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

WERC
Wood Education and Resource Center
310 Hardwood Lane
Princeton, WV 24740
304-487-1510
www.na.fs.fed.us/werc

Preliminary Feasibility Report

Biomass Heating Analysis for Potsdam Central School

Potsdam, New York

Prepared by:

YELLOW WOOD associates, inc.
228 North Main Street
St. Albans, VT 05478
Phone: (802)524-6141
www.yellowwood.org

Richmond Energy Associates, LLC
2899 Hinesburg Road
Richmond, VT 05477
Phone: (802) 434-3770

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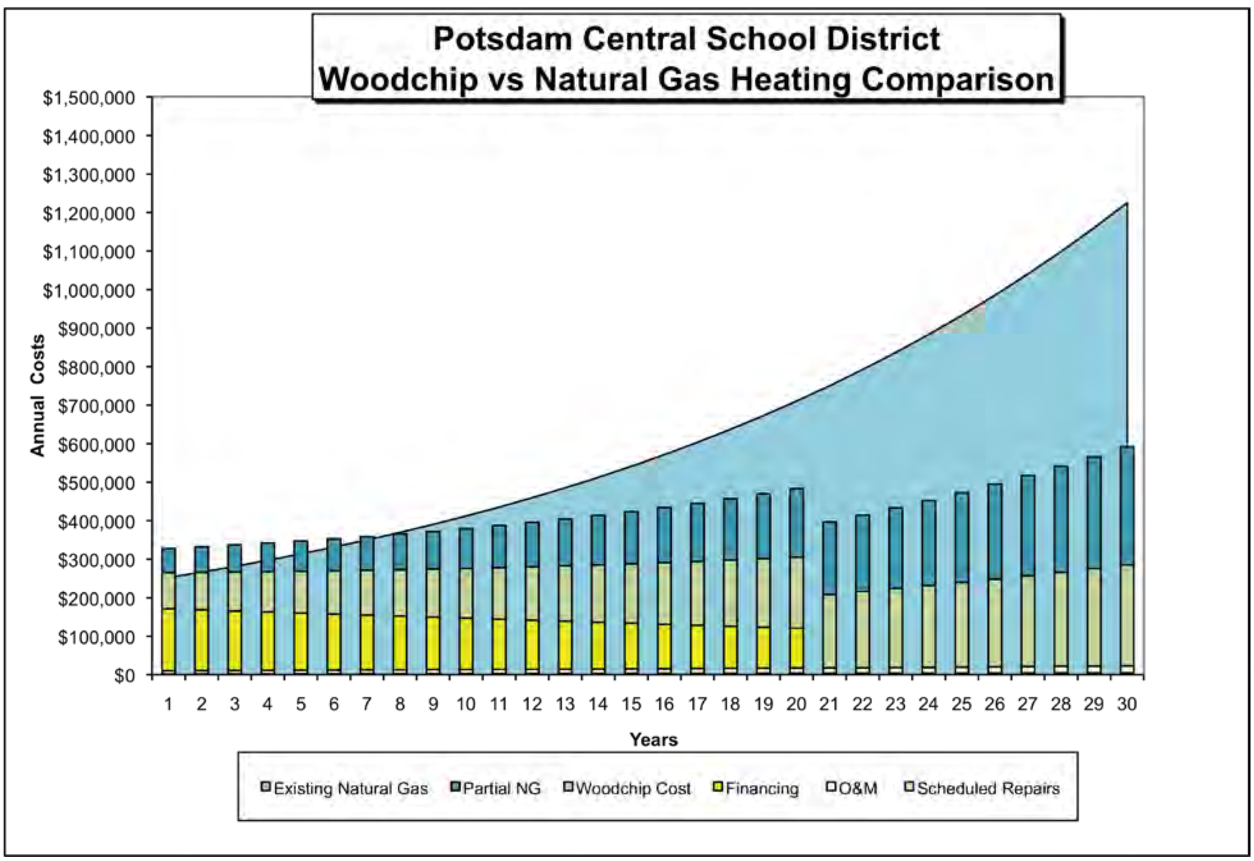
EXECUTIVE SUMMARY

Potsdam Central School is a school campus housing an Elementary School, Middle School, High School and Bus Garage located in Potsdam, New York. The school has approximately 385,000 square feet of conditioned space in these four buildings and heat is provided by four hot water boilers and three steam boilers. All boilers run on natural gas. The boilers are all between 12 and 15 years old and maintenance staff report that they are in good condition.

Over the last three heating seasons, Potsdam used an average of 219,480 therms of natural gas annually to heat these four buildings The average price paid by the school over the past three years was $1.15 per therm. At that price Potsdam will spend more than $252,000 on natural gas this coming year to heat its school campus.

The analysis provided in this report indicates that Potsdam Central School could save more than $2.7 million in operating costs over 30 years in today's dollars even when the cost of financing is included. The analysis shows over $95,000 in fuel savings in the first year alone.



Potsdam Central School appears to be a good candidate for a woodchip heating system. There is a good location to build a boiler house for a new woodchip boiler and chip storage facility that could service all buildings on the campus. The existing boiler systems could work well to provide back-up and supplemental heat in combination with a wood fired boiler. The school has good access to reasonably priced woodchip fuel. We recommend Potsdam 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.
2. Costs for upgrading from steam to hot water heating distribution in portions of the high school were not included in the analysis because it was beyond the scope of this study. However, the school should consider converting these portions of the school to hot water regardless of whether or not they proceed with a biomass boiler project. If the district does proceed with a biomass project, any planned improvements to the existing heating system should be done at the same time, as it will be the least costly time to do so.
3. It is our understanding that the district is engaged in updating its capital plan. At the very least, the district should include upgrading the heating distribution system in the high school. The district should also consider including a biomass boiler project in the 2010 capital plan.
4. If the district moves forward with a biomass project, it may want to consider decommissioning some of the existing natural gas boilers after facility staff have had some experience with the biomass equipment. Savings from salvaging the existing boilers were not included in the analysis.
5. The US Forest Service may be able to provide some engineering technical assistance from an engineering team with biomass experience that is part of the program that funded this study. If the district moves forward with this project, they should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area to see what assistance can be provided. His contact information is: 304-285-1538, lmccreery@fs.fed.us.
6. Regardless of whether the district moves forward with a biomass energy system, it should consider energy efficiency improvements. 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 is included in the *Biomass and Green Building Resources* binder accompanying this report.
7. 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 district 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.
8. Concurrent with the design of a biomass project, Potsdam should investigate potential woodchip fuel providers. The New York State Forest Utilization Program maintains an up to date list of

biomass fuel suppliers. Their contact information is included in the appendices at the end of this report.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates, LLC for Potsdam 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 the Potsdam Central School outlining whether or not woodchip heating makes sense for this facility from a practical perspective. In June 2010, staff from Yellow Wood Associates traveled to Potsdam, NY 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.

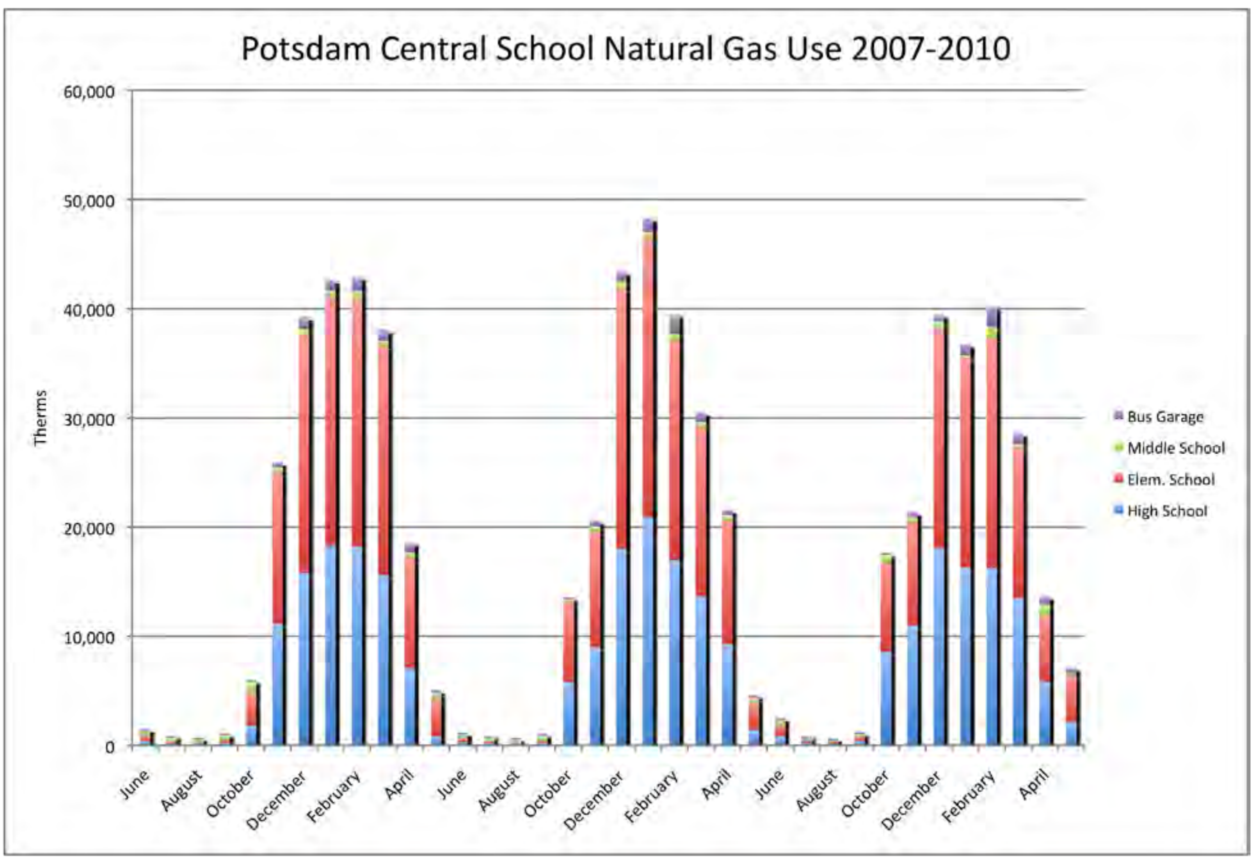
This preliminary feasibility study was prepared by Yellow Wood Associates and Richmond Energy Associates, LLC.

ANALYSIS ASSUMPTIONS

DESCRIPTION OF THE EXISTING HEATING SYSTEM

The Potsdam Central School serves grades K-12 with an Elementary School, Middle School, High School and bus garage in Potsdam, NY. The school houses approximately 1,500 students in the 178,000 square foot High School, 98,000 square foot Middle School and 95,000 square foot Elementary School. The Middle School and Elementary School are connected and have a centralized heating system run by three 167 BHP hot water boilers. The high school is heated by three 167 BHP steam boilers. The majority of the high school distribution has been switched over to hot water but there is still a portion of the high school heated by steam. The bus garage, located adjacent to the middle school, is heated by one 56.9 HP hot water boiler. All boilers run on natural gas. Over the last three heating seasons, the district used an average of 219,480 therms of natural gas annually to heat these four buildings.

Figure 1: Annual Fuel Use



DESCRIPTION OF THE PROPOSED BIOMASS SYSTEM

The biomass scenario envisions building a 2,500 square foot stand-alone boiler house and chip storage facility, which would house a 6.0 mmBtu woodchip hot water boiler, woodchip fuel storage and fuel handling equipment to feed the boiler automatically. A single biomass system would serve all four buildings via insulated underground piping. It was assumed that the woodchip boiler would be able to supply 75% of the facility's annual heating needs. The scenario assumes the existing boilers would remain to provide back-up heat for the shoulder seasons and supplemental heat during the coldest days of the year if necessary. Figure 2 shows the suggested boiler house location.

Figure 2: Proposed Biomass Boiler Location

Hot water from the woodchip boiler house would be tied into the exiting HVAC systems via approximately 1,100 feet of underground insulated piping. Costs for a tall stack were included to ensure good emissions dispersal. 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 thermal storage system is included in the capital cost estimate for this study. In this case the thermal storage system includes a large, insulated hot water tank and ancillary piping and pumps that connect the insulated storage tank to the wood fired boiler and to the buildings 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. This improved efficiency means fuel savings and reduced emissions. The 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 provides 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 combi-systems are often used in Europe to meet summer domestic hot water needs and increase overall system efficiency.

A healthy construction contingency, standard general contractor mark-up and professional design fees were also included. Below are examples of the type of recommended building and buried insulated piping.

Figure 3: Williamstown, VT High School Woodchip Boiler Plant

Figure 4: Underground Insulated District Energy Piping[1]

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 analysis performed for this facility compares 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 alternative biomass scenario envisions building a stand-alone biomass boiler house and chip storage facility near the bus garage that would serve the entire Potsdam Central School campus. The scenario includes all ancillary equipment and interconnection costs. Under the biomass scenario, the existing

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

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. It was assumed that the biomass boiler would serve the vast majority of the load during the year and that the existing natural gas boilers would receive minimal use. After the district has had some experience with the biomass equipment, it may want to consider decommissioning some of the natural gas boilers or even selling them. These boiler have been well maintained and have good value. However, savings from salvaging the existing boilers were not included the analysis.

The analysis projects current and future annual natural gas heating bills and compares 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 boiler facility. It is recommended that for a project of this scale, Potsdam Central 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 scenario are generic estimates based on our experience with similar scale projects.

NATURAL GAS COST ASSUMPTIONS

Fuel bills provided by the Potsdam Central School indicate that Potsdam used an average of 219,480 therms of natural gas per year to heat the buildings being considered in this analysis over the past three heating seasons. This is the assumed annual fuel consumption used for the base case in the analysis. Over the past three years, Potsdam paid an average of $1.15 per therm of natural gas; the biomass scenario in this study uses this price for the first year of the analysis. At that price, Potsdam will spend more than $252,000 for natural gas to heat this campus next year.

WOODCHIP FUEL COST ASSUMPTIONS

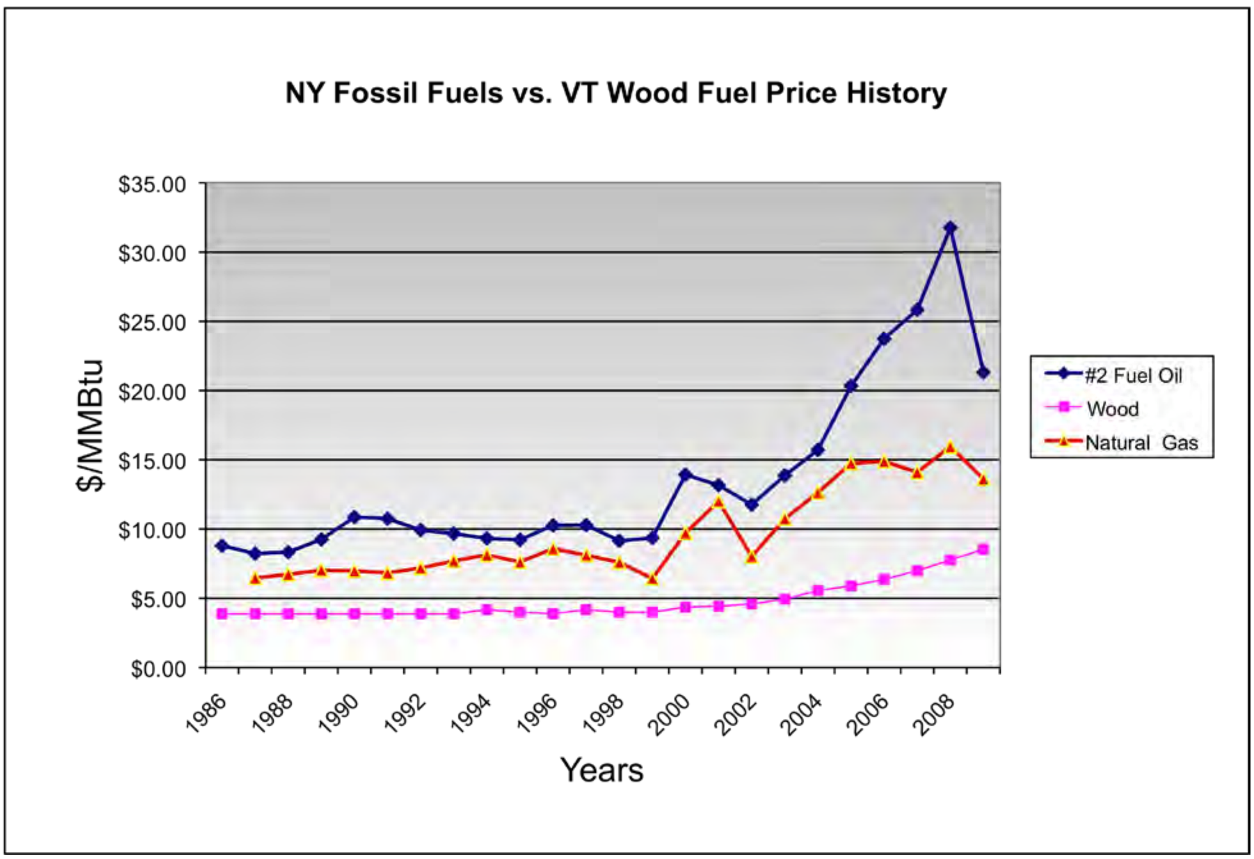
Frequently, operators of institutional woodchip systems don't fire up their biomass boilers until there is constant demand for building heat. During the fall and spring, fossil fuel boilers are often used as they are easier to start up and turn down. Woodchip boilers are then typically used in place of fossil fuel boilers for the bulk of the winter heating season. In Vermont where there are over 40 schools that heat with wood, the average annual wood utilization is about 85%. The woodchip scenario in this study assumes the facility will meet 75% of the winter heating needs for the school with woodchips and therefore consume 1,881 tons of chips per year. 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 $0.46 per therm of natural gas. The remaining 25% of the heating needs were then assumed to be provided by the existing natural gas boilers consuming about 55,000 therms of natural gas. The cost for supplemental natural gas 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 – 2009) using US Energy Information Agency data and found that the average annual increase for natural gas in New York was 5.6% per year. The analysis projects this average inflation rate for natural gas forward over the thirty-year analysis period. Potsdam's fuel rate of $1.15/therm was used for the first year of the analysis and then inflated each year at 5.6%.

Figure 5: Woodchip and Fossil Fuel Inflation



The overall Consumer Price Index for the period between 1990 and 2009, the last year for which full data is available, increased an average of 2.6% 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.

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 $55/ton in the period between 1990 and 2009. The average annual increase during this period was about 3.6% annually[2] 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. For the analysis in this report the cost of woodchip fuel was inflated 3.6% annually for the thirty years of the analysis.

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[3] 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.

Another operations and maintenance cost that is included in the analysis is periodic repair or replacement of major items on the boiler such as the furnace refractory. It is reasonable to anticipate these types of costs on a 10-15 year cycle. For this analysis, $25,000 of scheduled maintenance was anticipated in years 10, 20 and 30 and then annualized at $2,500 per year to simulate a sinking fund for major repairs. This $2,500 was then inflated at the general annual 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 natural gas boilers were taken into consideration as these are considered costs that

[2] Extrapolated from Vermont Superintendent Association School Energy Management Program data. Vermont wood chip price history is used because it is one of the only states that has this historical data.

[3] 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.

Potsdam Central 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 most of Potsdam Central School's boilers are 12 years old, it will be important to take this into consideration when timing the project. Even if the biomass boiler is not eligible for state school construction aid, the savings for this project may be so compelling that district decision makers may feel the project is worthwhile. In any event, the district should consult state officials about any planned construction project and get their determination on state aid directly from SED. At the very least, the district should consider including a biomass boiler project in its capital plan for when the existing boilers are fully depreciated.

For the analysis in this report, it was assumed that this project would receive no state school construction aid and that the local district would finance the entire project.

FINANCING ASSUMPTIONS

Financing costs were included in the analysis to give district decision makers a sense of how this project may impact their annual budget. Public schools typically have access to long-term, low interest bond financing. It was assumed that Potsdam Central School would be able to obtain a 20 year bond for the capital costs for the biomass project at an interest rate of 3%. The bond payment schedule that was used has fixed principal payments and variable interest payments. Other financing schedules could create even more favorable cash flows depending on how much of the project costs are financed and how the remaining financing is structured. If the district were to finance a smaller portion of the project, the annual savings would be greater.

BIOMASS SCENARIO ANALYSIS

The analysis shows that the district could save more than $2.7 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 project to be more than $95,000 per year in the first year and should increase over time as natural gas prices continue to climb. If fuel prices increase as projected, the project will have a positive annual cash flow within 8 years.

Table 1: Woodchip Scenario Analysis Assumptions

Potsdam Central School					
Capital Cost Assumptions					
6.0 mmBtu woodchip hot water boiler system including installation					$600,000
70 ft stack					$35,000
Underground insulated hot water lines	$150	/LF	1,100	LF	$165,000
Pollution control equipment					$125,000
Biomass boilerhouse and chip storage building	$150	/SF	2,500	SF	$375,000
Thermal storage 6,000 gallon					$60,000
Interconnect to existing boiler systems					$75,000
GC markup at 10%					$143,500
Construction contingency at 15%					$236,775
Design at 12%					$217,833
Total estimated project costs					$2,033,108
State Aid at		**0%**			$0
Total Local Share					$2,033,108
Financing Costs					
Financing, annual interest rate					3.0%
Finance term (years)					20
1st full year debt service					$162,649
Fuel Cost Assumptions					
Current annual natural gas consumption in therms					219,480
Assumed natural gas price per therm					$1.15
Projected annual natural gas bill					$252,402
Assumed woodchip price in 1st year (per ton)					$50
Projected 1st year woodchip fuel bill					$94,063
Projected 1st year supplemental natural gas bill					$63,101
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.6%
Natural gas inflation rate					5.6%
Woodchip inflation rate (average increase in VT from 1990 - 2009 for woodchips is 3.6%)					3.6%
O&M Assumptions					
Annual woodchip O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance					$8,375
Major repairs (annualized)					$2,500
Savings					
Net 1st year fuel savings					**$95,239**
Total 30 year NPV cumulative savings					**$2,783,218**

Figure 6: Annual Cash Flow Graph for Woodchip Scenario

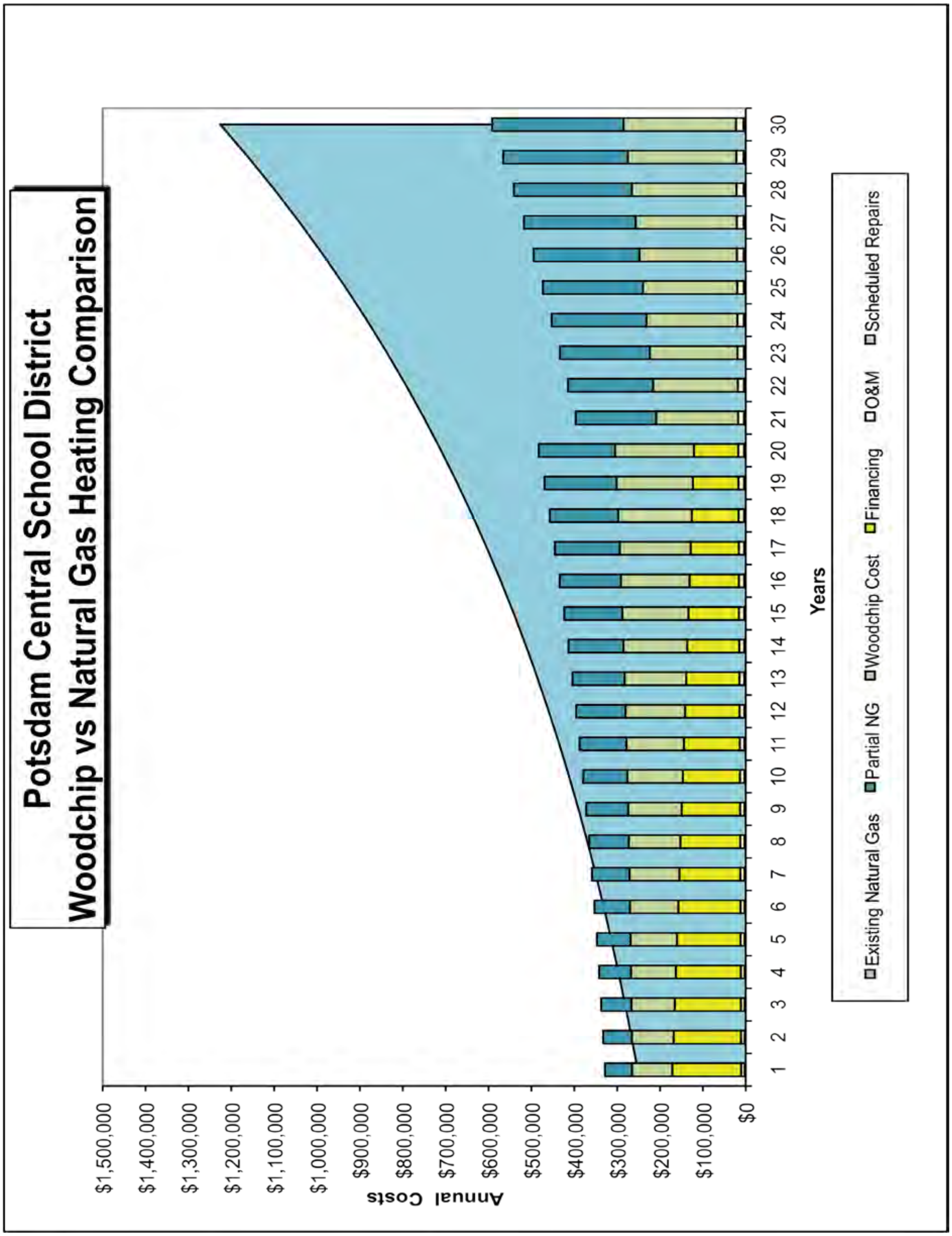


Table 2: 30-Year Life Cycle Analysis Spreadsheet for Woodchip Scenario

Potsdam Central School — **Preliminary Life Cycle Cost Estimate** — ***Woodchip - Heat Only***

Total estimated construction costs	***$2,033,108***	*Estimated state aid* **$0**	
Local Share:	**$2,033,108**		
Financing:	**3.0%**	*Assumed 20 year bond interest rate*	
Equivalent Natural Gas consumption	**219,480**		25% NG = 54,870 therms
Projected first year price of Natural Gas	**$1.15**	/therm in year 1	2,508 tons if 100% woodchips for NG
Projected first year cost of Natural Gas	**$252,402**		88 therms/ton of woodchips
Estimated woodchip utilization	**75%**		
Projected woodchip consumption	**1,881**	tons	
Estimated 1st year woodchip price	**$50**	/ ton Year 1	
Projected 1st year woodchip cost	**$94,063**		
Projected 1st year partial NG cost	**$63,101**		
General Inflation:	**2.6%**	**annually**	*Twenty year average annual US Labor Dept. Consumer Price Index increases*
Natural Gas Inflation	**5.6%**		*Average Increase for New York Commercial NG users from 1991 - 2009 (US EIA)*
Woodchip Inflation:	**3.6%**	**annually**	*Average increase in VT from 1990 - 2009 for woodchips is 3.6%*
O & M.:	**$8,375**	**in Year 1 $**	*Estimate of additional electricity for feed system motors and additional maintenance staff time*
Major Repairs:	**$2,500**		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*

Yr.	If NG Cost	Financing	Woodchip Cost	Partial NG Cost	O&M	Scheduled Repairs	Total	Annual Cashflow	Cumulative Cashflow
1	$252,402	$162,649	$94,063	$63,101	$8,375	$2,500	$330,687	-$78,285	-$78,285
2	$266,537	$159,599	$97,449	$66,634	$8,593	$2,565	$334,840	-$68,303	-$146,588
3	$281,463	$156,549	$100,957	$70,366	$8,816	$2,632	$339,320	-$57,858	-$204,446
4	$297,224	$153,500	$104,592	$74,306	$9,045	$2,700	$344,143	-$46,919	-$251,365
5	$313,869	$150,450	$108,357	$78,467	$9,281	$2,770	$349,325	-$35,456	-$286,821
6	$331,446	$147,400	$112,258	$82,861	$9,522	$2,842	$354,884	-$23,438	-$310,259
7	$350,007	$144,351	$116,299	$87,502	$9,769	$2,916	$360,837	-$10,831	-$321,089
8	$369,607	$141,301	$120,486	$92,402	$10,023	$2,992	$367,204	$2,403	-$318,687
9	$390,305	$138,251	$124,823	$97,576	$10,284	$3,070	$374,005	$16,300	-$302,387
10	$412,162	$135,202	$129,317	$103,041	$10,551	$3,150	$381,260	$30,902	-$271,485
11	$435,243	$132,152	$133,973	$108,811	$10,826	$3,232	$388,993	$46,251	-$225,234
12	$459,617	$129,102	$138,796	$114,904	$11,107	$3,316	$397,225	$62,392	-$162,842
13	$485,355	$126,053	$143,792	$121,339	$11,396	$3,402	$405,982	$79,374	-$83,469
14	$512,535	$123,003	$148,969	$128,134	$11,692	$3,490	$415,288	$97,247	$13,779
15	$541,237	$119,953	$154,332	$135,309	$11,996	$3,581	$425,172	$116,066	$129,844
16	$571,546	$116,904	$159,887	$142,887	$12,308	$3,674	$435,660	$135,886	$265,731
17	$603,553	$113,854	$165,643	$150,888	$12,628	$3,770	$446,784	$156,769	$422,500
18	$637,352	$110,804	$171,607	$159,338	$12,957	$3,868	$458,573	$178,779	$601,279
19	$673,044	$107,755	$177,784	$168,261	$13,293	$3,968	$471,062	$201,982	$803,261
20	$710,734	$104,705	$184,185	$177,684	$13,639	$4,071	$484,284	$226,451	$1,029,711
21	$750,535		$190,815	$187,634	$13,994	$4,177	$396,620	$353,915	$1,383,627
22	$792,565		$197,685	$198,141	$14,358	$4,286	$414,469	$378,096	$1,761,723
23	$836,949		$204,801	$209,237	$14,731	$4,397	$433,167	$403,782	$2,165,505
24	$883,818		$212,174	$220,955	$15,114	$4,512	$452,754	$431,064	$2,596,569
25	$933,312		$219,812	$233,328	$15,507	$4,629	$473,276	$460,036	$3,056,605
26	$985,577		$227,726	$246,394	$15,910	$4,749	$494,779	$490,798	$3,547,403
27	$1,040,770		$235,924	$260,192	$16,324	$4,873	$517,313	$523,457	$4,070,860
28	$1,099,053		$244,417	$274,763	$16,748	$4,999	$540,928	$558,125	$4,628,985
29	$1,160,600		$253,216	$290,150	$17,183	$5,129	$565,679	$594,921	$5,223,906
30	$1,225,593		$262,332	$306,398	$17,630	$5,263	$591,623	$633,970	$5,857,876
Totals	$18,604,012	$2,673,537	$4,936,471	$4,651,003	$373,601	$111,523	$12,746,135	$5,857,876	
	$10,800,086	$2,033,108	$2,984,198	$2,700,022	$230,681	$68,860	$8,016,868	$2,783,218	
	30 Yr. NPV at	3%	Discount Rate						

Total Annual Heating Costs	Woodchip Fuel /Year	Partial Natural Gas First Year	Woodchip System O&M /yr	Contingency Allowance / Year	Woodchip + NG + O&M + Contingency	Annual Fuel Cost Savings	Local Share Cost	Simple Payback (yrs)	30 Yr. NPV Savings
$252,402	$94,063	$63,101	$8,375	$2,500	$168,038	$95,239	$2,033,108	21.3	$2,783,218

ADDITONAL ISSUES TO CONSIDER

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 Environmental Protection Agency developed a public domain software program called *Portfolio Manager* that 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. Richmond Energy 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 Potsdam converts to biomass or stays with natural gas, the school 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 NYSERDA and NYPA programs is included in the *Biomass and Green Building Resources* binder accompanying this report.

To give an idea of the benefits of energy efficiency in schools, an Energy Efficiency Case Study for the U-32 Junior/Senior High School is included in the *Biomass and Green Building Resources* binder accompanying this report.

CAPITAL PLANNING

It is our understanding that the district is engaged in a capital planning effort for all its facilities. The existing boilers are 12 years old and will be fully depreciated in another two or three years. If the district does not move forward with a biomass project at this time, it should consider including a biomass boiler in the plan for when the existing boilers are fully depreciated. Once the district is eligible for state school construction aid, the local economics of the project could improve significantly.

HEATING SYSTEM UPGRADES

Costs for upgrading from steam to hot water heating distribution in portions of the high school were not included in the analysis because it was beyond the scope of this study. However, the school should consider converting this portion of the school to hot water regardless of whether or not they proceed with a biomass boiler project. If the district does proceed with a biomass project, any planned improvements to the existing heating system should be done at the same time as it will be the least costly time to do so.

COMMISSIONING

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 recommend that Potsdam Central 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.

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 their 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.

QUALIFIED SCHOOL CONSTRUCTION BOND

Qualified School Construction Bonds 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 school districts which have issued voter-approved bonds for construction projects, effectively allowing districts 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 districts which issues them. Through the program, bondholders receive full return on their investment while school districts are able to finance school construction projects less expensively and jobs are created in local communities.

For more information on Qualified School Construction Bonds, contact:
Carl Thurnau
cthurnau@mail.nysed.gov
(518) 474-3906

MUNICIPAL LEASE / PURCHASE

As a municipal entity, Potsdam 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:

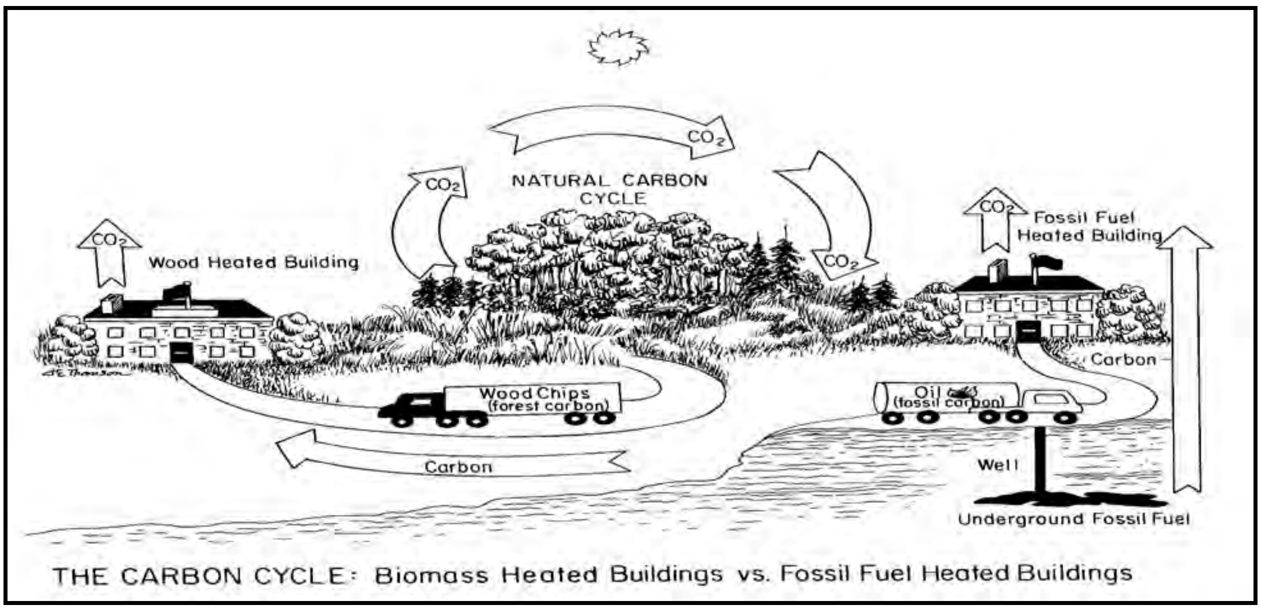
- In a municipal lease, the intent of the lessee is to purchase and take title to the equipment. The financing is a full payout contract with no significant residual or balloon payments at the end of the lease term.
- The lease payments include the return of principal and interest, with the interest 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 Potsdam Central School could undertake that would reduce its carbon footprint more than switching their heating fuel use from natural gas to a biomass fuel.

Figure 7: 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 11.7 lbs. of CO_2 is produced from each therm of natural gas consumed. It is projected that the Potsdam Central

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

School can offset approximately 165,000 therms of natural gas per year by replacing that heat using biomass. This is equivalent to about 965 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 $2,800 - $4,800 or a lump sum up front payment of as much as $28,000 to $48,000.

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

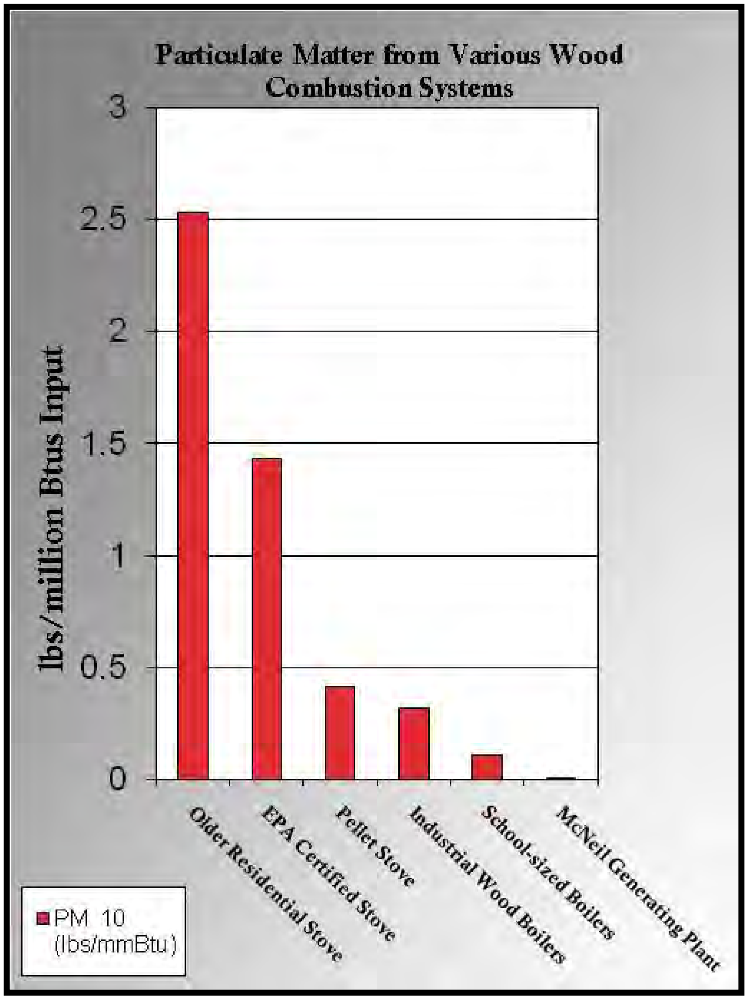
Modern biomass boiler technology is both clean and efficient. Controls moderate both the biomass fuel and air to create either a small hot fire or a large hot fire depending on heat demand from the building. Under full load, modern woodchip boilers routinely operate at steady state efficiencies of 70% – 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.

As with any combustion process, there are emissions from biomass boilers. The pollutant of greatest concern with biomass is particulates (PM_{10}). While biomass compares reasonably well with fuel oil, biomass boilers clearly generate more particulates. 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 8: Particulate Emissions[5]



New EPA Regulations

On April 29, 2010, the Environmental Protection Agency (EPA) issued a proposed rule that would reduce emissions of toxic air pollutants from existing and new industrial, commercial and institutional boilers located at area source or major source facilities. An area source facility emits or has the potential to 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 major source facility emits or has the potential to emit 10 or more tpy of any single air toxic or 25 tpy or more of any combination of air toxics.

The proposal would set different requirements for large and small boilers at the area source facility. Large boilers have a heat input capacity equal to or greater than 10 mmBtu/hr and small boilers have a heat input capacity less than 10 mmBtu/hr. The biomass fired new boilers would need to meet limits for PM and CO. For the major source facility, EPA has identified 11 different subcategories of boilers and process heaters based on the design of the various types of units. The proposed rule would include specific requirements for each subcategory.

Details on the status of this proposal will be posted 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, such as a bag house along with a requirement for a tall stack to help with dispersion. Costs for pollution control equipment and a 70 foot tall stack are included in the cost estimates for both woodchip scenario analyses 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.

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

CONCLUSIONS AND RECOMMENDATIONS

Potsdam Central School appears to be a good candidate for a woodchip heating system. There is a good location to build a boiler house for a new woodchip boiler and chip storage facility that could service all buildings on the campus. The existing boiler systems could work well to provide back-up and supplemental heat in combination with a wood fired boiler. The school has good access to reasonably priced woodchip fuel. We recommend Potsdam 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.
2. Costs for upgrading from steam to hot water heating distribution in portions of the high school were not included in the analysis because it was beyond the scope of this study. However, the school should consider converting these portions of the school to hot water regardless of whether or not they proceed with a biomass boiler project. If the district does proceed with a biomass project, any planned improvements to the existing heating system should be done at the same time, as it will be the least costly time to do so.
3. It is our understanding that the district is engaged in updating its capital plan. At the very least, the district should include upgrading the heating distribution system in the high school. The district should also consider including a biomass boiler project in the 2010 capital plan.
4. If the district moves forward with a biomass project, it may want to consider decommissioning some of the existing natural gas boilers after facility staff have had some experience with the biomass equipment. Savings from salvaging the existing boilers were not included the analysis.
5. The US Forest Service may be able to provide some engineering technical assistance from an engineering team with biomass experience that is part of the program that funded this study. If the district moves forward with this project, they should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area to see what assistance can be provided. His contact information is: 304-285-1538, lmccreery@fs.fed.us.
6. Regardless of whether the district moves forward with a biomass energy system, it should consider energy efficiency improvements. 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 is included in the *Biomass and Green Building Resources* binder accompanying this report.
7. 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 district 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.

8. Concurrent with the design of a biomass project, Potsdam should investigate potential woodchip fuel providers. The New York State Forest Utilization Program maintains an up to date list of biomass fuel suppliers. Their contact information is included in the appendices at the end of this report.

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

SENSITIVITY ANALYSIS

Table 3: Wood and Natural Gas Prices Vary - Interest and Inflation Rates Held Constant

	Natural Gas Prices/therm				
Wood Price/ton	**$0.80**	**$1.00**	**$1.20**	**$1.40**	**$1.60**
$40	$56,438	$89,360	$122,282	$155,204	$188,126
$45	$47,031	$79,953	$112,875	$145,797	$178,719
$50	$37,625	$70,547	$103,469	$136,391	$169,313
$55	$28,219	$61,141	$94,063	$126,985	$159,907
$60	$18,813	$51,735	$84,657	$117,579	$150,501

Annual Fuel Savings Shown

Table 4: Interest and Natural Gas Fuel Inflation Vary - Wood Fuel and General Inflation Rate Constant

	Fuel Inflation Rate (%)			
Interest Rate (%)	**2.6%**	**4.6%**	**6.6%**	**8.6%**
3.0%	-$102,723	$1,639,261	$4,163,199	$7,850,713
4.0%	-$342,638	$1,083,064	$3,131,257	$6,100,970
5.0%	-$541,084	$633,271	$2,305,646	$4,711,328
6.0%	-$706,380	$267,153	$1,641,117	$3,601,414
7.0%	-$845,017	-$32,804	$1,102,987	$2,709,846

30 Yr. NPV Shown

DISCUSSION OF BIOMASS FUELS

Purchasing wood fuel is a different exercise than purchasing natural gas. While natural gas is 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, Potsdam 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, Potsdam 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 for a list of local suppliers.

The bottom line is that both the Potsdam Central 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 Potsdam 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.

POTENTIAL BIOMASS FUEL SUPPLIERS

Active providers of woodchip fuel change regularly. For the most up-to-date information on potential providers contact the New York State Forest Utilization Program:

Sloane Crawford
Program Leader
NYS Forest Utilization Program
625 Broadway
Albany, NY 12233-4253
Phone: (518) 402-9415
Fax: (518) 402-9028
sncrawfo@gw.dec.state.ny.us