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

WERC

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Preliminary Feasibility Report

Biomass Heating Analysis for Watertown Industrial Center

Watertown New York

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Wood Education and Resource Center

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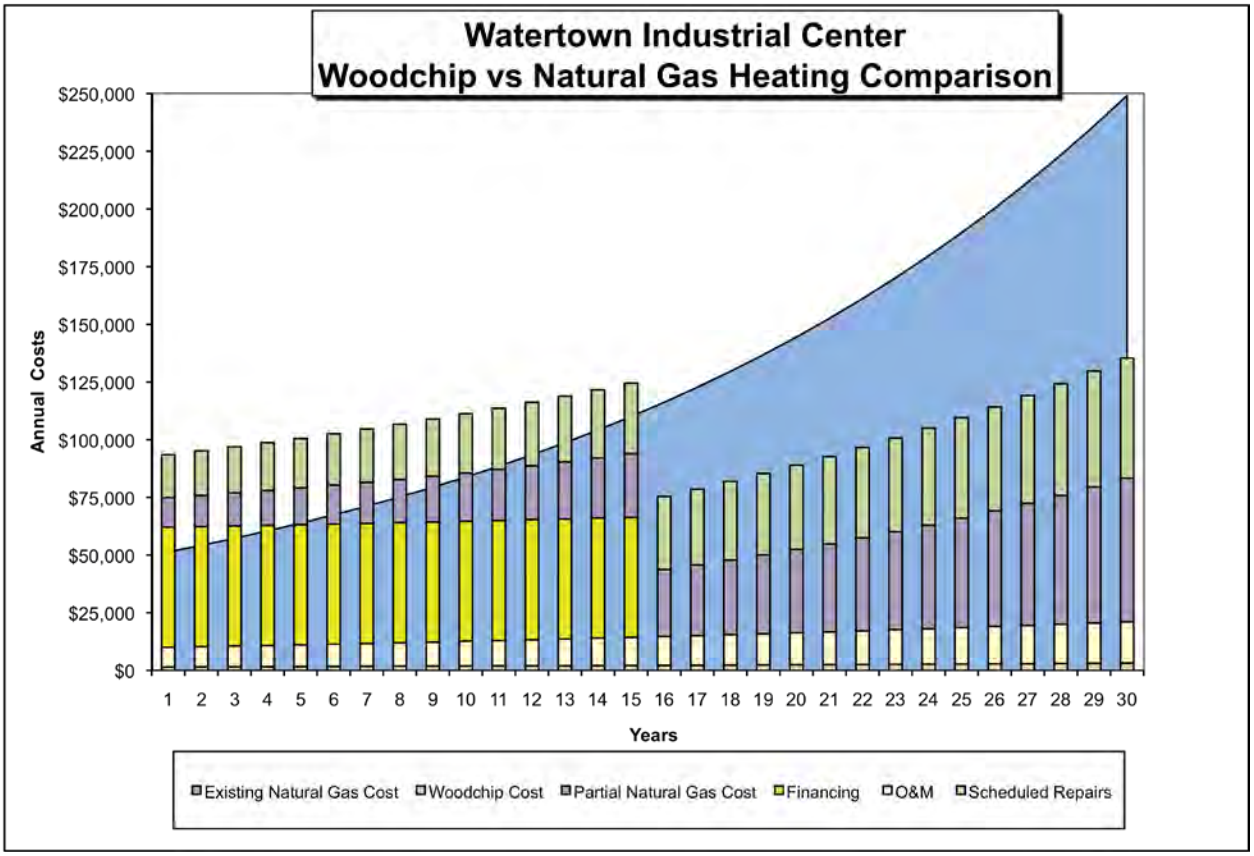
EXECUTIVE SUMMARY

The Watertown Industrial Center includes three buildings, totaling 139,000 SF located in Watertown, New York. (There is an additional building on the property that is not currently heated and is not considered in this analysis.) Each building has a variety of aging heating systems that run primarily on natural gas.

The complex currently uses approximately 43,485 therms of natural gas per year. The average price paid by the agency over the past two years was $1.18 per therm of natural gas. At that price the Watertown Industrial Center would spend around $51,300 on natural gas this coming year to heat these buildings.



It does not appear that the Watertown Industrial Center would be a good candidate for a woodchip heating system. For biomass energy projects to be cost effective, particularly when it comes to comparing wood fuel costs against current natural gas prices, bigger is generally better. It does not appear that the agency uses enough natural gas for heating this complex of buildings to seriously consider a woodchip heating system. The analysis in this report indicates that the agency would only save a few thousand dollars in present value operating costs over the 30-year life of a boiler if the costs of fuel, operation, maintenance and debt service are compared against existing fuel costs.

Higher natural gas prices or increasing the size of the system and therefore annual fuel consumption by incorporating additional buildings could improve the economics under this scenario. Woodchip fuel at $50/ton is equivalent to about half the current cost the agency is paying for heating fuel per Btu. If natural gas prices begin to approach $1.50 per therm, a biomass project for this site may be worth re-evaluating. Similarly, if the agency were able to obtain significant grant funding for the project, then obviously the economics of the project could improve. If the Watertown Industrial Center has a strong commitment to moving forward with a biomass heating project, additional analysis that investigates adding neighboring buildings to the project should be considered. To add these buildings would mean a completely new analysis, which was beyond the scope of this project. In general, for biomass energy projects, the larger the project, the more likely it is to be cost effective. However, adding neighboring buildings to the Watertown Industrial Center project would not guarantee a cost effective project and would substantially complicate the decision-making for the project.

Regardless of whether a biomass project seems appropriate for the agency at this time, there are energy related actions Yellow Wood recommends the agency take to reduce it energy use.

1. Regardless of whether the agency moves forward with a biomass energy project, it should consider upgrading to a central hot water heating distribution system. The existing heating system is aging and will only develop more maintenance issues over time. Hot water heat distribution from a central boiler system is generally easier to maintain, is easier to control and is a more comfortable heat source than individual heating systems for each tenant. It is also energy efficient because the distribution water temperature can be adjusted easily. The costs for converting the existing heat distribution system to a new hot water distribution system were not included in the analysis for this report because estimating those costs was beyond the scope of this project. However, it is likely that upgrading the existing heating distribution system to include a central boiler plant will cost many thousands of dollars and that the energy cost savings will not be enough to cover the costs for a heating distribution upgrade. If the agency wants to investigate a heating system upgrade, the first step would be to hire a mechanical engineering firm to develop a conceptual design and to estimate costs. Then, if the agency does decide to move forward with a biomass project, it will have a better idea of overall project costs.

2. 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 agency 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.

3. The agency should consider energy efficiency improvements in all of its buildings. 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 any major building project. Information on energy efficiency programs is included in the *Biomass and Green Building Resources* binder accompanying this report.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates for the Watertown Industrial Center. 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 Watertown Industrial Center 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 Watertown, NY to tour the complex. 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.

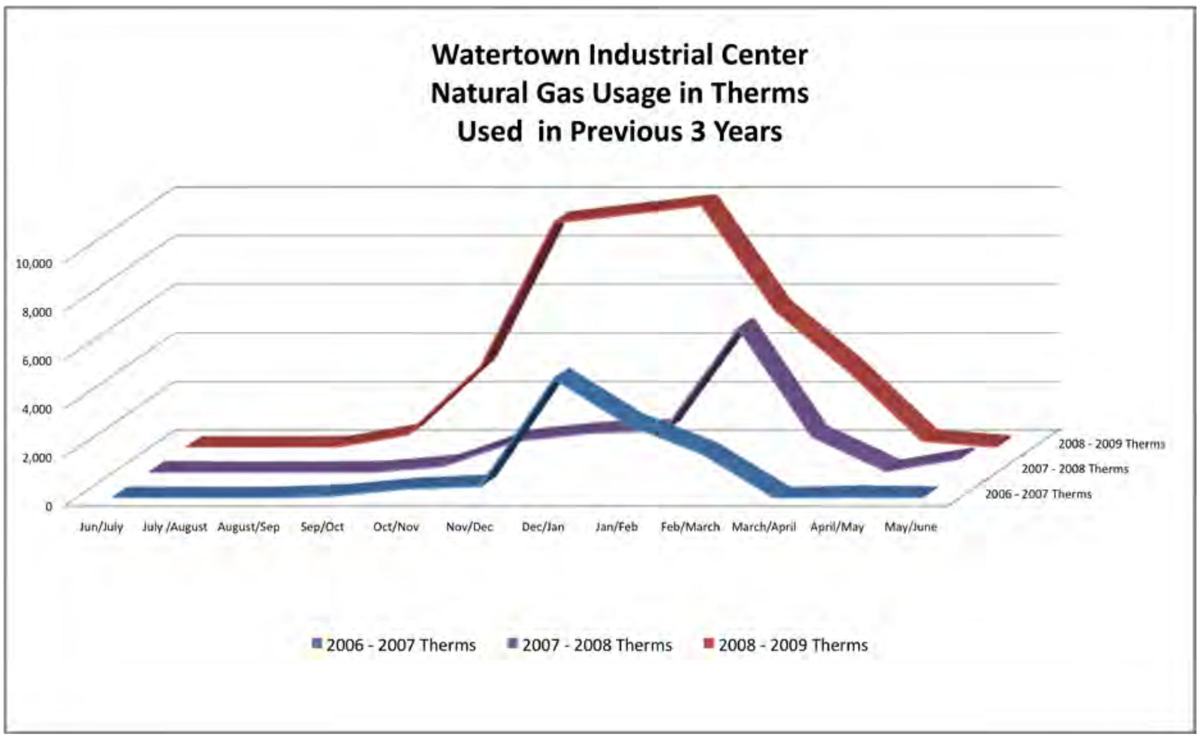
This preliminary feasibility study was prepared by Yellow Wood Associates and Richmond Energy Associates, LLC.

ANALYSIS ASSUMPTIONS

DESCRIPTION OF THE EXISTING HEATING SYSTEMS

This analysis looks at three buildings of the Watertown Industrial Center, Building A (94,000 SF), Buiding B (30,000 SF) and Building C (15,000 SF). This complex has multiple tenants and each building is heated by a variety of aging heating systems that run primarily on natural gas. Small portions of these buildings are heated with electric heat. Because the area heated with electricity is so small, the replacement of electric heat is not analyzed separately. Currently the majority of the second floor of building A is not occupied. This portion of the building has electric baseboard heat but that heat is not turned on. There are no plans for the current future to heat this portion of the building and it is not being considered in this analysis.

Figure 1: Natural Gas Usage



The heating systems of these buildings are not currently connected and it will be necessary to install a connected hot water distribution system in all parts of the complex in order to tie all of the buildings into the biomass heating system. Estimated costs for upgrading the heating distribution system were not included in this analysis as this task was beyond the scope of this project. The agency should hire a competent local mechanical engineering firm to evaluate the existing system, and to estimate costs for upgrading to a central hot water distribution system, if it wants to pursue a biomass energy project.

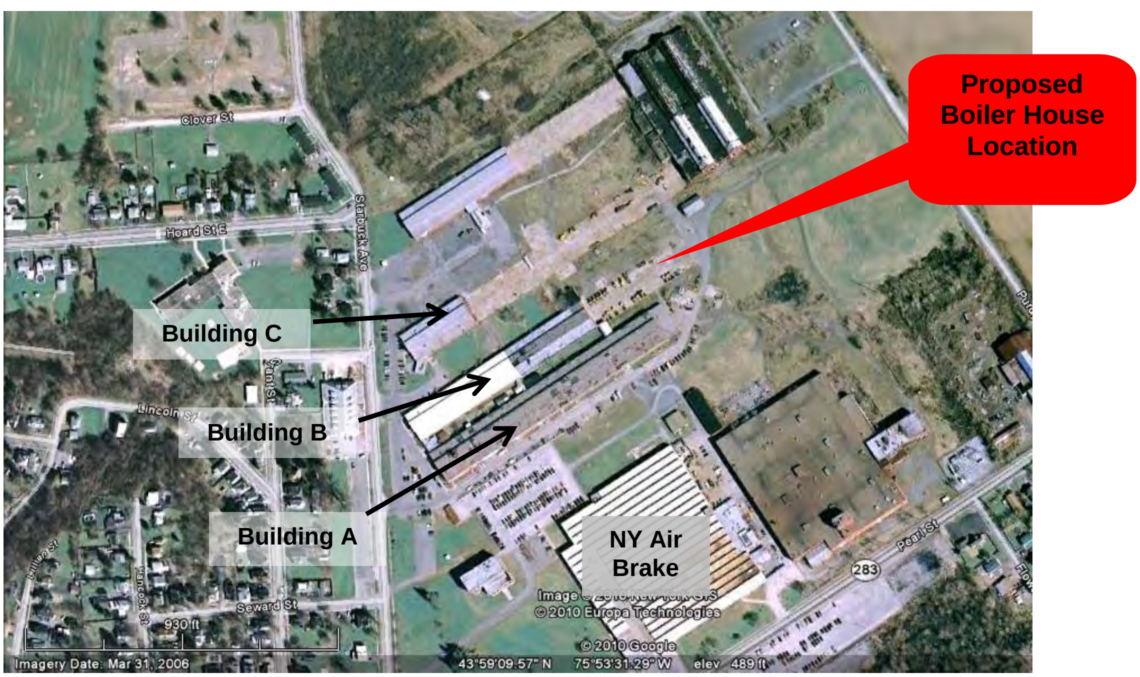
The analysis in this report is based on a billing analysis of the volume of heating fuel consumed over the past two years for the existing buildings. Based on that analysis, it is assumed that the three-building complex would consume 43,485 therms of natural gas per year at a price of $1.18 per therm for a total annual heating bill of approximately $51,312. These were the numbers used in the analysis for this study.

The agency may want to consider upgrading to a central heating distribution system and central boiler plant regardless of whether it moves forward with biomass project. The existing heating system is aging and it is our understanding that it has required increase maintenance over the past few years. A central boiler plant and interconnected heating distribution system would be more efficient that the existing set up and would be much easier to maintain.

DESCRIPTION OF THE PROPOSED BIOMASS SYSTEM

The biomass scenario that was analyzed envisions a stand-alone semi-automated woodchip boiler system and an at-grade woodchip storage bin immediately adjacent to the existing boiler room. This system requires the operator to spend approximately one extra hour per day for fuel handling and basic maintenance, but requires a much lower capital cost investment than a fully automated system, as the building that houses the system and the vendor equipment are both less expensive.

Figure 2: Site Plan



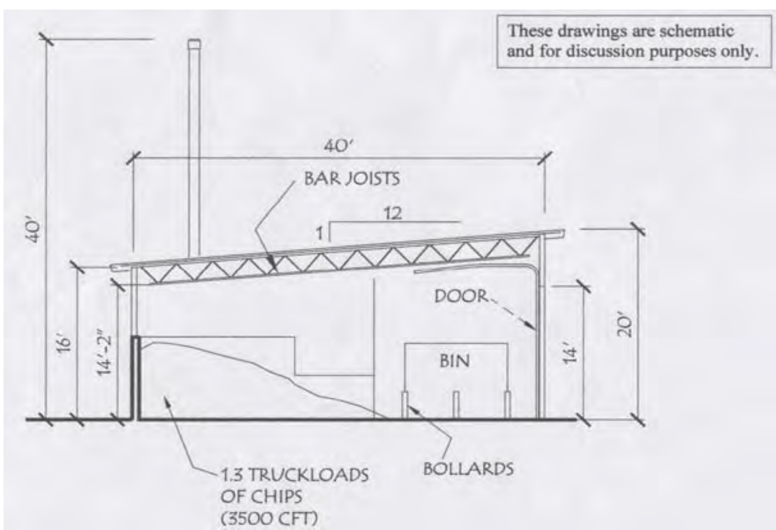
Approximately 200 feet of underground insulated piping would tie the buildings together into the updated HVAC systems which would be connected to one central woodchip boiler room. Costs for a tall stack were included to ensure good emissions dispersal. A healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

SEMI-AUTOMATED SYSTEMS

Semi-automated biomass systems[1] are a cost efficient alternative to fully automated systems. The semi-automated system is typically installed in an on-grade slab building that includes both a boiler room and chip storage. The system also includes a day bin fuel hopper to supply the boiler automatically for one-to-two days without reloading. The day bin of a semi-automated woodchip system is loaded by an operator using a small tractor with a front end bucket or skid steer. Semi-automated systems have automated controls to manage fuel supply and combustion air, although the controls are simpler than those in a fully automated system.

The attraction of a semi-automated system is that both the building that houses the system and the vendor equipment are less expensive than a fully automated system. The system takes the operator up to one hour per day over the typical operation and maintenance time required for a fully automated system; this additional time is for loading the day bin. The semi-automated woodchip system is a good match for a smaller rural school or office building where the additional time in fuel handling is not a significant burden to maintenance staff.

Figure 3: Schematic Section of Semi-Automated Biomass Boiler House
(Drawing Courtesy of the Biomass Energy Resource Center (BERC))



[1]Excerpted from a handout produced by the Biomass Energy Resource Center:
http://www.biomasscenter.org/resources/technology/heating-systems-semiautomated.html

Table 1: Characteristics of Semi-Automated Woodchip Heating Systems

CHARACTERISTICS OF SEMI-AUTOMATED WOODCHIP HEATING SYSTEMS	
Primary Fuel:	Green wood chips (mill or forest residue, 25%-50% mc)
Energy Output:	Hot water or steam (boiler system)
Size (Boiler Output):	0.5 – 2.0 Btu/hour (or larger)
Fuel Storage:	Slab-on-grade building (overhead door delivery)
Fuel Handling:	Tractor with front-end bucket, from pile to day bin (performed by operator, once or twice daily) Automated from day bin to combustion chamber (no operator labor)
Operator Work Load:	Up to 1 hour daily
Combustion Control:	Electronic control panel (minimum) On-off firing rate (minimum) Automated, tuned control of fuel and combustion air "Idle" or flame maintenance mode
Stack Emission Control Device:	None required (unless required by state regulations) Must meet applicable state regulations, if any
Ash Removal:	Manual or automated
Vendor-Supplied Equipment:	Boiler with standard controls Combustion chamber Day bin with automated fuel reclaim in bottom Automated fuel handling system (day bin to boiler) Control Panel Wood system wiring (from system control panel) Breaching (from boiler to stack)
Vendor Responsibilities:	All installation Coordination with General Contractor Warranty Service Capability (limited) (Plumbing connection by others) (Building construction by others) (Tractors by others) (Bonding generally not required)

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 installing a new woodchip heating system that would serve the Watertown Industrial Center. The scenario includes all ancillary equipment and interconnection costs. Under the biomass scenario, 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 analysis projects current and future annual 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, the Watertown Industrial Center 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 Watertown Industrial Center indicate that the complex has used an average of 43,485 therms of natural gas per year to heat the three buildings being considered in this analysis. This is the assumed annual fuel consumption used for the base case in the analysis. Over the past two years, Watertown Industrial Center paid an average of $1.18 per therm of natural gas; the biomass scenario in this study uses this price for the first year of the analysis.

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%. However, all of these systems are fully automated and do not require operators to load bins over weekends. Since a semi-automated system was characterized for this site, it was assumed that in some cases natural gas boilers would cover a portion of weekend heating loads during the coldest times of the year. Therefore the woodchip scenario in this study assumes the complex will meet 75% of the winter heating needs with woodchips.

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 $0.57 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 10,871 therms of natural gas. The cost for supplemental natural gas is then adjusted for inflation each year over the 30-year horizon.

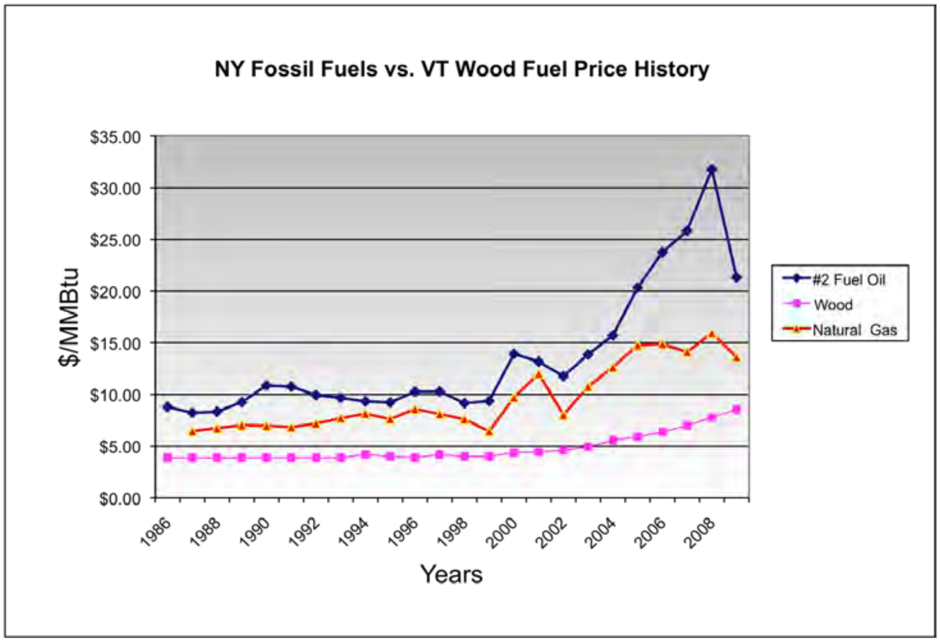
INFLATION ASSUMPTIONS

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. Watertown Industrial Center's fuel rate of $1.18/therm was used for the first year of the analysis and then inflated each year at 5.6%.

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.

Figure 4: 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.

OPERATION AND MAINTENANCE ASSUMPTIONS

It is typical for operators of semi-automated woodchip heating systems of this size to spend up to one hour per day to load fuel, 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 hour per day in addition to their current boiler maintenance for 150 days per year and 20 hours during the

[2] Extrapolated from Vermont Superintendent Association School Energy Management Program 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 by on-site maintenance staff.

summer months for routine maintenance. At a loaded labor rate of $25/hr, this equals $4,250 annually. An additional $4,250 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, $15,000 of scheduled maintenance was anticipated in years 10, 20 and 30 and then annualized at $1,500 per year to simulate a sinking fund for major repairs. This $1,500 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 the agency would have paid anyway. It was assumed that all costs for the operation and maintenance of a biomass boiler are incremental additional costs.

FINANCING ASSUMPTIONS

Financing costs were included in the analysis to give facility decision makers a sense of how this project may impact their annual budget. This analysis assumes that the agency will finance the entire cost of the biomass project with a low interest 5% loan. At this time the analysis does not take into account any potential tax credits, grants or lower interest loans. 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 agency would like to see other cash flows using different financing schemes, Yellow Wood can provide additional analysis.

BIOMASS SCENARIO ANALYSIS

It appears that the Watertown Industrial Center would not be a very good candidate for a woodchip heating system. The analysis in this report indicates that the agency would only have marginal savings in present value operating costs over the 30-year life of a boiler if the costs of fuel, operation, maintenance and debt service are compared against existing fuel costs. Higher natural gas prices or increasing the size of the system and therefore annual fuel consumption by incorporating additional buildings could improve the economics under this scenario. Woodchip fuel at $50/ton is equivalent to about half the current cost the agency is paying for heating fuel per Btu. If natural gas prices begin to approach $1.50 per therm, then a biomass project for this site may be worth re-evaluating. Similarly, if the agency were able to obtain significant grant funding for the project, then obviously the economics of the project could improve.

Table 2 shows the assumptions used in this analysis, Figure 5 graphs annual costs under the current natural gas heating scenario and the alternate biomass heating scenario, and Table 3 presents the actual spreadsheet analysis tool. Yellow Wood can run the analysis again if the agency would like to change any of these assumptions.

Table 2: Woodchip Scenario Analysis Assumptions

Watertown Industrial Center					
Capital Cost Assumptions					
1.0 mmBtu woodchip hot water boiler system including installation					$150,000
50 ft stack					$25,000
Pollution control equipment					$35,000
Chip Storage building	$50	/SF	1,000	SF	$50,000
Renovations to existing space to create boiler room	$50	/SF	1,000	SF	$50,000
1.0 mmBtu Natural Gas Back-up boiler					$50,000
Thermal Storage 1,000 gallon					$10,000
Cost of Skid Steer					$20,000
GC markup at 10%					$37,000
Construction contingency at 15%					$55,500
Design at 12%					$57,900
Total estimated project costs					$540,400
Grants			**0%**		$0
Total Local Share					$540,400
Financing Costs					
Financing, annual interest rate					5.0%
Finance term (years)					15
1st full year debt service					$54,040
Fuel Cost Assumptions					
Current annual natural gas consumption in therms					43,485
Assumed natural gas price per therm					$1.18
Projected annual natural gas bill					$51,312
Assumed woodchip price in 1st year (per ton)					$50
Projected 1st year woodchip fuel bill					$18,636
Projected 1st year supplemental natural gas bill					$12,828
Inflation Assumptions					
General inflation rate (twenty year average CPI)					2.6%
Natural gas inflation rate (average increase for New York commercial NG users from 1991 - 2009 (US EIA))					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					$8,500
Major repairs (annualized)					$1,500
Savings					
Net 1st year fuel savings					**$19,848**
Total 30 year NPV cumulative savings					**$5,605**

Figure 5: Annual Cash Flow Graph for Woodchip Scenario

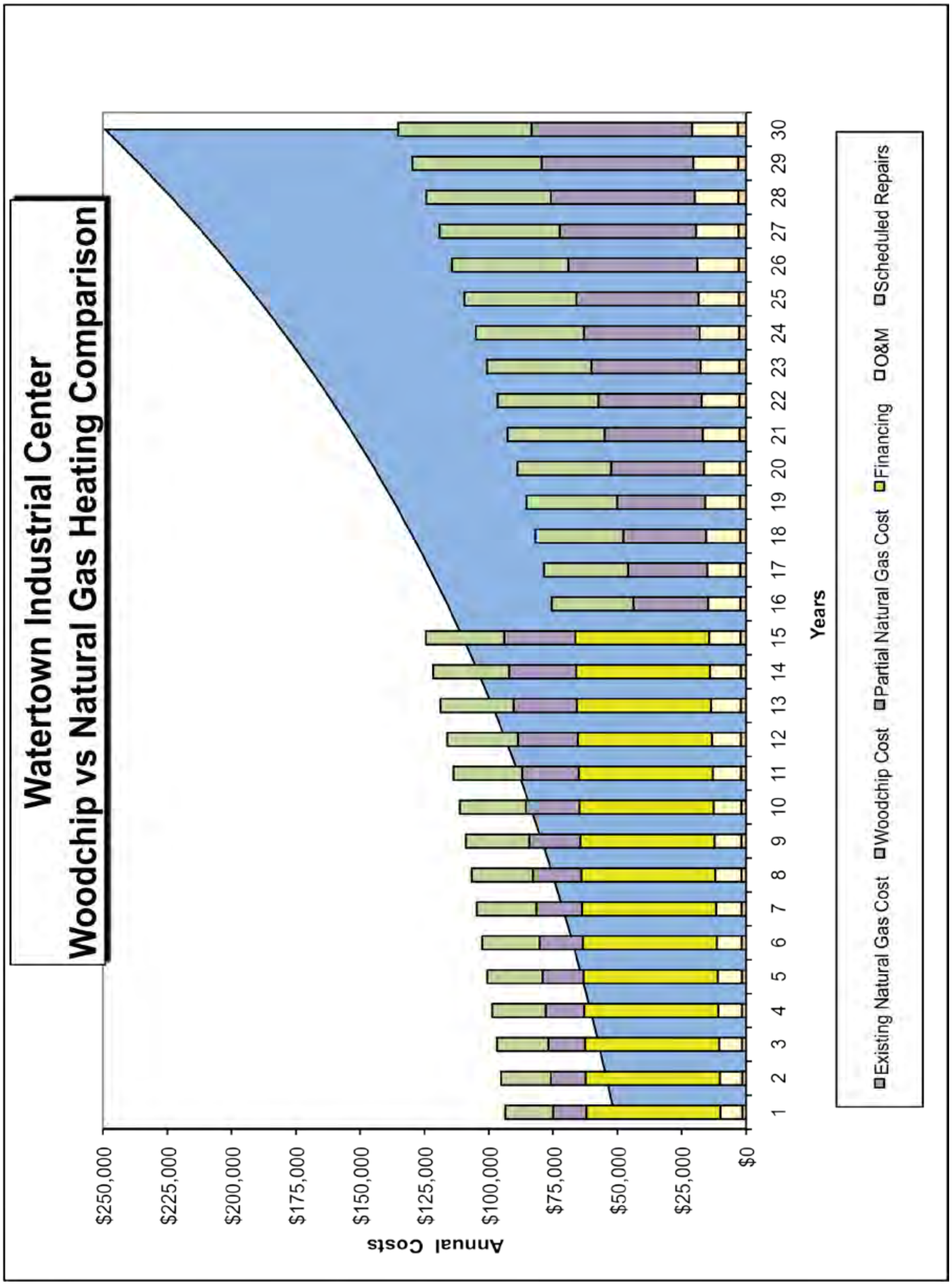


Table 3: 30-Year Life Cycle Analysis Spreadsheet for Woodchip Scenario

Watertown Industrial Center — **Preliminary Life Cycle Cost Estimate** — ***Semi-Automated Woodchip - Heat Only***

Total estimated construction costs	$540,400	*Estimated grant funding*	$0
Local Share:	$540,400		
Financing:	5.0%	*Assumed interest rate each year, 15 years*	
Natural Gas heat consumption	43,485	25% NG = 10,871 therms	497 tons if 100% woodchips for Natural Gas; 88 therm / ton of woodchip
Natural Gas heat price	$1.18		
Natural Gas heat cost	$51,312		
Estimated woodchip utilization	75%		
Projected woodchip consumption	373	tons	
Estimated 1st year woodchip price	$50	/ ton Year 1	
Projected 1st year woodchip cost	$18,636		
Projected 1st year partial NG cost	$12,828		
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.:	$8,500	in Year 1 $	*Estimate of additional electricity for feed system motors and additional maintenance staff time*
Major Repairs:	$1,500		*Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized*

Yr.	Natural Gas Cost	Total	Financing	Woodchip Cost	Partial NG Cost	O&M	Scheduled Repairs	Total	Annual Cashflow	Cumulative Cashflow
1	$51,312	$51,312	$52,063	$18,636	$12,828	$8,500	$1,500	$93,528	-$42,216	-$42,216
2	$54,186	$54,186	$52,063	$19,307	$13,546	$8,721	$1,539	$95,177	-$40,991	-$83,207
3	$57,220	$57,220	$52,063	$20,002	$14,305	$8,948	$1,579	$96,898	-$39,677	-$122,884
4	$60,425	$60,425	$52,063	$20,722	$15,106	$9,180	$1,620	$98,692	-$38,268	-$161,152
5	$63,808	$63,808	$52,063	$21,469	$15,952	$9,419	$1,662	$100,565	-$36,757	-$197,909
6	$67,382	$67,382	$52,063	$22,241	$16,845	$9,664	$1,705	$102,520	-$35,138	-$233,047
7	$71,155	$71,155	$52,063	$23,042	$17,789	$9,915	$1,750	$104,559	-$33,404	-$266,451
8	$75,140	$75,140	$52,063	$23,872	$18,785	$10,173	$1,795	$106,688	-$31,549	-$298,000
9	$79,347	$79,347	$52,063	$24,731	$19,837	$10,438	$1,842	$108,911	-$29,563	-$327,563
10	$83,791	$83,791	$52,063	$25,621	$20,948	$10,709	$1,890	$111,231	-$27,440	-$355,003
11	$88,483	$88,483	$52,063	$26,544	$22,121	$10,987	$1,939	$113,654	-$25,171	-$380,174
12	$93,438	$93,438	$52,063	$27,499	$23,360	$11,273	$1,989	$116,184	-$22,746	-$402,920
13	$98,671	$98,671	$52,063	$28,489	$24,668	$11,566	$2,041	$118,827	-$20,157	-$423,077
14	$104,196	$104,196	$52,063	$29,515	$26,049	$11,867	$2,094	$121,588	-$17,392	-$440,469
15	$110,031	$110,031	$52,063	$30,577	$27,508	$12,175	$2,149	$124,473	-$14,441	-$454,910
16	$116,193	$116,193		$31,678	$29,048	$12,492	$2,204	$75,423	$40,770	-$414,140
17	$122,700	$122,700		$32,819	$30,675	$12,817	$2,262	$78,572	$44,128	-$370,012
18	$129,571	$129,571		$34,000	$32,393	$13,150	$2,321	$81,863	$47,708	-$322,304
19	$136,827	$136,827		$35,224	$34,207	$13,492	$2,381	$85,303	$51,524	-$270,780
20	$144,489	$144,489		$36,492	$36,122	$13,843	$2,443	$88,900	$55,590	-$215,191
21	$152,581	$152,581		$37,806	$38,145	$14,203	$2,506	$92,660	$59,921	-$155,270
22	$161,125	$161,125		$39,167	$40,281	$14,572	$2,571	$96,591	$64,534	-$90,736
23	$170,148	$170,148		$40,577	$42,537	$14,951	$2,638	$100,703	$69,445	-$21,291
24	$179,677	$179,677		$42,038	$44,919	$15,339	$2,707	$105,003	$74,674	$53,383
25	$189,739	$189,739		$43,551	$47,435	$15,738	$2,777	$109,501	$80,237	$133,621
26	$200,364	$200,364		$45,119	$50,091	$16,147	$2,850	$114,207	$86,157	$219,778
27	$211,584	$211,584		$46,743	$52,896	$16,567	$2,924	$119,130	$92,454	$312,232
28	$223,433	$223,433		$48,426	$55,858	$16,998	$3,000	$124,282	$99,151	$411,383
29	$235,945	$235,945		$50,169	$58,986	$17,440	$3,078	$129,673	$106,272	$517,656
30	$249,158	$249,158		$51,975	$62,290	$17,893	$3,158	$135,316	$113,842	$631,498
Totals	$3,762,120	$3,762,120	$780,951	$978,050	$945,630	$379,177	$66,914	$1,227,041	$2,555,078	
	30 Yr. NPV at		5%	Discount Rate						
		$1,594,276	$540,400	$441,259	$398,569	$177,176	$31,256	$1,558,671		

Total Annual Heating Costs	Woodchip Fuel /Year	Partial Natural Gas First Year	Woodchip System O&M /yr	Contingency Allowance / Year	Woodchip + Fuel + O&M + Contingency	Annual Fuel Cost Savings	Local Share Cost	Simple Payback (yrs)	30 Yr. NPV Savings
$51,312	$18,636	$12,828	$8,500	$1,500	$41,465	$19,648	$540,400	27.2	$5,605

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. Yellow Wood recommends that the agency 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 Watertown Industrial Center converts to biomass or stays with natural gas, 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 agency'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 agency 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.

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 strongly recommend that Watertown Industrial Center 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.

CENTRAL HEATING DISTRIBUTION SYSTEM

Regardless of whether the agency moves forward with a biomass energy project, it should consider upgrading to a central hot water heating distribution system. The existing heating system is aging and will only develop more maintenance issues over time. Hot water heat distribution from a central boiler system is generally easier to maintain, is easier to control and is a more comfortable heat source than individual heating systems for each tenant. It is also energy efficient because the distribution water temperature can be adjusted easily. When it is very cold outside, the water temperature can be high which provides more heat. When the outdoor temperature is only cool, then the distribution temperature can be set back to provide some heat, but not too much.

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. The reality is that the energy cost savings from a biomass energy system for this facility will not offset the costs associated with installing a central heating distribution system. Upgrading the existing heating distribution system to include a central boiler plant will cost many thousands of dollars. The first step should be to hire a mechanical engineering firm to estimate heating distribution upgrades. We recommend the agency consider this alternative and invest in determining those costs. Then, if the agency does decide to move forward with a biomass project, it will have a better idea of overall project costs.

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 agency 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.

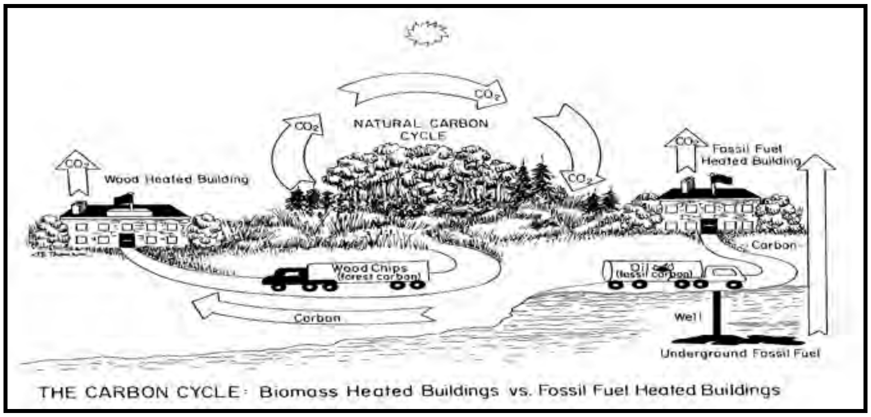
These grants and loans are also competitive. Highest priority projects are those that serve small communities, those that serve low-income communities and those that are highly leveraged with other loan and grant awards.

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.

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 the Watertown Industrial Center could undertake that would reduce its carbon footprint more than switching their heating fuel use from natural gas to a biomass fuel.

Figure 6: 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 Watertown Industrial Center can offset approximately 32,614 therms of natural gas per year by replacing that heat using biomass. This is equivalent to about 190 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 $572 - $953 or a lump sum up front payment of as much as $9,530.

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.

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

PERMITTING

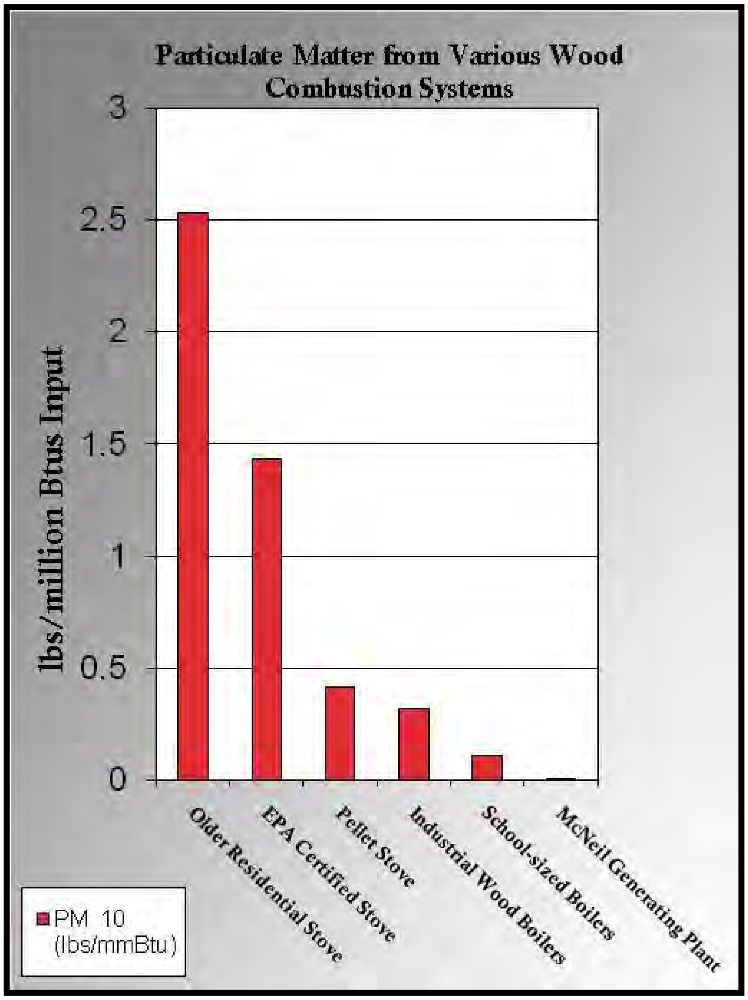
Modern biomass boiler technology is both clean and efficient. Controls moderate both the biomass fuel and air to create either a small hot fire or a large hot fire depending on heat demand from the building. Under full load, modern woodchip boilers routinely operate at steady state efficiencies of 70%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

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 7: 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 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 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.

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

CONCLUSIONS AND RECOMMENDATIONS

It does not appear that the Watertown Industrial Center would be a good candidate for a woodchip heating system. For biomass energy projects to be cost effective, particularly when it comes to comparing wood fuel costs against current natural gas prices, bigger is generally better. It does not appear that the agency uses enough natural gas for heating this complex of buildings to seriously consider a woodchip heating system. The analysis in this report indicates that the agency would only save a few thousand dollars in present value operating costs over the 30-year life of a boiler if the costs of fuel, operation, maintenance and debt service are compared against existing fuel costs.

Higher natural gas prices or increasing the size of the system and therefore annual fuel consumption by incorporating additional buildings could improve the economics under this scenario. Woodchip fuel at $50/ton is equivalent to about half the current cost the agency is paying for heating fuel per Btu. If natural gas prices begin to approach $1.50 per therm, a biomass project for this site may be worth re-evaluating. Similarly, if the agency were able to obtain significant grant funding for the project, then obviously the economics of the project could improve.

Regardless of whether a biomass project seems appropriate for the agency at this time, there are energy related actions Yellow Wood recommends the agency take to reduce it energy use.

Regardless of whether the agency moves forward with a biomass energy project, it should consider upgrading to a central hot water heating distribution system. The existing heating system is aging and will only develop more maintenance issues over time. Hot water heat distribution from a central boiler system is generally easier to maintain, is easier to control and is a more comfortable heat source than individual heating systems for each tenant. It is also energy efficient because the distribution water temperature can be adjusted easily. The costs for converting the existing heat distribution system to a new hot water distribution system were not included in the analysis for this report because estimating those costs was beyond the scope of this project. However, it is likely that upgrading the existing heating distribution system to include a central boiler plant will cost many thousands of dollars and that the energy cost savings will not be enough to cover the costs for a heating distribution upgrade. If the agency wants to investigate a heating system upgrade, the first step would be to hire a mechanical engineering firm to develop a conceptual design and to estimate costs. Then, if the agency does decide to move forward with a biomass project, it will have a better idea of overall project costs. If the Watertown Industrial Center has a strong commitment to moving forward with a biomass heating project, additional analysis that investigates adding neighboring buildings to the project should be considered. To add these buildings would mean a completely new analysis, which was beyond the scope of this project. In general, for biomass energy projects, the larger the project, the more likely it is to be cost effective. However adding neighboring buildings to the Watertown Industrial Center project would not guarantee a cost effective project and would substantially complicate the decision-making for the project.

1. 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 agency 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.

2. The agency should consider energy efficiency improvements in all of its buildings. 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 any major building project. Information on energy efficiency programs is included in the *Biomass and Green Building Resources* binder accompanying 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

DISCUSSION OF BIOMASS FUELS

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, Watertown Industrial Center 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, Watertown Industrial Center 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 Watertown Industrial Center 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 Watertown Industrial Center 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.

SENSITIVITY ANALYSIS

Table 4: 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	$11,182	$17,705	$24,227	$30,750	$37,273
$45	$9,318	$15,841	$22,364	$28,886	$35,409
$50	$7,455	$13,977	$20,500	$27,023	$33,546
$55	$5,591	$12,114	$18,636	$25,159	$31,682
$60	$3,727	$10,250	$16,773	$23,296	$29,818

Annual Fuel Savings Shown

Table 5: 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%	-$347,081	$7,057	$520,163	$1,269,820
4.0%	-$369,338	-$79,498	$336,891	$940,622
5.0%	-$387,926	-$149,184	$190,803	$679,868
6.0%	-$403,558	-$205,642	$73,679	$472,199
7.0%	-$416,793	-$251,673	-$20,771	$305,897

30 Yr. NPV shown

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:

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Program Leader
NYS Forest Utilization Program
625 Broadway
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