annual inflation rate was applied to all future pellet fuel costs in the pellet analysis.

The overall Consumer Price Index for the period between 1990 and 2010, the last year for which full data is available, increased an average of 2.7% annually. This is the annual inflation rate that was used in projecting all future labor costs, operations and maintenance costs and scheduled major repair costs for the biomass scenario.

OPERATION AND MAINTENANCE ASSUMPTIONS

It is typical for operators of fully automated woodchip heating systems of this size to spend 15-30 minutes per day to clean ashes[2] and to check on pumps, motors and controls. For the woodchip scenario, it was assumed that existing on-site staff would spend on average approximately one half hour per day in addition to their current boiler maintenance for 150 days per year and 20 hours during the summer months for routine maintenance. At a loaded labor rate of $25/hr, this equals $2,375 annually. An additional $6,000 in annual operational costs is assumed for electricity to run pumps, motors and pollution control equipment.

[1] Extrapolated from Vermont Superintendent Association District Energy Management Program data

[2] Wood ash is generally not considered a hazardous material in most states and can be landfilled or land applied as a soil amendment by farmers or on-site maintenance staff.

Pellet boilers require very little maintenance in comparison to woodchip boilers. For the pellet scenario, it was assumed that existing on-site staff would spend on average approximately one hour per week in addition to their current boiler maintenance for 30 weeks per year and 20 hours during the summer months for routine maintenance. At a loaded labor rate of $20/hr this equals $1,000 annually. An additional $1,000 in annual operational costs is assumed for electricity to run pumps and motors.

Another operations and maintenance cost that is included in both analyses is periodic repair or replacement of major items on the boilers such as the furnace refractory. It is reasonable to anticipate these types of costs on a 10-15 year cycle. Analysis for the woodchip scenario included $15,000 of scheduled maintenance anticipated in years 10, 20 and 30 and then annualized at $1,500 per year to simulate a sinking fund for major repairs. The $1,500 annual payments were inflated at the general annual inflation rate. Pellet boiler systems have fewer moving parts and should not require as much scheduled maintenance as a woodchip system. An annualized maintenance cost of $1,000 per year was included in the pellet scenario analysis and then inflated at the general inflation rate.

Under any biomass scenario, a case could be made that the existing heating units will require less maintenance and may last longer since they will only be used for a small portion of the heating season. However, all heating equipment should be serviced at least annually no matter how much it is used. Additionally it is very difficult to estimate how long the replacement of the existing units might be delayed. For these reasons, no additional annual maintenance, scheduled repair or planned replacement costs for the existing fuel oil boilers were taken into consideration as these are considered costs that the School would have paid anyway. It was assumed that all costs for the operation and maintenance of a biomass boiler are incremental additional costs.

STATE SCHOOL CONSTRUCTION AID

Biomass boilers are eligible for New York State school construction aid. The New York Facilities Planning Division for the State Department of Education (SED) does not like to fund new boilers until the existing boilers are fully depreciated. SED generally considers boilers fully depreciated after fifteen years although they do recognize that boilers can last a good deal longer. Since Alexandria Central School has recently installed new fuel oil boilers, this project would not likely be eligible to receive State School Construction Aid for the school boilers. However, some limited state aid may be available if the biomass system replaced the 40-year-old boiler system in the bus garage. For the analyses in this report it was assumed that there would be no state school construction aid and that the School would finance the entire biomass project. Yellow Wood recommends that the district contact the NY State Department of Education to discuss the potential for state school construction aid if a biomass project moves forward.

FINANCING ASSUMPTIONS

Financing costs were included in the analyses to give facility decision makers a sense of how this project may impact their annual budget. This analysis assumes that the School will finance the entire cost of the biomass project with a 20-year bond at an interest rate of 4.5%. At this time the analysis does not take into account any potential grants or lower interest loans. A typical bond payment schedule that includes a fixed principal payment and declining interest payments was used in the analysis. Other financing schedules could create more favorable cash flows depending on how much of the project costs are financed and how the remaining costs are financed. See the section in this report on Project Funding Opportunities to learn about alternative funding and financing options.

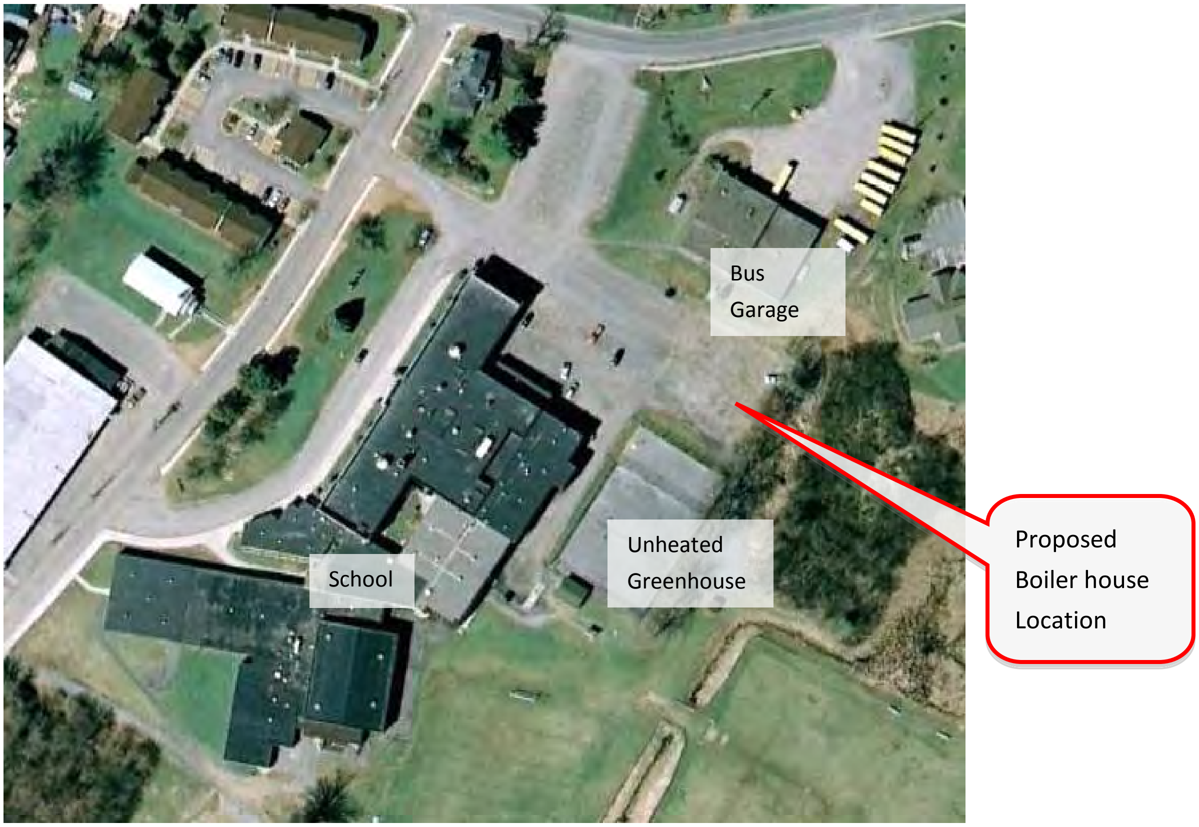
A sensitivity analysis is included in the appendices to this report that show the relative life cycle cost savings under various financing scenarios. If the School would like to see other cash flows using different financing schemes, Yellow Wood can provide additional analysis.

Figure 3: Underground Insulated Piping[3]

[3] Photos excerpted from *Heating Communities with Renewable Fuels* published by Natural Resource Canada.

BIOMASS SCENARIO ANALYSIS

Figure 4: Site Plan



This report analyzes two different biomass scenarios, the first includes a pellet boiler and the second a woodchip boiler. Both scenarios propose building a new boiler house in the location identified in figure 4 above. It may be possible to consolidate all heating equipment into an on-site stand-alone boiler house. It may then be possible to retire some of the existing boilers and to use the existing boiler rooms for storage or other purposes.

BIOMASS PELLET SCENARIO

The pellet scenario that was analyzed for this facility envisions adding two 1.7 mmBtu wood pellet boilers to the School's existing heating system. The boilers would be housed in a new boiler house behind the School and a 40-ton pellet silo, for pellet storage, would be placed adjacent to the new boiler house allowing for bulk delivery of pellets and automatic feeding of the pellet boiler. Steam from the woodchip boiler house would be tied into the exiting HVAC systems in the main school building via approximately 130 feet of underground insulated piping. Hot water would also be pumped to the bus garage via an additional 100 feet of insulated piping. Costs for 230 feet of insulated piping and an allowance for interconnecting to the existing heating distribution systems are included in the proposed capital costs. The scenario assumes the existing fuel oil boilers would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary.

The analysis of the biomass pellet scenario shows that the Alexandria Central School could save more than $2 million in today's dollars in operating costs over the next 30 years by installing a pellet heating system, even including debt service on the cost of the system. Annual fuel savings alone are projected to be more than $46,500 per year in the first year and should increase over time as fossil fuel prices continue to climb. This project would have a positive annual cash flow within five years.

Table 1: Pellet Scenario Analysis Assumptions

Alexandria Central School **Pellet Scenario**					
Capital Cost Assumptions					
Two 1.7 mmBtu pellet hot water boiler systems including installation					$350,000
40 ton pellet storage silo					$30,000
Stand-alone pellet boiler house	500	SF	$75	/SF	$37,500
Underground insulated steam piping from biomass boilerhouse to school	130	LF	$500	/LF	$65,000
Underground insulated hot water piping to bus garage	100	LF	$150	/LF	$15,000
Interconnect to existing boiler system					$50,000
GC markup at 10%					$54,750
Construction contingency at 15%					$90,338
Design at 12%					$83,111
Total estimated project costs					$775,698
Financing Costs					
Financing, annual interest rate					4.5%
Finance term (years)					20
1st full year debt service					$72,819
Fuel Cost Assumptions					
Current annual fuel oil use (gal)					62,100
Assumed fuel oil price in 1st year					$2.55
Projected annual fuel oil bill					$158,355
Percent pellet fuel utilization					85%
Assumed pellet price in 1st year (per ton)					$200
Projected 1st year pellet fuel bill					$88,060
Projected 1st year supplemental fuel oil bill					$23,753
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.7%
Fuel oil inflation rate (twenty year EIA average for New York)					6.4%
Pellet inflation rate (estimate from Biomass Energy Resource Center)					4.25%
O&M Assumptions					
Annual pellet O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance					$2,000
Major repairs (annualized)					$1,000
Savings					
Return on Investment					**6.0%**
Net 1st year fuel savings					**$46,542**
Total 30 year NPV cumulative savings					**$2,042,384**

Figure 5: Annual Cash Flow Graph for Pellet Scenario

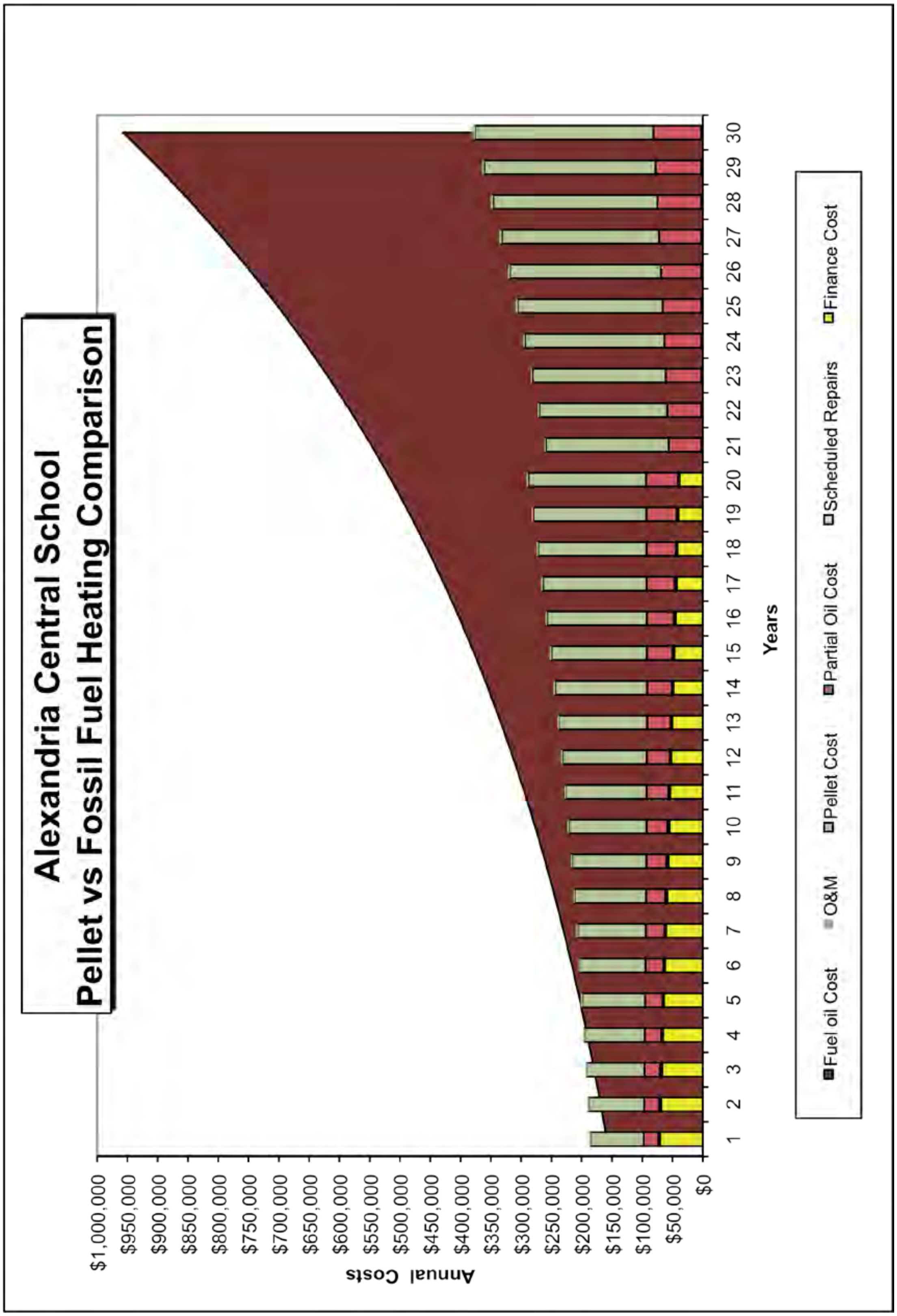


Table 2: 30-Year Life Cycle Analysis Spreadsheet for Pellet Scenario

Alexandria Central School — **Preliminary Life Cycle Cost Estimate** — ***Pellets - Heat Only***

Total estimated construction costs	$775,698	*Estimated state aid* **$0**	
Financing:	4.5%	*Bond interest rate*	
Oil heat consumption	62,100	15% Load covered by Fuel oil = 9,315 gallons	120 gal. / ton of pellets
Oil heat price	$2.55		
Oil heat cost	$158,355	518 tons if 100% pellets for oil	
Estimated pellet utilization	85%		
Projected pellet consumption	440	tons	
Estimated 1st year pellet price	$200	/ ton Year 1	
Projected 1st year pellet cost	$88,060		
Projected 1st year partial fuel oil cost	$23,753		
General Inflation:	2.7%	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*
Oil Inflation	6.4%		*Average increase for New York Residential Fuel Oil from 1991 - 2009 (US EIA)*
Pellet Inflation:	4.25%	**annually**	*Estimate from Biomass Energy Resource Center*
O & M.:	$2,000	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*
Major Repairs:	$1,000		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*

Yr.	Current Fuel oil Cost	Finance Cost For Entire Project	Pellet Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$158,355	$72,819	$88,060	$23,753	$2,000	$1,000	$187,632	-$29,277	-$29,277
2	$168,490	$71,073	$91,803	$24,763	$2,054	$1,027	$190,720	-$22,230	-$51,507
3	$179,273	$69,328	$95,704	$25,815	$2,109	$1,055	$194,012	-$14,739	-$66,246
4	$190,747	$67,583	$99,772	$26,912	$2,166	$1,083	$197,516	-$6,770	-$73,015
5	$202,954	$65,837	$104,012	$28,056	$2,225	$1,112	$201,243	$1,712	-$71,304
6	$215,943	$64,092	$108,432	$29,248	$2,285	$1,142	$205,200	$10,743	-$60,561
7	$229,764	$62,347	$113,041	$30,492	$2,347	$1,173	$209,399	$20,365	-$40,196
8	$244,469	$60,601	$117,845	$31,787	$2,410	$1,205	$213,849	$30,620	-$9,577
9	$260,115	$58,856	$122,854	$33,138	$2,475	$1,238	$218,561	$41,554	$31,977
10	$276,762	$57,111	$128,075	$34,547	$2,542	$1,271	$223,545	$53,217	$85,194
11	$294,475	$55,365	$133,518	$36,015	$2,611	$1,305	$228,814	$65,660	$150,855
12	$313,321	$53,620	$139,192	$37,546	$2,681	$1,341	$234,380	$78,941	$229,796
13	$333,374	$51,875	$145,108	$39,141	$2,753	$1,377	$240,254	$93,119	$322,915
14	$354,710	$50,129	$151,275	$40,805	$2,828	$1,414	$246,451	$108,258	$431,173
15	$377,411	$48,384	$157,704	$42,539	$2,904	$1,452	$252,984	$124,427	$555,601
16	$401,565	$46,639	$164,407	$44,347	$2,983	$1,491	$259,867	$141,699	$697,299
17	$427,266	$44,894	$171,394	$46,232	$3,063	$1,532	$267,114	$160,151	$857,451
18	$454,610	$43,148	$178,678	$48,197	$3,146	$1,573	$274,742	$179,869	$1,037,319
19	$483,706	$41,403	$186,272	$50,245	$3,231	$1,615	$282,766	$200,939	$1,238,259
20	$514,663	$39,658	$194,189	$52,380	$3,318	$1,659	$291,204	$223,459	$1,461,718
21	$547,601		$202,442	$54,606	$3,408	$1,704	$262,160	$285,441	$1,747,159
22	$582,648		$211,046	$56,927	$3,500	$1,750	$273,222	$309,425	$2,056,585
23	$619,937		$220,015	$59,347	$3,594	$1,797	$284,753	$335,184	$2,391,769
24	$659,613		$229,366	$61,869	$3,691	$1,846	$296,771	$362,842	$2,754,611
25	$701,828		$239,114	$64,498	$3,791	$1,895	$309,298	$392,530	$3,147,141
26	$746,745		$249,276	$67,240	$3,893	$1,947	$322,355	$424,390	$3,571,531
27	$794,537		$259,870	$70,097	$3,998	$1,999	$335,965	$458,572	$4,030,103
28	$845,387		$270,915	$73,076	$4,106	$2,053	$350,150	$495,237	$4,525,340
29	$899,492		$282,429	$76,182	$4,217	$2,108	$364,936	$534,556	$5,059,896
30	$957,060		$294,432	$79,420	$4,331	$2,165	$380,348	$576,712	$5,636,607
Totals	$13,436,819	$1,124,762	$5,150,241	$1,389,221	$90,659	$45,329	$7,800,212	$5,636,607	
	30 Yr. NPV at	4.5% Discount Rate							
		$5,975,483	$764,346	$2,442,272	$658,776	$45,136	$22,568	$3,933,099	$2,042,384

Total Annual Heating Costs	Pellet Fuel First year	Partial Fossil Fuel First Year	Pellet System O&M /yr	Scheduled Repair Allowance / Year	Pellet + Fossil Fuel + O&M + Sheduled Repair	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$158,355	$88,060	$23,753	$2,000	$1,000	$187,632	$46,542	$775,698	16.7	$2,042,384	6.0%

BIOMASS WOODCHIP SCENARIO

The second scenario analyzes the installation of a woodchip boiler. The woodchip biomass scenario envisions building a 2,500 square foot stand-alone boiler house and chip storage facility which would house one 4.2 mmBtu woodchip steam boiler, woodchip fuel storage and fuel handling equipment to feed the boiler automatically. Steam from the woodchip boiler house would be tied into the exiting HVAC systems in the main school building via approximately 130 feet of underground insulated piping. Hot water would also be pumped to the bus garage via an additional 100 feet of insulated piping. The scenario assumes the existing fuel oil boilers would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary.

While we are recommending that the district consider upgrading the existing steam distribution system to hot water in the main school building, those costs were not included in this study. Determining the costs for a hot water distribution upgrade was beyond the scope of this project. The School should engage a local engineering team to design a heating distribution upgrade and estimate the costs. See the section on *Hot Water vs. Steam Heating Distribution* on page 21 of this report to learn more about the potential benefits of hot water distribution.

Figure 6: Williamstown, VT High School Woodchip Boiler Plant

Costs for a tall stack were included to ensure good emissions dispersal. An allowance for pollution control equipment was also included. Either a bag house or an electrostatic precipitator will likely be required for a system of this size by air quality regulators. The School should direct its design engineers to investigate the costs and benefits of both before making a decision on which technology will work best in this situation.

Costs for an underground woodchip storage bin were included, as below grade chip storage bins are less likely to freeze in the coldest winter weather, and chip delivery using self unloading trailers into below grade bins is fast and easy.

A healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

The analysis shows that the Alexandria Central School could save more than $2.48 million in today's dollars in operating costs over the next 30 years by installing a woodchip heating system, even including debt service on the cost of the system. Annual fuel savings alone are projected to be close to $90,000 per year in the first year and should increase over time as fuel oil prices continue to climb. This project would have a positive annual cash flow within six years.

Table 3: Woodchip Scenario Analysis Assumptions

Alexandria Central School **Woodchip Analysis**					
Capital Cost Assumptions					
4.2 mmBtu woodchip steam boiler including installation					$450,000
70 ft stack					$35,000
Pollution control equipment					$100,000
Woodchip boilerhouse and chip storage building	2,500	SF	$150	/SF	$375,000
Underground insulated steam piping from biomass boilerhouse to schoo	130	LF	$500	/LF	$65,000
Underground insulated hot water piping to bus garage	100	LF	$150	/LF	$15,000
Interconnection to existing boiler rooms					$50,000
GC markup at 10%					$109,000
Construction contingency at 15%					$163,500
Design at 12%					$130,800
Total estimated project costs					$1,362,500
Financing Costs					
Financing, annual interest rate					4.5%
Finance term (years)					20
1st full year debt service					$129,438
Fuel Cost Assumptions					
Current annual fuel oil use (gal)					62,100
Assumed fuel oil price in 1st year					$2.55
Projected annual fuel oil bill					$158,355
Percentage of wood utilization					85%
Fuel oil (gal)/ton ratio					59
Assumed wood price in 1st year (per ton)					$50
Projected 1st year wood fuel bill					$44,905
Projected 1st year supplemental fuel oil bill					$23,753
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.7%
Fuel oil inflation rate (twenty year average EIA)					6.4%
Wood inflation rate					3.6%
O&M Assumptions					
Annual Wood O&M cost					$8,375
Major repairs (annualized)					$1,500
Savings					
Return on Investment from fuel savings					**6.6%**
Net 1st year fuel savings					**$89,697**
Total 30 year NPV cumulative savings					**$2,480,388**

Figure 7: Annual Cash Flow Graph for Woodchip Scenario

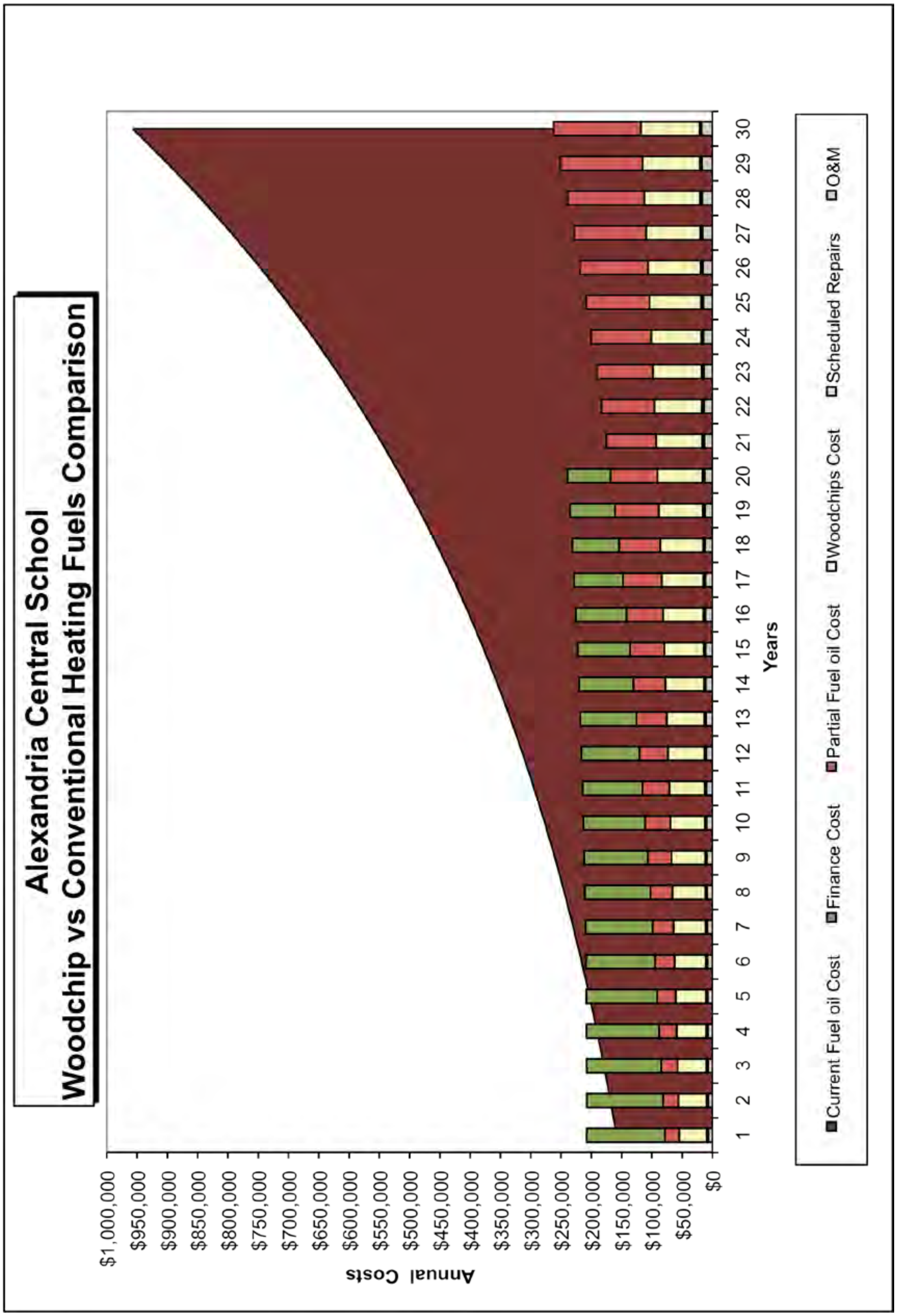


Table 4: 30-Year Life Cycle Analysis Spreadsheet for Woodchip Scenario

Alexandria Central School — **Preliminary Life Cycle Cost Assessment** — ***Woodchips - Heat Only***

Total estimated construction costs	***$1,362,500***	*Conceptual project cost, Woodchips system, building and associated costs.*			
Financing:	**4.5%**	*Assumed bond int*	20 Term of bond		
Fuel oil consumption	**62,100**	gallons/year	15% Load covered by Fuel oil =	9,315 gallons	59 gallons/ton
Fuel oil heat price	**$2.55**	/gallon in year 1			
Fuel oil heat cost	**$158,355**		1,057 tons if 100% Woodchips		
Estimated Woodchips utilization	**85%**				
Projected Woodchips consumption	**898**	tons			
Estimated 1st year Woodchips price	**$50.00**	/ton			
Projected 1st year Woodchips cost	**$44,905**				
Projected 1st year partial fuel oil cost	**$23,753**				
General Inflation:	**2.7%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*		
Fuel oil inflation:	**6.4%**	**annually**	*Average increase for New York Residential Fuel Oil from 1990 - 2010 (US EIA)*		
Woodchips Inflation:	**3.6%**	**annually**	*Average increase for Vermont Schools 1990 - 2010 (VSA SEMP)*		
O & M.:	**$8,375**	**in Year 1 $**	*Estimate of additional maintenance staff time*		
Major Repairs:	**$1,500**		*Contingency for major repair (e.g. refractory replacement) at Years 10 and 20 annualized*		

Yr.	Current Fuel oil Cost	Finance Cost For Entire Project	Woodchips Cost	Partial Fuel oil Cost	O&M	Scheduled Repairs	Total Costs	Annual Cashflow	Cumulative Cashflow
1	$158,355	$129,438	$44,905	$23,753	$8,375	$1,500	$207,971	-$49,616	-$49,616
2	$168,490	$126,372	$46,118	$25,273	$8,601	$1,541	$207,905	-$39,415	-$89,031
3	$179,273	$123,306	$47,363	$26,891	$8,833	$1,582	$207,976	-$28,702	-$117,733
4	$190,747	$120,241	$48,642	$28,612	$9,072	$1,625	$208,191	-$17,444	-$135,178
5	$202,954	$117,175	$49,955	$30,443	$9,317	$1,669	$208,559	-$5,604	-$140,782
6	$215,943	$114,109	$51,304	$32,392	$9,568	$1,714	$209,087	$6,857	-$133,925
7	$229,764	$111,044	$52,689	$34,465	$9,827	$1,760	$209,784	$19,980	-$113,946
8	$244,469	$107,978	$54,112	$36,670	$10,092	$1,808	$210,660	$33,809	-$80,136
9	$260,115	$104,913	$55,573	$39,017	$10,365	$1,856	$211,723	$48,392	-$31,745
10	$276,762	$101,847	$57,073	$41,514	$10,644	$1,906	$212,985	$63,777	$32,032
11	$294,475	$98,781	$58,614	$44,171	$10,932	$1,958	$214,456	$80,019	$112,051
12	$313,321	$95,716	$60,197	$46,998	$11,227	$2,011	$216,148	$97,173	$209,224
13	$333,374	$92,650	$61,822	$50,006	$11,530	$2,065	$218,073	$115,301	$324,524
14	$354,710	$89,584	$63,491	$53,206	$11,841	$2,121	$220,244	$134,466	$458,990
15	$377,411	$86,519	$65,205	$56,612	$12,161	$2,178	$222,675	$154,736	$613,726
16	$401,565	$83,453	$66,966	$60,235	$12,489	$2,237	$225,380	$176,185	$789,911
17	$427,266	$80,388	$68,774	$64,090	$12,827	$2,297	$228,375	$198,890	$988,802
18	$454,610	$77,322	$70,631	$68,192	$13,173	$2,359	$231,677	$222,934	$1,211,736
19	$483,706	$74,256	$72,538	$72,556	$13,529	$2,423	$235,302	$248,404	$1,460,140
20	$514,663	$71,191	$74,496	$77,199	$13,894	$2,488	$239,269	$275,394	$1,735,534
21	$547,601	$0	$76,508	$82,140	$14,269	$2,556	$175,473	$372,129	$2,107,662
22	$582,648	$0	$78,574	$87,397	$14,654	$2,625	$183,250	$399,398	$2,507,060
23	$619,937	$0	$80,695	$92,991	$15,050	$2,696	$191,431	$428,506	$2,935,566
24	$659,613	$0	$82,874	$98,942	$15,456	$2,768	$200,040	$459,573	$3,395,139
25	$701,828	$0	$85,111	$105,274	$15,874	$2,843	$209,102	$492,726	$3,887,865
26	$746,745	$0	$87,409	$112,012	$16,302	$2,920	$218,643	$528,102	$4,415,967
27	$794,537	$0	$89,769	$119,181	$16,742	$2,999	$228,691	$565,846	$4,981,813
28	$845,387	$0	$92,193	$126,808	$17,194	$3,080	$239,275	$606,112	$5,587,925
29	$899,492	$0	$94,682	$134,924	$17,659	$3,163	$250,428	$649,065	$6,236,990
30	$957,060	$0	$97,239	$143,559	$18,135	$3,248	$262,181	$694,878	$6,931,868
Totals	$13,436,819	$2,006,281	$2,035,521	$2,015,523	$379,633	$67,994	$6,504,951	$1,735,534	
Discount Rate	4.5%								
30 Yr. NPV		$5,975,483	$1,362,500	$1,013,415	$189,006	$33,852	$3,495,094	$2,480,388	

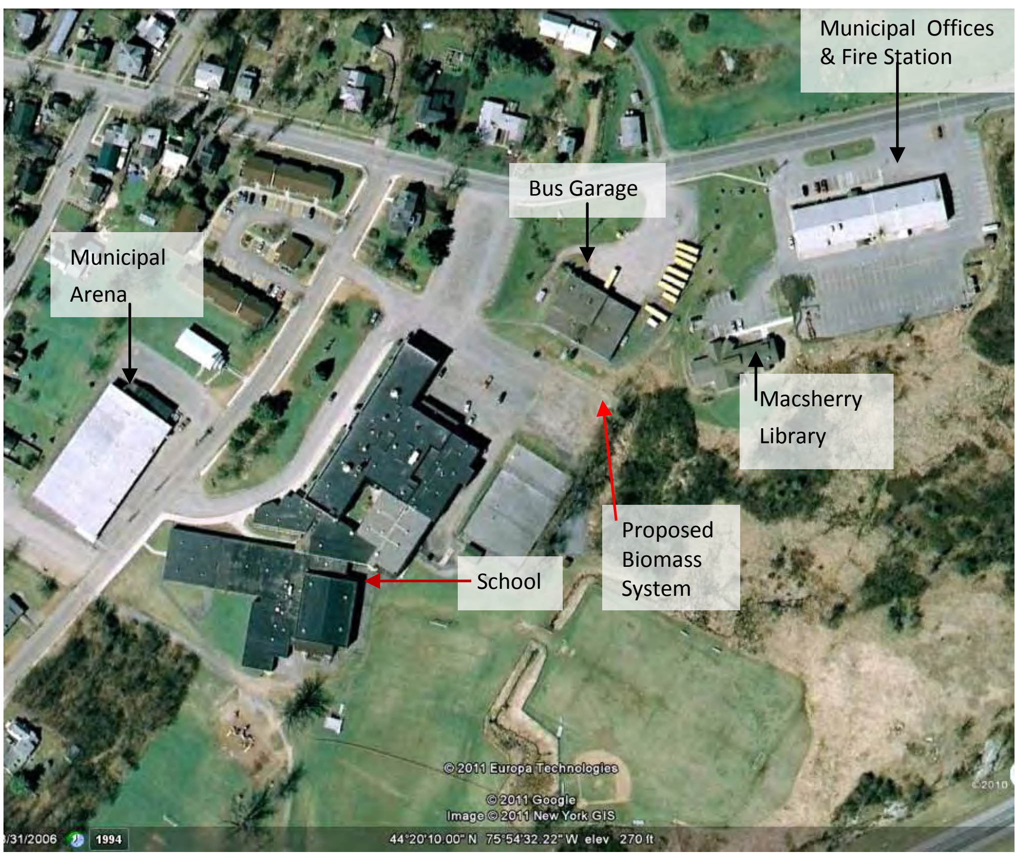
Total Annual Heating Costs	Woodchip Cost First Year	Partial Fossil Fuel First Year	Woodchips System O&M /Year	Scheduled Repair Allowance / Year	Woodchips + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Total Project Cost	Simple Payback (yrs)	30 Yr. NPV Savings	Return on Investment
$158,355	$44,905	$23,753	$8,375	$1,500	$78,533	$89,697	$1,362,500	15.2	$2,480,388	6.6%

ADDITIONAL ISSUES TO CONSIDER

DISTRICT ENERGY

Due to the proximity of the Alexandria Central School to several Town and Village buildings, this project also has the potential to act as a small district energy project. In a district heating system, insulated underground pipelines distribute thermal energy (usually in the form of hot water or steam) from a central boiler plant to each of the buildings connected to the system. In this case, the School would be the anchor facility for the project (the building using the majority of the heat) with potential for also providing heat to the Municipal Arena, the Macsherry Library and the Municipal Offices and Fire Station (see the District Site Plan below). District energy can extend and expand the benefits of biomass heating by economies of scale.

Figure 8: District Site Plan



Located directly across Bolton Avenue from the School, the Municipal Arena uses both propane and kerosene for heat and hot water. The Arena currently operates six months a year and spends approximately $10,000 annually on propane and kerosene and would be interested in extending their season if it was cost effective. Located Southeast of the bus garage, the 5,200 square foot Macsherry Library is heated with 1,443 gallons of fuel oil. The library is open 6 days a week and spends approximately $4,300 on heat and hot water each year. To the Northeast of the bus garage is the Village of Alexandria Bay Municipal Offices and Fire Station. This facility uses approximately 4,400 gallons of fuel oil each year at an average cost of $13,160. It was not within the scope of this study to analyze the feasibility of a biomass system at each of these additional facilities. However, if the School moves forward with a biomass project, it would be worth analyzing whether or not a district energy system is feasible.

Table 5: Additional Buildings (District System) Information

Facility	Existing Fuel Use & Cost			Required piping to Biomass System*	Potential Annual Savings with Biomass
	Fuel Type	Annual Usage	Annual Cost		
Municipal Arena	Propane Kerosene	455 gal 3,045 gal	$980 $8,615	90 LF	$5,927
Macsherry Library	Fuel Oil	1,443 gal	$4372	190 LF	$2,803
Municipal Offices & Fire Station	Fuel Oil	4,400 gal	$13,160	155 LF	$8,542
Total			**$22,594**	**435 LF**	**$17,273**

*in addition to piping required to connect the main school building and bus garage

A district energy system could have a good return on investment depending on the cost to lay piping and any additional equipment costs that might be needed in the biomass boiler house. In considering a district energy project, the key decision-maker will be the School as they are by far the largest consumers of energy. If the School does decide to move forward with a biomass project, it should ask their engineering design team to carefully evaluate the potential for a district energy system at this site. Concurrently, the School should discuss its plans with town officials and gauge their interest in investing in a district energy project. The piping and interconnection costs could be as much as $100,000 to add all of these buildings to a biomass boiler plant. However with a $17,000 annual energy cost savings that equates to a 17.3% return on investment.

ENERGY MANAGEMENT

In order to effectively manage energy use and to identify efficiency opportunities in buildings it is very important to track energy usage. Unless energy consumption is measured over time, it is difficult or impossible to know the impact of efficiency improvements or renewable energy investments. The School appears to have an excellent energy management system that will allow them to track energy use carefully. Another tool that may be helpful is a public domain software too developed by the Environmental Protection Agency called *Portfolio Manager*. This tool can track and assess energy and water consumption across an entire portfolio of buildings. *Portfolio Manager* can help set efficiency priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance. Yellow Wood recommends that the School input several

years' worth of energy and water use data into *Portfolio Manager* as soon as it can. The EPA *Portfolio Manager* software can be downloaded at the following address:
http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

ENERGY EFFICIENCY

Whether Alexandria Central School converts to biomass or stays with fuel oil, the facility should use its heating fuel efficiently. The New York State Energy Research and Development Authority (NYSERDA) and/or the New York Power Authority (NYPA) can help identify and prioritize appropriate energy efficiency projects that will improve the School's infrastructure and save money. Both of these agencies can help with the evaluation of energy efficiency opportunities and provide financial incentives to upgrade and improve equipment efficiencies. If the School decides to move forward with a biomass energy project, it should work with one of these agencies to identify other efficiency projects that could be completed at the same time.

General information on efficiency programs in New York is included in the *Biomass and Green Building Resources Binder* accompanying this report.

COMMISSIONING

Building, or systems, commissioning is a process that verifies that a facility and/or system is functioning properly. The commissioning process takes place at all phases of construction, from planning to operation, to confirm that facilities and systems are performing as specified. Commissioning of a new system provides quality assurance, identifies potential equipment problems early on and provides financial savings on utility and maintenance costs during system operations. A recent study of 224 buildings found that the energy savings from commissioning new buildings had a payback period of less than five years. Additional benefits of commissioning include: improved indoor air quality, fewer deficiencies and increased system reliability. We strongly recommend that the School work with an independent, third-party, commissioning agent during the design and construction of a biomass heating system. See the *Biomass and Green Building Resources* binder for more information on commissioning.

HOT WATER VS. STEAM HEATING DISTRIBUTION

According to the US Department of Energy, steam systems are generally less efficient than hot water heating systems. In addition, hot water heat distribution is generally easier to maintain, is easier to control and is a more comfortable heat source than steam. The distribution water temperature can be adjusted more easily than steam. When it is very cold outside, the water temperature can be high which provides more heat. When the outdoor temperature is cool the distribution temperature can be set back to provide some heat, but not more than is required to make the space comfortable.

It is sometimes possible to convert existing steam distribution pipes to hot water, if the existing steam system is a two-pipe system. If the existing system is not a two-pipe system, then conversion costs can be considerably more expensive. The School should work with an engineer to understand the existing distribution system and opportunities for upgrades.

The costs for converting the existing heat distribution system were not included in the analysis for this report because estimating those costs was beyond the scope of this project. In addition, these are costs that could be incurred regardless of the choice of boiler fuels. Nevertheless, we recommend the School consider converting to a hot water heat distribution system in the future.

THERMAL STORAGE

If the School does convert from steam to hot water heating distribution, then it would have the ability to include thermal storage in the biomass project. Thermal storage systems include large, insulated hot water tanks and ancillary piping and pumps to connect the insulated storage tank to the wood fired boiler and to the building heating system. Heat from the wood boiler is stored in the water in the insulated tank until needed by the building system. This allows the boiler to operate in a high fire state at peak efficiency and then be turned off or to go into a stand-by mode where a minimal amount of fuel is being burned.

The improved efficiency from thermal storage means fuel savings and reduced emissions. A thermal storage system also allows peak load shaving and, as a result, a smaller combustion system can be installed. The stored energy in the tank provides a buffer for peak loads during the day. The boiler loads energy into the tank during periods of low demand. When periods of peak demand occur, the energy stored in the tank responds immediately to the buildings' demand while the wood-fired boiler is reaching a "high fire" state. Then the boiler can provide the additional energy required to meet the peak demand. In commercial or school settings, these peak demand periods are often periods of maximum air exchange with the outdoors.

Additional benefits of the thermal storage system include the ability to extend the operation of the wood combustion system during warmer spring and fall periods, and in some cases, to address summer domestic hot water needs. Additionally solar thermal energy systems can be connected to the storage tank. In fact such combination systems are often used in Europe to meet summer domestic hot water needs and increase overall system efficiency.

PROJECT FUNDING POSSIBILITIES

USDA FUNDING OPPORTUNITIES

2008 Farm Bill

The 2008 Farm Bill has a number of provisions that may help rural communities consider and implement renewable energy and energy efficiency projects.

- **Section 9009** provides grants for the purpose of enabling rural communities to increase their energy self-sufficiency.
- **Section 9013** provides grants to state and local governments to acquire wood energy systems.

These grants and loan guarantee programs are competitive. The School should check with the local USDA office to express interest and to get program updates.

Rural Community Facilities Grant and Loan Program

The USDA provides grants and loans to assist the development of essential community facilities. Grants can be used to construct, enlarge or improve community facilities for health care, public safety and other community and public services. The amount of grant assistance depends on the median household income and the population of the community where the project is located.

These grants and loans are also competitive. Highest priority projects are those that serve small communities, those that serve low-income communities and those that are highly leveraged with other loan and grant awards.

For more information about USDA programs and services, contact your local USDA office. Information on programs and contact information is provided in the *Biomass and Green Building Resources Binder.*

NYSERDA GRANT FUNDING

NYSERDA has announced funding available for high efficiency wood pellet boilers through program opportunity (PON) 2357. This is a valuable opportunity to receive funding for pellet boilers systems, emission control technologies and/or pneumatic wood pellet fuel delivery equipment. Grant proposals for funding are due **November 30, 2011.** You can find an overview of this opportunity in the *Biomass and Green Building Resources Binder* or at http://www.nyserda.org/funding/2357pon.asp.

QUALIFIED SCHOOL CONSTRUCTION BONDS

Qualified School Construction Bonds (QSCB) are awarded through the American Recovery and Reinvestment Act. These no-interest loans can be used for taxpayer approved projects to improve school facilities. The Qualified School Construction Bond program absorbs costs that would otherwise be incurred by schools which have issued voter-approved bonds for construction projects, effectively allowing schools to borrow funds without paying interest. Bondholders are provided with federal tax credits in lieu of the interest that would ordinarily be paid by the school which issues them. Through the program, bondholders receive full return on their investment while schools are able to finance school construction projects less expensively and jobs are created in local communities.

QSCB is winding down and it is not clear at this time whether funds are still available for this program in New York. School officials should contact the New York State Education Department to find out more information. For more information on Qualified School Construction Bonds, contact:

Carl Thurnau
New York State Education Department
cthurnau@mail.nysed.gov
(518) 474-3906

MUNICIPAL LEASE PURCHASE

As a municipal entity, Alexandria Central School may be eligible for a municipal lease/purchase arrangement to finance the anticipated project costs for a biomass heating system. A municipal lease is a contract that has many of the characteristics of a standard commercial lease, with at least two primary differences:

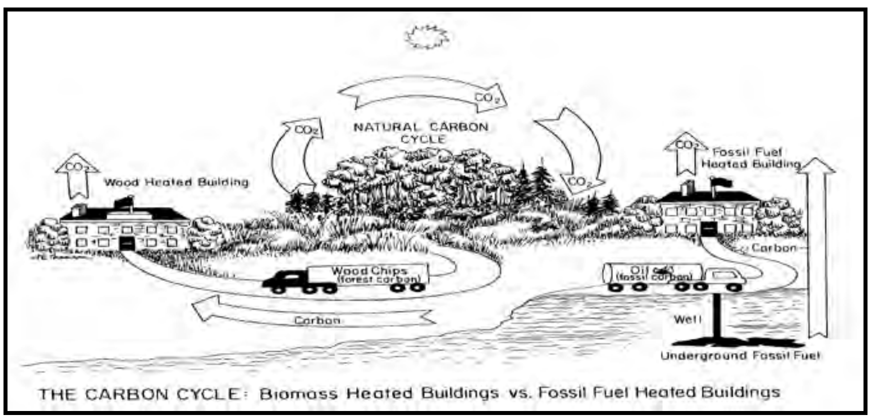
- In a municipal lease, the intent of the lessee is to purchase and take title to the equipment. The financing is a full payout contract with no significant residual or balloon payments at the end of the lease term.
- The lease payments include the return of principal and interest, with the interest being exempt from Federal income taxation to the recipient. Because the interest is exempt from federal tax, a tax-exempt lease offers the lessee a significant cost savings when compared to conventional leasing.

There are a number of companies that provide municipal leases. Information about municipal leases is included in the *Biomass and Green Building Resources Binder* accompanying this report.

CARBON OFFSETS

While fossil fuels introduce carbon that has been sequestered for millions of years into the atmosphere, the carbon dioxide emitted from burning biomass comes from carbon that is already above the ground and in the carbon cycle. Biomass fuels typically come from the waste of some other industrial activity such as a logging operation or from sawmill production. The carbon from this waste would soon wind up in the atmosphere whether it was left to decompose or it was burned as slash. There are few measures Alexandria Central School could undertake that would reduce its carbon footprint more than switching their heating fuel use from fuel oil to a biomass fuel.

Figure 9: Carbon Cycle Illustration[4]



Carbon offsets help fund projects that reduce greenhouse gases emissions. Carbon offset providers sell the greenhouse gas reductions associated with projects like wind farms or biomass projects to customers who want to offset the emissions they caused by flying, driving, or using electricity. Selling offsets is a way for some renewable energy projects to become more financially viable. Buying offsets is a way for companies and individuals to compensate for the CO_2 pollution they create.

For a biomass heat-only project, a Btu-for-Btu displacement of heating fuel (based on historic purchase records) by biomass is assumed over the project's predicted operating life. CO_2 avoidance is based on the emissions profile (Lbs. CO_2 /Btu) of the displaced fuel. The US EPA calculates that 22.2 lbs. of CO_2 is produced from each gallon of fuel oil consumed. It is projected that the Alexandria Central

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[4] Illustration taken from a handout produced by the Biomass Energy Resource Center

School can offset approximately 52,000 gallons of fuel oil per year by replacing that heat using biomass. This is equivalent to about 577 tons of CO_2 annually. The market value of this type of offset is between $3/ton and $5/ton. These offsets can be negotiated as either a lump sum offset for up to 10 years or can be paid out as an annual payment. This could mean annual payments of $1,730 - $2,880 or a lump sum up front payment of as much as $28,800.

There are a number of companies that are interested in contributing to the construction of new sources of clean and renewable energy through carbon offsets. Information about carbon offsets is included in the *Biomass and Green Building Resources Binder* accompanying this report.

PERMITTING

Modern biomass boiler technology is both clean and efficient. Controls moderate both the biomass fuel and air to create either a small hot fire or a large hot fire depending on heat demand from the building. Under full load, modern woodchip boilers routinely operate at steady state efficiencies of 70% – 75%. Operating temperatures in commercial scale biomass boilers can reach up to 2,000 degrees and more, completely eliminating creosote and the need to clean stacks. The amount of ash produced from a 25 ton tractor trailer load of green hardwood chips can fit in a 25 gallon trash can, is not considered a hazardous waste and can be used as a soil amendment on lawns, gardens and playing fields.

However, as with any combustion process, there are emissions from biomass boilers. There is no question that natural gas is the cleanest fuel used for heating. However, biomass compares favorably with fuel oil and modern commercial scale biomass boilers with the appropriate pollution control devices can burn very cleanly and efficiently.

Table 6: Comparison of Boiler Emissions Fired by Woodchips and Distillate Oil[5]

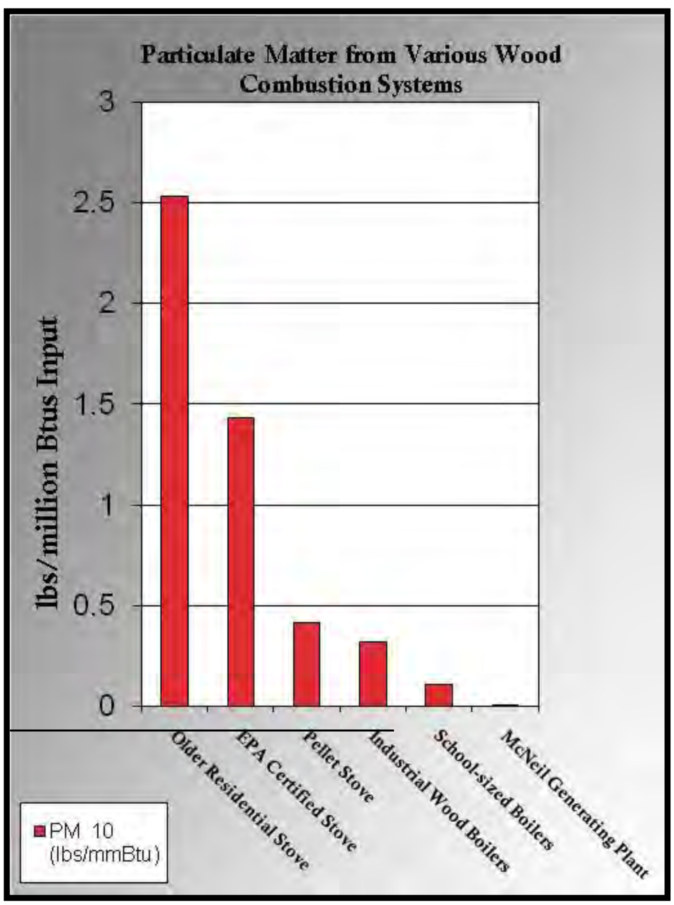
	(Pounds per million Btu output)	
	Wood	Distillate Oil
PM_{10}	0.1000	0.0140
NO_X	0.1650	0.1430
CO	0.7300	0.0350
SO_2	0.0082	0.5000
TOC	0.0242	0.0039
CO_2	gross 220 (net 0)	159

[5] Data excerpted from the paper *An Evaluation of Air Pollution Control Technologies for Small Wood-Fired Boilers* prepared by Resource Systems Group, Inc. White River Jct., VT, for the New York Department of Public Service and others, Revised September 2001.

The pollutant of greatest concern with biomass is particulates (PM_{10}). Biomass boilers clearly generate more particulates than fuel oil or gas boilers. That is why it is important to install appropriate pollution control equipment. Many modern types of emission control equipment, capable of reducing particulate matter emissions from 50-99 percent, are commercially available in the US. The most common emission control equipment technologies are baghouses, cyclones, multi-cyclones, electrostatic precipitators, and wet scrubbers. Appropriate emission control equipment technologies should be identified in consultation with local air quality regulators. The emissions from a modern woodchip boiler are much less than most people think.

One of the most common misconceptions about institutional/commercial biomass energy systems comes from the experience people have with residential wood stoves and outdoor wood boilers. In general, an institutional/commercial-scale wood energy system emits only one fifteenth (seven percent) the PM_{10} of the average wood stove on a Btu basis. Over the course of a year, a large, woodchip heated school in a climate like Vermont may have the same particulate emissions as four or five houses heated with wood stoves.

Figure 10: Particulate Emissions[6]



New EPA Regulations

On February 21, 2011, the Environmental Protection Agency (EPA) issued a final rule that will reduce emissions of toxic air pollutants (including mercury, metals and organic air toxics, including dioxins) from existing and new industrial, commercial and institutional boilers. For area source boilers (those that emit less than 10 tons per year (tpy) of any single air toxic or less than 25 tpy of any combination of air toxics) the EPA is issuing regulations based on boiler design. Biomass boilers with heat input equal to or greater than 10 million Btu per hour must meet emission limits for particulate matter (PM) only.

[6] Excerpted from a handout produced by the Biomass Energy Resource Center

Biomass boilers with heat input less than 10 million Btu must perform a boiler tune-up every two years.

The boilers analyzed in this report are smaller than 10 million Btu – under the new regulations Alexandria Bay would be required to perform a boiler tune-up every two years on the biomass boiler. Starting on September 17, 2011 the EPA requires an *Area Source Notification Form* for new boilers 120 days after the startup of the new boiler. To access the notification form with instructions, go to: www.epa.gov/ttn/atw/boiler/area_**initial_notification**.doc. Up-to-date information on EPA emission requirements is available at: www.epa.gov/airquality/combustion/

In order to install a new woodchip boiler, it is often necessary to obtain an air quality permit or an amendment to an existing permit. For a woodchip boiler, the permit would likely include requirements for pollution control equipment along with a requirement for a tall stack to help with dispersion. Costs for pollution control equipment are included in the cost estimates for the woodchip scenario analysis in this report. Other permit conditions might include testing for emissions and efficiency, keeping records of fuel consumption and test results and making periodic submittals to regulatory agencies.

CONCLUSIONS AND RECOMMENDATIONS

Alexandria Central School appears to be a very good candidate for a biomass heating system. The School is well sited for a biomass boiler house and the existing boiler systems could work well to provide back-up and supplemental heat in combination with a wood fired boiler. We recommend moving forward with a biomass project. We recommend the Alexandria Central School take the following steps to investigate this opportunity further:

1. Hire an engineering firm to help refine the project concept and to obtain firm local estimates on project costs. Further examination should help the School to determine whether a pellet system or woodchip system is more appropriate at this time. The US Forest Service may be able to provide some technical assistance from an engineering team with biomass experience. If the School move forward with this project, decision-makers should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area, to see what assistance can be provided. Contact Lew at (304)285-1538 or lmccreery@fs.fed.us

2. The School should identify any additional heating system improvements it plans to undertake and consider including those projects with the biomass project. It will be more cost effective to implement boiler room upgrades and heating distribution improvements at the same time a new boiler system is installed than it would be to postpone those improvements for a later time.

3. The School should consider energy efficiency improvements simultaneously with boiler upgrades. The efficiency of the building envelope and ventilation equipment need to be considered when sizing new boiler equipment. The New York State Energy Research and Development Authority (NYSERDA) and/or the New York Power Authority (NYPA) should be engaged to develop comprehensive energy efficiency recommendations and proposals for incentives for efficiency upgrades before undertaking a major building project. This should be done regardless of whether or not the district moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives are included in the *Biomass and Green Building Resources* binder accompanying this report.

4. In order to effectively measure progress toward energy efficiency goals historical energy consumption data should be collected and updated frequently. There are many tools to help the School accomplish this. One such tool is the EPA Energy Star *Portfolio Manager* software. It is free public domain software that helps facility managers track energy and water use. This software can be downloaded at:
http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

5. Concurrent with the design of the project, the district should cultivate potential biomass fuel suppliers. There are two pellet manufacturers within 200 miles of Alexandria Bay that can provide the School with pellets if a pellet boiler is installed. If a woodchip boiler is installed, school staff should work with the State of New York Wood Utilization program staff to identify

potential New York woodchip fuel suppliers. Sloane Crawford is the leader of that program. He can be reached at:

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WHO WE ARE

Yellow Wood Associates

Yellow Wood Associates (Yellow Wood) is a woman-owned small business specializing in rural community economic development since 1985. Yellow Wood has experience in green infrastructure, program evaluation, business development, market research, business plans, feasibility studies, and strategic planning for rural communities. Yellow Wood provides a range of services that include measurement training, facilitation, research, and program management.

Richmond Energy Associates

Richmond Energy Associates was created in 1997 to provide consulting services to business and organizations on energy efficiency and renewable energy program design and implementation. Richmond Energy has extensive experience in wood energy systems. Jeff Forward provides analysis and project management on specific biomass projects and works with state, regional and federal agencies to develop initiatives to promote biomass utilization around the country. In addition to his own consulting business, he is also a Senior Associate with Yellow Wood.

APPENDICES

PELLET SENSITIVITY ANALYSIS

Table 7: Annual Fuel Pellet and Fuel Oil Prices Vary

Pellet Cost per ton	# 2 Fuel Oil per Gallon				
	$2.50	$3.00	$3.50	$4.00	$4.50
$180	$52,708	$79,101	$105,493	$131,886	$158,278
$200	$43,902	$70,295	$96,687	$123,080	$149,472
$220	$35,096	$61,489	$87,881	$114,274	$140,666
$240	$26,290	$52,683	$79,075	$105,468	$131,860
$260	$17,484	$43,877	$70,269	$96,662	$123,054

Table 7 (above) is a sensitivity analysis comparing annual fuel savings from the installation of a pellet heating system based on varying prices for pellets and fuel oil. In this analysis the assumed loan interest rate of 4.5% and the inflation rates outlined in the assumptions are held constant. For example, when the cost of fuel oil goes up to $4.00 a gallon and pellets are available at $220 per ton, Alexandria Central School would have annual fuel savings of $114,274.

Table 8 (below) is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a pellet heating system based on varying financing interest rates and fuel inflation rates. In this analysis the cost of $200/ton of pellets and the General Inflation rate of 2.7% are held constant. For example, if the School was able to get a loan for this project with a 3.0% interest rate, and the fuel oil inflation rate stayed at 6.4%, the NPV of the project would increase to $2,930,446. (If Fuel Oil inflation drops to 2.4%, a pellet project would have a negative NPV.)

Table 8: 30-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary

Interest Rate	NPV Relative to Fuel Oil Inflation Rate				
	2.4%	4.4%	6.4%*	8.4%	10.4%
3.0%	($508,122)	$896,800	$2,930,446	$5,899,431	$10,262,481
3.5%	($501,584)	$768,961	$2,600,275	$5,263,679	$9,164,421
4.0%	($496,869)	$654,004	$2,305,660	$4,698,440	$8,190,710
4.5%	($493,693)	$550,458	$2,042,384	$4,195,204	$7,326,144
5.0%	($491,816)	$457,036	$1,806,765	$3,746,551	$6,557,486

*6.4% is the average rate of fuel oil inflation in New York over the past 20 years.

WOODCHIP SENSITIVITY ANALYSIS

Table 9: Annual Fuel Savings When Wood and Fuel Oil Prices Vary

Woodchip $ /Ton	Fuel Oil $ / Gallon				
	$2.50	$3.00	$3.50	$4.00	$4.50
$35.00	$100,529	$126,921	$153,314	$179,706	$206,099
$40.00	$96,038	$122,431	$148,823	$175,216	$201,608
$45.00	$91,548	$117,940	$144,333	$170,725	$197,118
$50.00	$87,057	$113,450	$139,842	$166,235	$192,627
$55.00	$82,567	$108,959	$135,352	$161,744	$188,137

Table 9 is a sensitivity analysis showing the annual savings from the installation of a woodchip boiler based on varying prices for wood and fuel oil. In this analysis the assumed loan interest rate of 4.5% and the inflation rates outlined in the assumptions are held constant. For example, if woodchips cost $45 a ton and Fuel Oil costs $3.50 a gallon, the annual fuel savings will be $144,333. ($3.05 was the average price for #2 fuel oil in Jefferson County from August 2010 – August 2011 and $3.45 is the current price for #2 fuel oil in Jefferson County (August 25, 2011))[7]

Table 10: 30-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary

Interest Rate	Fuel Oil Inflation Rate				
	2.4%	4.4%	6.4%*	8.4%	10.4%
3.0%	$714,160	$1,908,344	$3,636,943	$6,160,580	$9,869,173
4.0%	$441,960	$1,420,202	$2,824,110	$4,857,973	$7,826,403
5.0%	$218,249	$1,024,772	$2,172,042	$3,820,860	$6,210,155
6.0%	$33,104	$702,338	$1,645,710	$2,990,318	$4,924,329
7.0%	($121,182)	$437,692	$1,218,225	$2,321,295	$3,895,687

*6.4% is the average rate of fuel oil inflation in New York over the past 20 years.

Table 10 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a woodchip boiler based on varying financing interest rates and fuel inflation rates. In this analysis the cost of woodchips ($50) and the General Inflation rate of 2.7% are held constant. For example if Alexandria Central School was able to borrow money at 3.0% and the fuel oil inflation rate climbs up to 8.4%, the 30-year net present value of the project would be $6,160,580.

[7] Jefferson County fuel prices obtained from the New York Office of General Services: http://www.ogs.state.ny.us/asp/purchase/snt/fuels/index.asp

WOOD PELLET FUEL

Wood pellets are made from wood waste materials that are compressed into pellets under heat and pressure. Natural plant lignin holds the pellets together without glues or additives. Wood pellets are of uniform size, shape and composition making them easy to store and to burn.

Much of the pellet fuel market is geared toward supplying 40 pound bags for residential scale pellet stoves and boilers. Commercial scale systems typically have bulk storage of pellet fuel that can then be fed into the boiler automatically. Therefore pellet fuel suppliers for a commercial scale system need to have the ability to deliver in self unloading trucks. Commercial scale pellet consumers should identify several pellet fuel manufacturers within a 200 mile radius that have the capability to deliver pellet fuel in bulk. There are two pellet manufacturers within 200 miles of Alexandria Bay, one of which is only 72 miles away from the School. This facility currently provides bulk pellet delivery and has stated that they will offer a 3-year fixed price contract for pellets.

Figure 11: Typical Bulk Pellet Fuel Storage and Delivery[8]

It is best to secure a supplier that will guarantee supply for at least a complete heating season. Distance from the manufacturer will affect cost so generally the closer the supplier, the better the delivered price.

[8] Photo taken from the *Wood Pellet Heating Guidebook* published by Massachusetts Division of Energy Resources.

WOODCHIP FUEL

Purchasing wood fuel is a different exercise than purchasing fossil fuels. While conventional fuels are delivered to the site with little interaction from facility managers, biomass fuel suppliers will need to be cultivated and educated about the type of fuel needed, its characteristics and the frequency of deliveries. Concurrently with designing a wood-energy system, Alexandria Central School should also be cultivating potential biomass fuel suppliers.

Potential wood fuel suppliers include sawmills, loggers, chip brokers and large industrial users such as paper mills or power plants. Many of these forest products producers already make woodchips for pulp and to reduce waste, but may not have much experience dealing with the needs of smaller volume customers. Woodchips produced for institutional/commercial biomass boilers have more stringent specifications than those produced for large industrial customers. And woodchip fuel may need to be delivered in different trailers.

When talking to potential woodchip fuel suppliers, it is important to have the wood fuel specification in mind. A one to three inch square chip is ideal. If possible, woodchips for institutional/commercial biomass systems will come from logs that are debarked prior to chipping because bark produces more ash which translates into a little more daily maintenance. Pieces or small branches that are six inches or longer can jam augers and conveyors which will interrupt the operation of automated fuel handling equipment. Institutional/commercial scale biomass boiler systems in the Northeast are typically designed to operate with wood fuel that is within a 35% to 45% range for moisture content.

Typically institutional/commercial biomass systems of this scale have limited chip storage capacity which means they may need deliveries on relatively short notice. Woodchip fuel suppliers will need to be within a 100 to 150 mile radius or so of the user, the closer the better, as transportation costs will affect price. Chip deliveries are typically made in "live bottom" trailers that will self unload into below-grade chip storage bins. Therefore, potential suppliers must have access to a self-unloading trailer for deliveries.

It is possible to design a wood-energy system that uses any one of a variety of biomass fuels, but green hardwood chips make the best fuel. If it is readily available, it should be the fuel of choice. In addition, users should focus on reliability of supply and consistency of the fuel rather than just lowest cost. The goal should be to minimize maintenance and optimize system performance.

Whichever fuel is used, the fuel type needs to be part of the combustion system design process, and the wood system should be operated using the fuel it is set up to use. Ideally, sample fuel chips should be sent to the manufacturer of the biomass heating equipment so that they can design the fuel handling equipment around the type of fuel and calibrate the system properly when setting the system up. No system handles widely varying fuel types at the same time very well. A system can be re-calibrated for a different fuel type, but the most practical approach is to stick with one fuel type, at least for a given heating season. If, for some reason, that fuel type becomes unavailable, the manufacturer of the equipment should be consulted to help reconfigure or retune the system for another fuel.

It is best to try to locate several potential suppliers. By doing so, the School will have the security of knowing there will be back-up in case of an interruption from their primary supplier. This will also generate some competition. Contact the New York State Forest Utilization Program (http://www.dec.ny.gov/lands/4963.html) for a list of local suppliers.

The bottom line is that both the School and fuel suppliers need to clearly understand the characteristics of fuel needed for their particular system. Consistent particle size and moisture content is particularly important for institutional/commercial customers, and Alexandria Central School should insist on the quality of the chip. A sample fuel specification is included in the *Biomass and Green Building Resources Binder* to give an idea of the types of characteristics to look for in woodchip fuel. Below is a description of the advantages and disadvantages of different types of biomass fuels in order of preference.

Green Hardwood Chips

A consistent green hardwood chip is the easiest fuel for institutional/commercial scale automated biomass heating systems to handle. Rarely will they jam an auger or conveyor. Green chips burn somewhat cooler than most other biomass fuels making it easier to control the combustion. With proper controls, they burn very cleanly with minimal particulate emissions and little ash. They have less dust than other biomass fuels so they are less messy and safer to handle. Ideally moisture content will be between 35% and 45% on a wet basis. Green hardwood chips can come from sawmill residues or timber harvest operations.

Mill Residues vs. Harvest Residues

Woodchips can be produced at sawmills or other primary wood products industrial sites as part of their waste wood disposal process. Mill residues are typically the most desirable source of fuel woodchips. Mills can produce a bark-free chip with few long pieces or branches that can jam augers and fuel conveyors. A mill supplier can easily calculate trucking costs and can negotiate dependable delivery at a consistent price.

Another potential type of wood fuel is whole tree chips which are produced as part of tree harvesting. Whole tree chips tend to be a dirtier fuel than sawmill residues and may contain small branches, bark, twigs and leaves. The longer pieces can jam the relatively small augers of an institutional/commercial scale biomass system and can add to the daily maintenance because they produce more ash.

The bole of a tree is the de-limbed trunk or stem. Chips made from boles are in-between the quality of a sawmill chip and a whole tree chip. Bole-tree chips tend to have fewer twigs and long stringers than whole tree chips. Both bole-chips and whole-tree chips can be potentially good sources for biomass fuels, although they have a greater likelihood of including oversized chips and they will produce somewhat more ash, compared to mill residues.

Softwood Chips

Green softwood chips will generally have less energy and more water content per truckload, and therefore they will be more expensive to transport than hardwood chips. As long as the combustion and fuel handling equipment is properly calibrated for softwood chips, an automated woodchip heating system can operate satisfactorily with softwood chips. Softwoods tend to have higher moisture contents and can range up to 60% moisture on a wet basis. The best biomass fuel will have less than 50% moisture. One species to avoid altogether is white pine. It has a very high moisture content and therefore relatively low bulk density. The experience in Vermont schools with white pine is that it is a poor biomass fuel for institutional/commercial-scale woodchip systems.

Dry Chips vs. Green Chips

Dry chips (less than 20% moisture on a wet basis) burn considerably hotter than green chips and typically have more dust. The increased operating temperature can deteriorate furnace refractory faster increasing maintenance costs slightly. The dust can make for a somewhat dirtier boiler room which will be a problem for some maintenance staff. Dry chips are also easier to accidentally ignite in the fuel storage bin or fuel handling system. If dry chips are used, the combustion equipment needs to be carefully calibrated to handle these higher temperatures. Dry chips are not generally recommended for institutional/commercial settings.

Bark

Bark has a high energy value, but it also comes with significant maintenance costs. It produces a considerable amount of ash that needs disposal; it can create more smoke than green chips; and it can cause other routine maintenance problems such as frequent jamming of augers from rocks. Bark can be an inexpensive fuel, but the additional maintenance costs make it unattractive for institutional/commercial biomass systems.

Sawdust and Shavings

Sawdust and shavings should ordinarily be ruled out for the institutional/commercial wood heating market. Dry sawdust can be dusty to handle and raises fire safety and explosion issues. Shavings are also dusty and easily ignited and are difficult to handle with typical fuel handling equipment. This fuel type can work fine in an industrial setting, but institutions typically do not have the maintenance staff that can provide the supervision that these fuels need.

Ground or "Hog" Fuel

Ground or "Hog" fuel is common in the logging industry. It is typically made by grinding any manner of woody material by using a "tub grinder". Hog fuel does not typically make good wood fuel for institutional scale biomass energy systems. The fuel is "dirty" meaning there are many contaminants such as bark, dirt, gravel and foreign objects. The material is typically rough and is irregularly shaped making it difficult to handle in the relatively small augers and conveyors of institutional scale wood fuel handling equipment. Additionally, since the fuel might come from a variety of sources, hog fuel can have a wider range of moisture content than wood chip fuel. Hog fuel can work well in industrial biomass energy systems, but institutions typically do not have the maintenance staff that can deal with these kinds of fuels.

BIOMASS AND GREEN BUILDING RESOURCES BINDER

TABLE OF CONTENTS

- **Biomass Energy Resources**
  - Carbon Dioxide and Biomass Energy
  - Air Emissions from Modern Wood Energy Systems
  - Information on Air Pollution Control Technology for Woody Biomass Boilers
  - EPA Institutional Boilers Fact Sheet
  - Sample Woodchip Specification
  - North America's Wood Pellet Sector - USDA
  - Pellet Fuel – Pellet Fuels Institute
  - The Wider World of Pellet Fuel – Pellet Fuels Institute
  - Pellet Fuel Standards – Pellet Fuels Institute
  - Demonstration and Public Education at the W!ld Center – NYSERDA
  - *Commercial-Scale Biomass Boilers Market Growing in the Northeast – David Dungate, Northeast Sun*
  - Wood Pellet Heating Guide Book (ON ENCLOSED CD)
  - Directory of Primary Wood-Using Industry in New York (ON ENCLOSED CD)
  - Emission Controls for Small Wood Fired Boilers (ON ENCLOSED CD)
  - Biomass Boiler and Furnace Emissions and Safety Regulations in the Northeast States (ON ENCLOSED CD)
  - Woodchip Heating Systems, *A Guide for Institutional and Commercial Installations* (ON ENCLOSED CD)