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

# Preliminary Feasibility Report

## Biomass Heating Analysis for Colton-Pierrepont Central School

Colton, New York

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WERC

Wood Education and Resource Center

The Wood Education and Resource Center is located in Princeton, W.Va., and administered by the Northeastern Area State and Private Forestry unit of the U.S. Department of Agriculture Forest Service. The Center's mission is to work with the forest products industry toward sustainable forest products production for the eastern hardwood forest region. It provides state-of-the-art training, technology transfer, networking opportunities, applied research, and information. Visit www.na.fs.fed.us/werc for more information about the Center.

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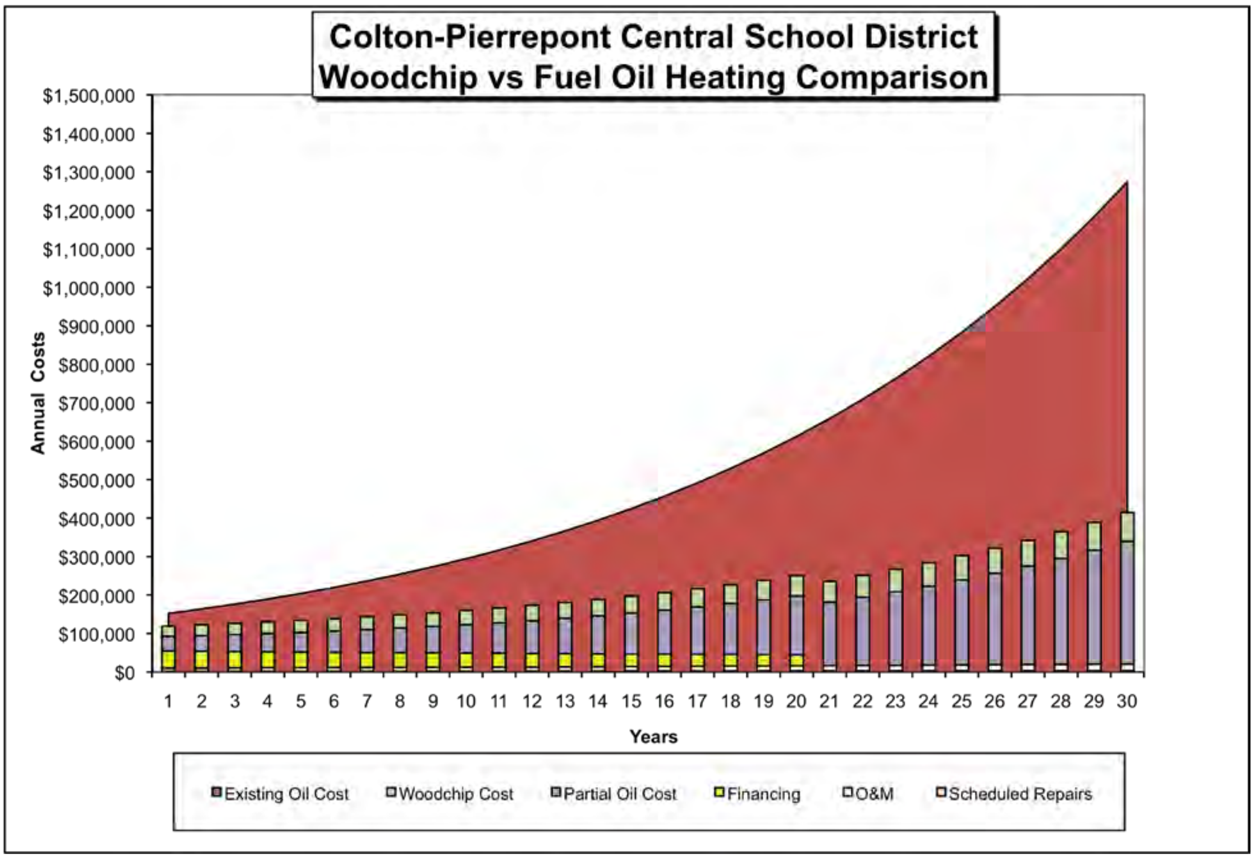
# EXECUTIVE SUMMARY

Colton-Pierrepont Central School is a K-12 school located in Colton, New York. The school has approximately 115,000 square feet of building space which is heated by two steam boilers. Both boilers use #2 fuel oil. Maintenance staff report that either boiler will carry the entire heat load of the building. These boilers are approximately 21 years old and maintenance staff report that they are in good condition. The two boilers are fully depreciated and the analysis in this report assumes that the district will receive 47% state school construction aid for the project. School officials should consult with the New York State Department of Education before embarking on any construction project to determine eligibility for state school construction aid.

The district currently uses approximately 48,500 gallons of fuel oil on average each year. At the average price of $3.14 per gallon (this is the average price paid by the school over the past two years), the school will spend more than $152,000 on fuel costs this coming year.




The biomass analysis in this report shows that the Colton-Pierrepont Central School District could save more than $5 million in today's dollars in operating costs over the next 30 years by installing a woodchip heating system, even including debt service on the cost of the system. Annual fuel savings alone are projected to be approximately $87,000 in the first year. If the district is able to obtain full state school construction aid, the project will have a substantial positive annual cash flow in the first year. Even without state school construction aid, the project breaks even the first year and energy costs savings increase over time as fuel oil prices climb.

The Colton-Pierrepont Central School appears to be an excellent candidate for a woodchip heating system. The school is well sited for a biomass boiler house. The existing boiler systems could work well to provide back-up and supplemental heat in combination with a wood fired boiler. The school has ready access to low cost woodchip fuel. We recommend the district 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. 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.
3. Regardless of whether Colton-Pierrepont moves forward with a biomass project, the district should consider upgrading the existing steam distribution system to a hot water distribution system. Costs for a heating distribution system were not included in this analysis because a project of that nature will require a careful engineering study to determine the best equipment alternatives and to estimate costs. Such an engineering study was beyond the scope for this project. However, hot water distribution is typically easier to maintain, is more energy efficient and provides a more comfortable heat than steam. It is likely that the fuel cost savings from a biomass project will more than offset the costs of converting to a hot water distribution system.
4. Emission regulations for commercial boilers will be changing in the near future. The EPA is undergoing a public review process for draft rules that could affect the type of equipment specified for a site like this. The engineers hired by the district for a biomass project should carefully review the new rules and evaluate the best available technology options for pollution control devices when they are designing this project.
5. The biomass scenario analyzed in this report assumes one of the existing boilers will be replaced with a biomass boiler. If an existing boiler is replaced, the district should be able to sell it, as both existing boilers have been well maintained.
6. Regardless of whether Colton-Pierrepont moves forward with a biomass energy system, the district 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 Resource 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, Colton-Pierrepont 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 for the Colton-Pierrepont 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 Colton-Pierrepont 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 Colton, 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.

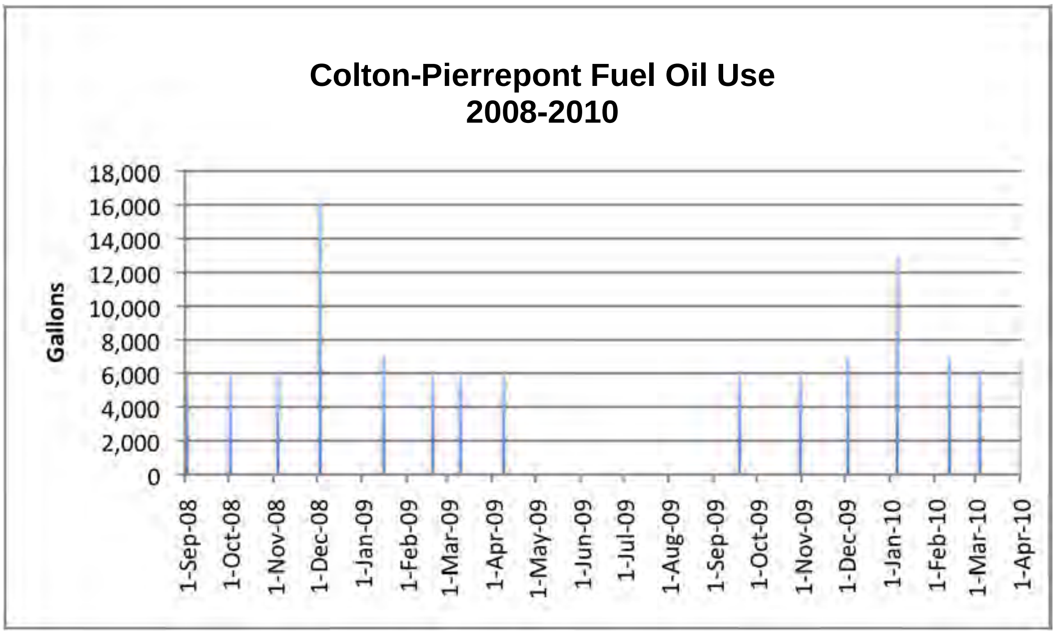
# ANALYSIS ASSUMPTIONS

## DESCRIPTION OF THE EXISTING HEATING SYSTEM

Colton-Pierrepont Central School is a K-12 school located in Colton, NY. The school houses approximately 400 students and staff in the 115,000 square foot building. The school building is heated by a central boiler plant that includes two Cleaver Brooks low-pressure steam boilers that use #2 fuel oil. Maintenance staff report that either boiler will carry the entire heat load of the building and therefore the school currently has 100% redundant boiler capacity. The boilers were purchased in 1989 and both appear to have been well maintained and are in good working condition. In fact, the boiler room at this school was one of the cleanest and best maintained boiler rooms we have seen. The school uses an average of 48,500 gallons of fuel oil to heat the building annually.

The school has an antiquated steam heat distribution system that it would like to replace. Hot water heating distribution provides much greater control of heat output than steam heat - this means greater comfort for occupants. Hot water distribution has additional benefits of increased efficiency (due to less heat loss during piping distribution) and less required ongoing maintenance. Regardless of whether or not Colton-Pierrepont installs a biomass boiler, school decision makers should consider upgrading the heating distribution system in this school to a hot water distribution system.

**Figure 1: Fuel Use**




Since the decision to upgrade to a hot water heating distribution system is independent from what fuel the school uses, the costs for a distribution upgrade were not included in this analysis. School decision makers should hire a qualified mechanical engineer to thoroughly scope and price a distribution upgrade before proceeding with, or concurrent with, a biomass boiler project.

**Figure 2: Interior of Colton-Pierrepont Existing Boiler Room**

## DESCRIPTION OF THE PROPOSED BIOMASS SYSTEM

The biomass scenario that was analyzed envisions replacing one of the existing boilers with a semi-automated woodchip boiler system in the existing boiler room. An at-grade woodchip storage bin immediately adjacent to the existing boiler room is included in the capital cost estimate. This type of system requires the operator to spend approximately one hour per day for fuel handling and basic maintenance, but requires a much lower capital cost investment than a fully automated system.

Typically for a fully automated woodchip heating system, an underground chip storage bin is recommended. Below grade chip storage bins are unlikely to freeze in the coldest winter weather and chip delivery using self unloading trailers into below grade bins is fast and easy. But this convenience comes with considerable cost.

For a semi-automated woodchip system, chips are unloaded into a chip storage building at grade and then loaded into a day-bin hopper with a bucket loader. This requires more effort on the part of the operator than a fully automated system, but the building that stores the chips is considerably less expensive to build and the smaller chip handling system is also less expensive. See the section below for a description of how a semi-automated system works.

The existing boiler room has 100% redundancy with two 5.2 mmBtu Cleaver Brooks boilers. The biomass scenario assumes that a new 2.0 mmBtu biomass boiler system would replace one of the existing boilers. It was assumed that this biomass system would cover 75% of the annual heating needs for the school. The existing boiler room is spacious and a new boiler could fit easily within the confines of the existing boiler room if one of the existing boilers was removed. The boiler room is also located on an outside wall at grade, which would make construction of a chip storage facility relatively easy.

## 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 conventional boiler; this additional time is for loading the day-bin and for routine maintenance. The semi-automated woodchip

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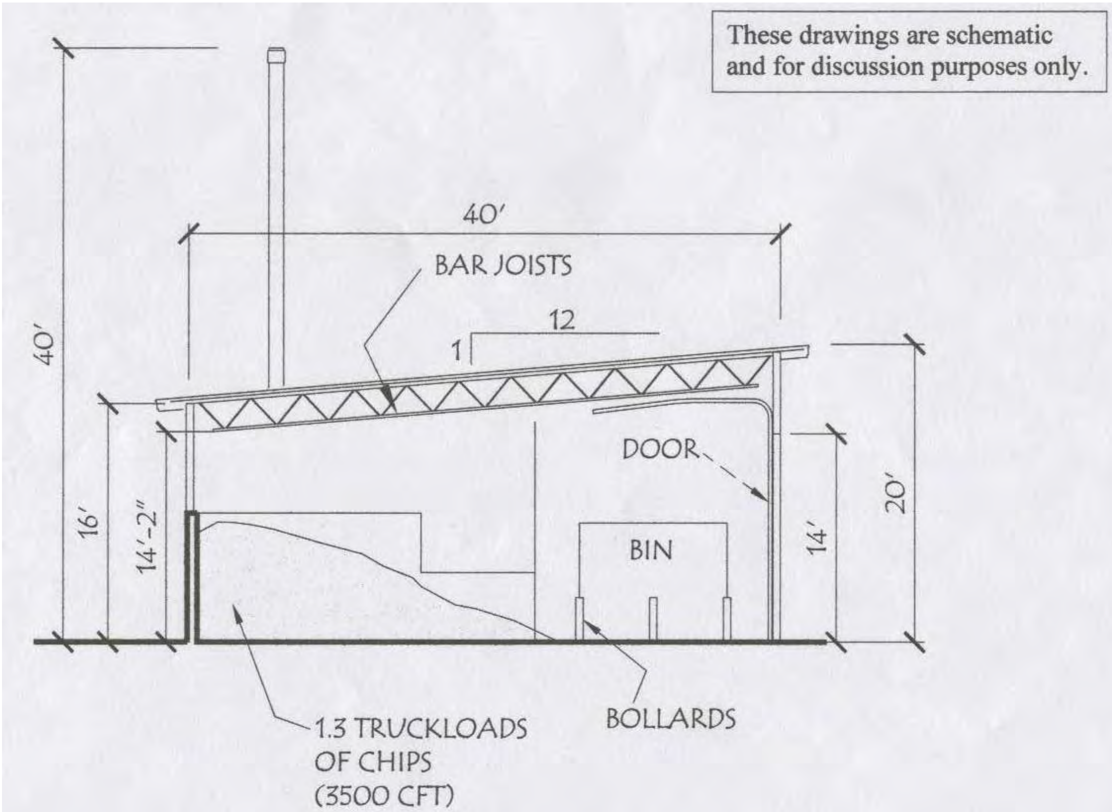
[1]Excerpted from a handout produced by the Biomass Energy Resource Center:
http://www.biomasscenter.org/resources/technology/heating-systems-semiautomated.html

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.

**Table 1: 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)<br>Automated from day-bin to combustion chamber (no operator labor) |
| Operator Work Load: | Up to 1 hour daily |
| Combustion Control: | Electronic control panel (minimum)<br>On-off firing rate (minimum)<br>Automated, tuned control of fuel and combustion air<br>"Idle" or flame maintenance mode |
| Stack Emission Control Device: | None required (unless required by state regulations)<br>Must meet applicable state regulations, if any |
| Ash Removal: | Manual or automated |
| Vendor-Supplied Equipment: | Boiler with standard controls<br>Combustion chamber<br>Day-bin with automated fuel reclaim in bottom<br>Automated fuel handling system (day-bin to boiler)<br>Control Panel<br>Wood system wiring (from system control panel)<br>Breaching (from boiler to stack) |
| Vendor Responsibilities: | All installation<br>Coordination with General Contractor<br>Warranty<br>Service Capability (limited)<br>(Plumbing connection by others)<br>(Building construction by others)<br>(Tractors by others)<br>(Bonding generally not required) |

**Figure 3: Schematic Section of Semi-Automated Biomass Boiler House**[2]




## 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

[2] Drawing Courtesy of the Biomass Energy Resource Center (BERC)

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 semi-automated woodchip heating system that would serve the Colton-Pierrepont Central School. 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 fuel oil 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 district 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.

Because the biomass scenario assumes that the new biomass boiler system would replace one of the existing boilers, a possible cost savings would be to sell the boiler that is removed to make room for the biomass boiler. Although the existing boilers are older, they have been very well maintained and should have good resale value. (The resale of an existing boiler is not included in the capital cost estimate for the analysis but should be considered in the next phase of study.)

## FUEL OIL COST ASSUMPTIONS

Fuel bills provided by the district indicate that Colton-Pierrepont Central School uses an average of 48,500 gallons of fuel oil per year to heat the school building 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, the district paid an average of $3.14 per gallon for fuel oil. At that price, the district will spend approximately $152,000 for fuel oil to heat this building next year.

## WOODCHIP FUEL COST ASSUMPTIONS

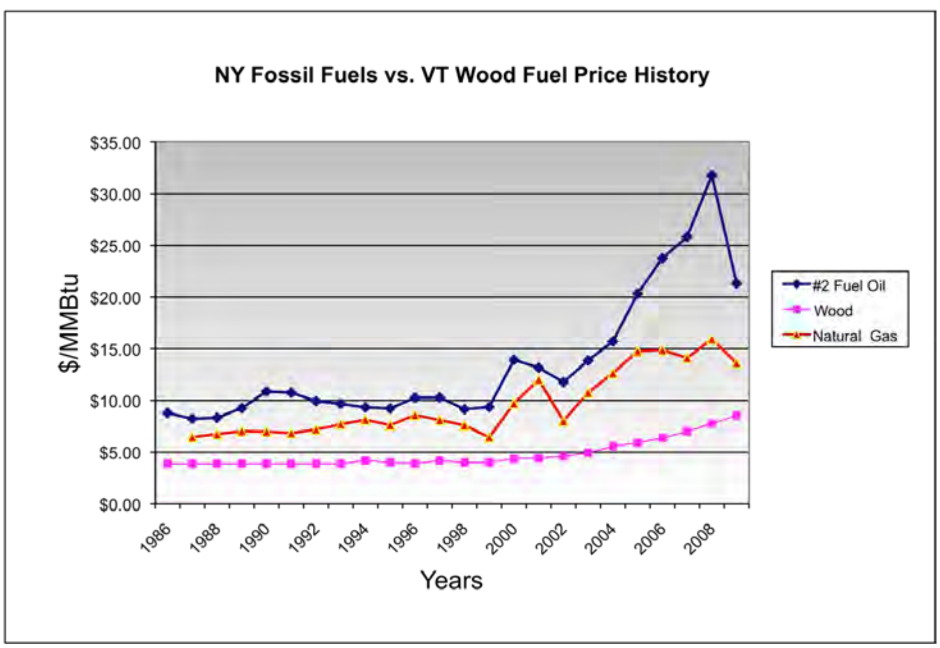
Frequently, operators of institutional woodchip systems don't fire up their biomass boilers until there is constant demand for building heat. During the fall and spring, fossil fuel boilers are often used as they are easier to start up and turn down. Woodchip boilers are then typically used in place 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 75%. 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 538 tons of chips per year. After consulting with the regional suppliers, we are projecting a first year cost of $50 per ton for woodchips, which is equivalent to about $0.80 per gallon for fuel oil. The remaining 25% of the heating needs were then assumed to be provided by #2 fuel oil, consuming about 12,125 gallons of fuel oil per year. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.

## INFLATION ASSUMPTIONS

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

We looked retrospectively over the last 20 years (1990 – 2009) using US Energy Information Agency data and found that the average annual increase for fuel oil in New York was 7.6% per year. The analysis projects this average inflation rate for fuel oil forward over the thirty-year analysis period. The district's fuel cost of $3.14/gallon was used for the first year of the analysis and then inflated each year at 7.6%.

**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 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 fuel oil boilers were taken into consideration as these are considered costs that the district 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. However, 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 the last time Colton-Pierrepont Central School upgraded its boilers was over twenty years ago in 1989, the school may be eligible for state school construction aid for a biomass boiler. If so, the school is typically eligible for 47% state school construction aid for school construction projects. Even if the biomass boiler is not

[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.

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 even without state school construction aid. In any event, the district should consult state officials about any planned construction project and get their determination on state aid directly from SED.

For the analysis in this report, it was assumed that this project would receive 47% state school construction aid and that the local district would finance the remaining cost of the 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 the district 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 forego financing and pay for the project outright, overall savings would be considerably greater.

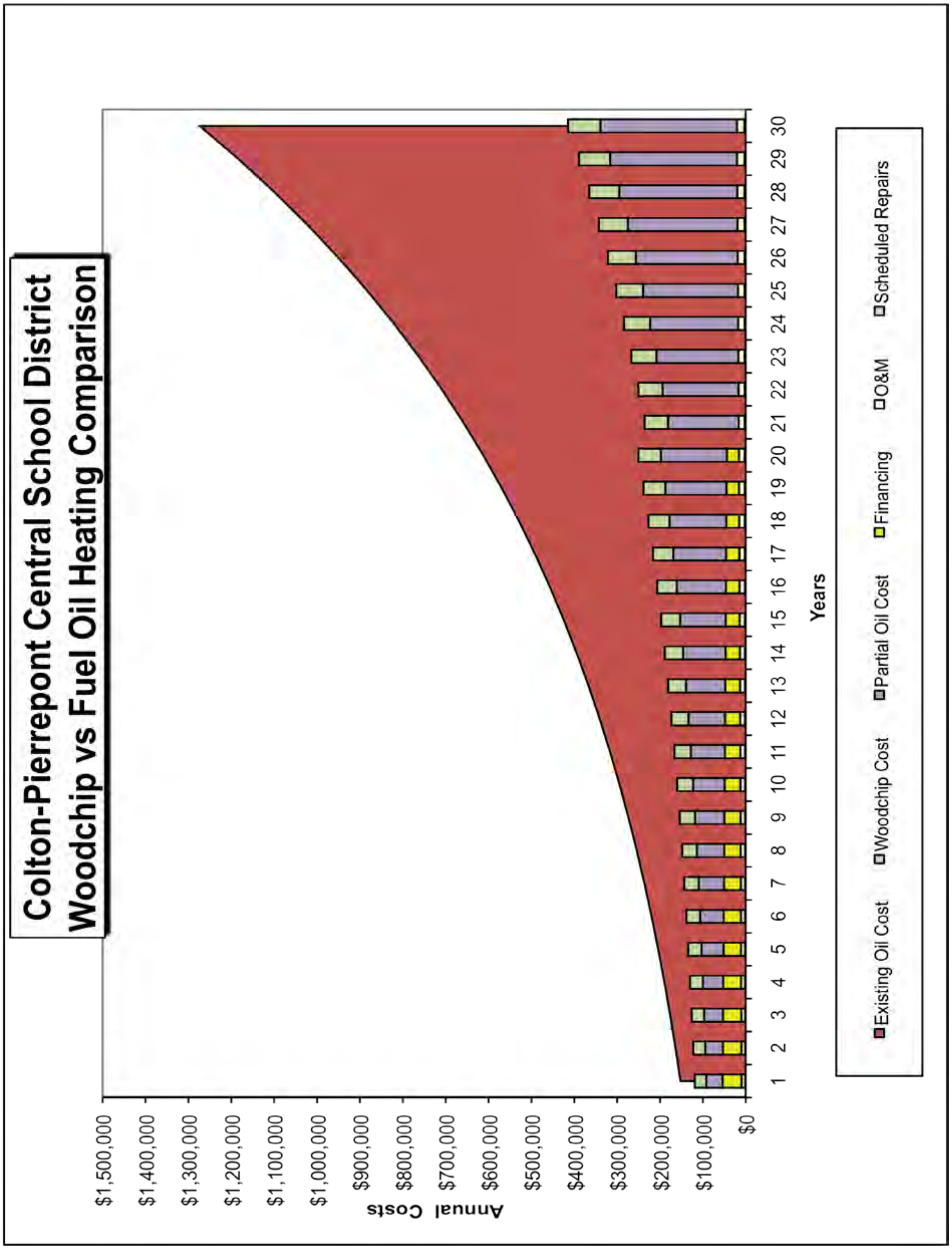
# BIOMASS SCENARIO ANALYSIS

The analysis shows that Colton-Pierrepont Central School District could save more than $5 million in today's dollars in operating costs over the next 30 years by installing a woodchip heating system, even including debt service on the cost of the system. Annual fuel savings alone are projected to be approximately $87,000 in the first year. If the district is able to obtain full state school construction aid, the project will have a substantial positive annual cash flow in the first year. Even without state school construction aid, the project breaks even the first year and energy cost savings increase over time as fuel oil prices climb.

**Table 2: Woodchip Scenario Analysis Assumptions**

| Colton-Pierrepont Central School | | | |
|---|---|---|---|
| Capital Cost Assumptions | | | |
| 2.0 mmBtu woodchip hot water boiler system including installation | | | $400,000 |
| 50 ft stack | | | $25,000 |
| Pollution control equipment | | | $100,000 |
| Chip Storage building | $100 /SF | 1,000 SF | $100,000 |
| Boiler room retrofit costs | | | $50,000 |
| Thermal Storage 3,000 gallon | | | $30,000 |
| Interconnect to existing boiler system | | | $25,000 |
| Cost of Skid Steer | | | $20,000 |
| GC markup at 10% | | | $73,000 |
| Construction contingency at 15% | | | $109,500 |
| Design at 12% | | | $111,900 |
| **Total estimated project costs** | | | $1,044,400 |
| **State Aid at** | | **47%** | $490,868 |
| **Total Local Share** | | | $553,532 |
| Financing Costs | | | |
| Financing, annual interest rate | | | 3.0% |
| Finance term (years) | | | 20 |
| 1st full year debt service | | | $44,283 |
| Fuel Cost Assumptions | | | |
| Current annual fuel oil consumption in gallons | | | 48,500 |
| Assumed fuel oil price per gallon | | | $3.14 |
| Projected annual fuel oil bill | | | $152,290 |
| Assumed woodchip price in 1st year (per ton) | | | $50 |
| Projected 1st year woodchip fuel bill | | | $26,892 |
| Projected 1st year supplemental fuel oil bill | | | $38,073 |
| Inflation Assumptions | | | |
| General inflation rate (twenty year average CPI) | | | 2.6% |
| Fuel oil inflation rate | | | 7.6% |
| Woodchip inflation rate (average increase in VT from 1988 - 2008 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** | | | **$87,326** |
| **Total 30 year NPV cumulative savings** | | | **$5,044,181** |

**Figure 5: Annual Cash Flow Graph for Woodchip Scenario**



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

**Colton-Pierrepont Central School** — **Preliminary Life Cycle Cost Estimate** — ***Semi-Automated Woodchip - Heat Only***

| | | | |
|---|---|---|---|
| **Total estimated construction costs** | *$1,044,400* | *Estimated state aid* | **$490,868** |
| **Local Share:** | $553,532 | | |
| **Financing:** | 3.0% | *Assumed interest rate each year, 20 years* | |
| **Oil heat consumption** | 48,500 | 25% oil = 12,125 gallons | 717 tons if 100% woodchips for oil; 68 gal. / ton of woodchips |
| **Oil heat price** | $3.14 | | |
| **Oil heat cost** | $152,290 | | |
| **Estimated woodchip utilization** | 75% | | |
| **Projected woodchip consumption** | 538 tons | | |
| **Estimated 1st year woodchip price** | $50 / ton Year 1 | | |
| **Projected 1st year woodchip cost** | $26,892 | | |
| **Projected 1st year partial fuel oil cost** | $38,073 | | |
| **General Inflation:** | 2.6% annually | *Twenty year average annual US Labor Dept. Consumer Price Index increases* | |
| **Oil Inflation** | 7.6% | *Average increase for New York Residential Fuel Oil from 1991 - 2009 (US EIA)* | |
| **Woodchip Inflation:** | 3.60% annually | *Average increase in VT from 1988 - 2008 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. | Oil Cost | Total | Financing | Woodchip Cost | Partial Oil Cost | O&M | Scheduled Repairs | Total | Annual Cashflow | Cumulative Cashflow |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $152,290 | $152,290 | $44,283 | $26,892 | $38,073 | $8,500 | $1,500 | $119,247 | $33,043 | $33,043 |
| 2 | $163,864 | $163,864 | $43,452 | $27,860 | $40,966 | $8,721 | $1,539 | $122,538 | $41,326 | $74,370 |
| 3 | $176,318 | $176,318 | $42,622 | $28,863 | $44,079 | $8,948 | $1,579 | $126,091 | $50,227 | $124,597 |
| 4 | $189,718 | $189,718 | $41,792 | $29,902 | $47,429 | $9,180 | $1,620 | $129,923 | $59,795 | $184,391 |
| 5 | $204,136 | $204,136 | $40,961 | $30,978 | $51,034 | $9,419 | $1,662 | $134,055 | $70,082 | $254,473 |
| 6 | $219,651 | $219,651 | $40,131 | $32,093 | $54,913 | $9,664 | $1,705 | $138,506 | $81,144 | $335,617 |
| 7 | $236,344 | $236,344 | $39,301 | $33,249 | $59,086 | $9,915 | $1,750 | $143,300 | $93,044 | $428,661 |
| 8 | $254,306 | $254,306 | $38,470 | $34,446 | $63,577 | $10,173 | $1,795 | $148,461 | $105,845 | $534,506 |
| 9 | $273,634 | $273,634 | $37,640 | $35,686 | $68,408 | $10,438 | $1,842 | $154,014 | $119,620 | $654,126 |
| 10 | $294,430 | $294,430 | $36,810 | $36,970 | $73,607 | $10,709 | $1,890 | $159,986 | $134,443 | $788,570 |
| 11 | $316,807 | $316,807 | $35,980 | $38,301 | $79,202 | $10,987 | $1,939 | $166,409 | $150,398 | $938,968 |
| 12 | $340,884 | $340,884 | $35,149 | $39,680 | $85,221 | $11,273 | $1,989 | $173,313 | $167,571 | $1,106,539 |
| 13 | $366,791 | $366,791 | $34,319 | $41,109 | $91,698 | $11,566 | $2,041 | $180,732 | $186,058 | $1,292,597 |
| 14 | $394,667 | $394,667 | $33,489 | $42,588 | $98,667 | $11,867 | $2,094 | $188,705 | $205,962 | $1,498,559 |
| 15 | $424,662 | $424,662 | $32,658 | $44,122 | $106,165 | $12,175 | $2,149 | $197,269 | $227,392 | $1,725,952 |
| 16 | $456,936 | $456,936 | $31,828 | $45,710 | $114,234 | $12,492 | $2,204 | $206,469 | $250,468 | $1,976,419 |
| 17 | $491,663 | $491,663 | $30,998 | $47,356 | $122,916 | $12,817 | $2,262 | $216,348 | $275,316 | $2,251,735 |
| 18 | $529,030 | $529,030 | $30,167 | $49,060 | $132,257 | $13,150 | $2,321 | $226,956 | $302,074 | $2,553,809 |
| 19 | $569,236 | $569,236 | $29,337 | $50,827 | $142,309 | $13,492 | $2,381 | $238,346 | $330,890 | $2,884,699 |
| 20 | $612,498 | $612,498 | $28,507 | $52,656 | $153,124 | $13,843 | $2,443 | $250,573 | $361,925 | $3,246,624 |
| 21 | $659,048 | $659,048 | | $54,552 | $164,762 | $14,203 | $2,506 | $236,023 | $423,025 | $3,669,649 |
| 22 | $709,135 | $709,135 | | $56,516 | $177,284 | $14,572 | $2,571 | $250,943 | $458,192 | $4,127,841 |
| 23 | $763,030 | $763,030 | | $58,550 | $190,757 | $14,951 | $2,638 | $266,897 | $496,133 | $4,623,974 |
| 24 | $821,020 | $821,020 | | $60,658 | $205,255 | $15,339 | $2,707 | $283,960 | $537,060 | $5,161,034 |
| 25 | $883,417 | $883,417 | | $62,842 | $220,854 | $15,738 | $2,777 | $302,212 | $581,206 | $5,742,239 |
| 26 | $950,557 | $950,557 | | $65,104 | $237,639 | $16,147 | $2,850 | $321,740 | $628,817 | $6,371,056 |
| 27 | $1,022,799 | $1,022,799 | | $67,448 | $255,700 | $16,567 | $2,924 | $342,639 | $680,161 | $7,051,217 |
| 28 | $1,100,532 | $1,100,532 | | $69,876 | $275,133 | $16,998 | $3,000 | $365,007 | $735,525 | $7,786,742 |
| 29 | $1,184,173 | $1,184,173 | | $72,392 | $296,043 | $17,440 | $3,078 | $388,952 | $795,220 | $8,581,962 |
| 30 | $1,274,170 | $1,274,170 | | $74,998 | $318,542 | $17,893 | $3,158 | $414,591 | $859,578 | $9,441,541 |
| Totals | $16,035,744 | $16,035,744 | $727,895 | $1,411,282 | $4,008,936 | $379,177 | $66,914 | $1,173,985 | $14,861,759 | |
| | 30 Yr. NPV at | $8,968,403 | 3% Discount Rate $553,532 | $853,149 | $2,242,101 | $234,124 | $41,316 | $3,924,222 | | |

| Total Annual Heating Costs | Woodchip Fuel /Year | Partial Fuel Oil 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 |
|---|---|---|---|---|---|---|---|---|---|
| $152,290 | $26,892 | $38,073 | $8,500 | $1,500 | $74,964 | $87,326 | $553,532 | 6.3 | $5,044,181 |

# 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 Colton-Pierrepont converts to biomass or stays with fuel oil, 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.

## 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 Colton-Pierrepont 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.

## HOT WATER VS. STEAM HEATING DISTRIBUTION

Regardless of whether the district moves forward with a biomass energy project, it should consider upgrading to a hot water heating distribution system. The existing steam system is aging and will only develop more maintenance issues over time. Hot water heat distribution is generally easier to maintain, is easier to control and is a more comfortable heat source than steam. It is also more 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. Nevertheless, we recommend the district consider converting to a hot water heat distribution system in the near future.

If the district does move ahead with a biomass project, we recommend the district consider including any needed improvements to its entire heating distribution system as part of the conversion project. The least costly time to deal with heating distribution upgrades is at the time of conversion. The design team will need to evaluate the condition and efficiency of the distribution system when sizing a new boiler system anyway and if improvements can be made, then it is possible to save money when sizing new boiler equipment.

# 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 district 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 issue 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
New York State Department of Education
cthurnau@mail.nysed.gov
(518) 474-3906

## MUNICIPAL LEASE / PURCHASE

As a municipal entity, this district 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.

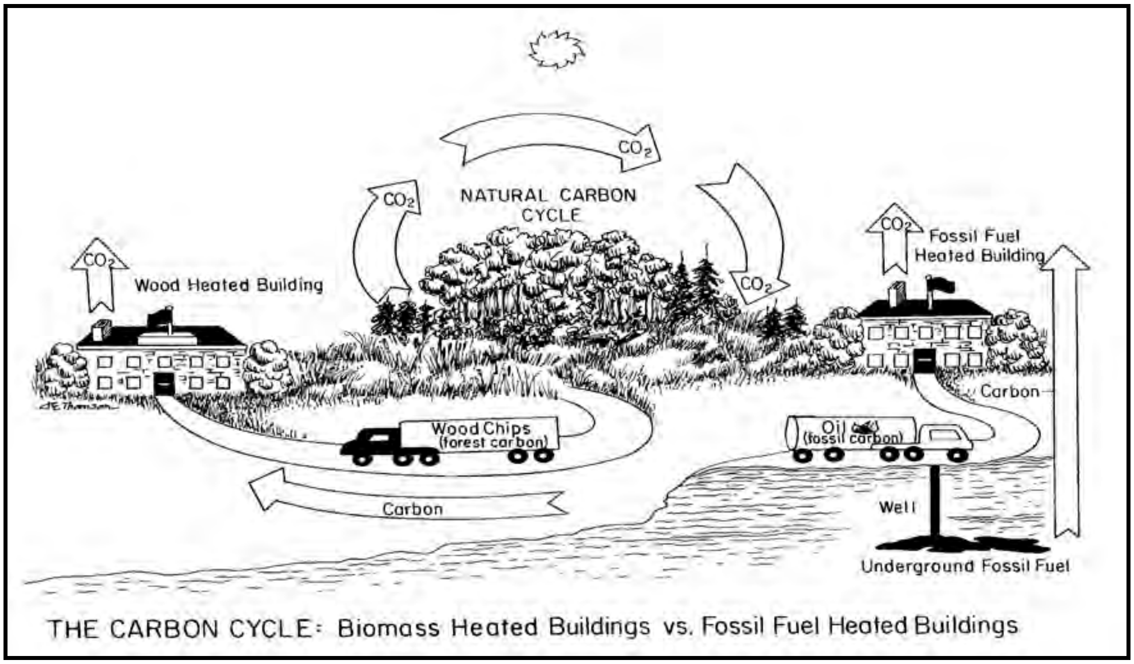
There are a number of companies that provide municipal leases. Information on municipal leasing is included in the *Biomass and Green Building Resources* binder accompanying this report.

## 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 the district could undertake that would reduce its carbon footprint more than switching their heating fuel use from fuel oil to a biomass fuel.

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.

**Figure 5: Carbon Cycle Illustration**[4]




For a biomass heat-only project, a Btu-for-Btu displacement of heating fuel (based on historic purchase records) by biomass is assumed over the project's predicted operating life. $CO_2$ avoidance is based on the emissions profile (Lbs. $CO_2$ /Btu) of the displaced fuel. The US EPA calculates that 22.2 lbs. of $CO_2$ is produced from each gallon of fuel oil consumed. It is projected that the Colton-Pierrepont Central School can offset approximately 36,000 gallons of fuel oil per year by replacing that heat using biomass. This is equivalent to about 400 tons of $CO_2$. The market value of this type of offset is between $3/ton and $5/ton. These offsets can be negotiated as either a lump sum offset for up to 10 years or can be paid out as an annual payment. This could mean annual payments of $1,200 - $2,000 or a lump sum up front payment of as much as $20,000.

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.

[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.

**Table 4: Comparison of Boiler Emissions Fired by Woodchips and Distillate Oil[5]**

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

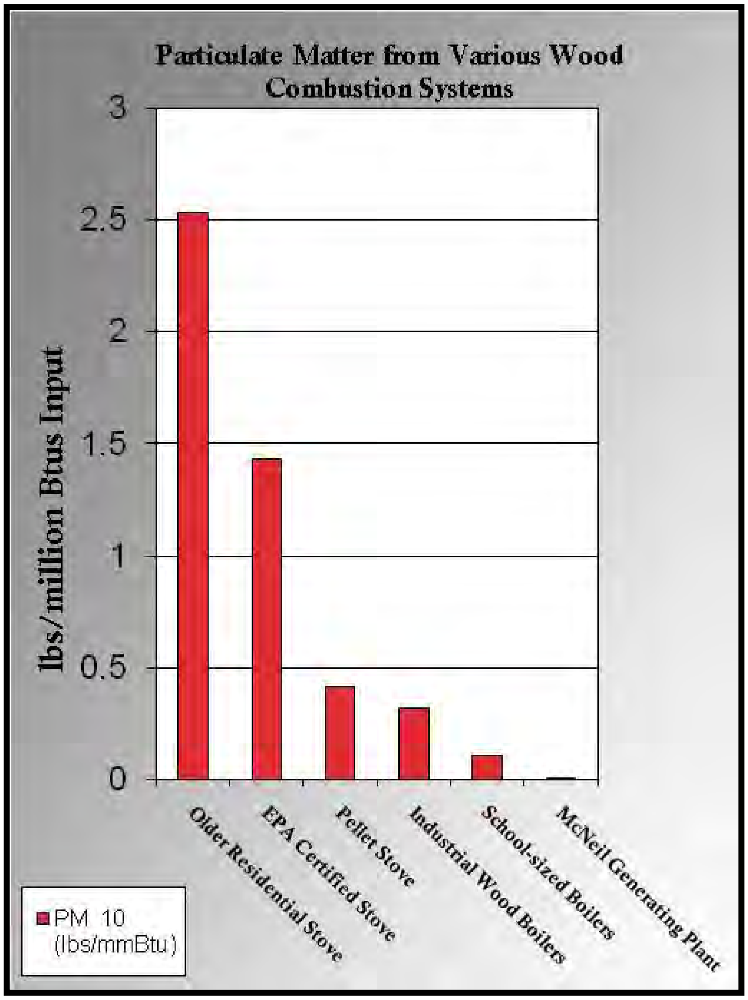
As with any combustion process, there are emissions from biomass boilers. The pollutant of greatest concern with biomass is particulates ($PM_{10}$). While biomass compares reasonably well with fuel oil, biomass boilers clearly generate more particulates. That is why it is important to install appropriate 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

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

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 6: Particulate Emissions**[6]




**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 likely that the district will need 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 or an electrostatic precipitator along with a requirement for a tall stack to help with dispersion. Costs for pollution control equipment and a

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

tall stack are included in the cost estimates for the woodchip scenario analyzed in this report. Other permit conditions might include testing for emissions and efficiency, keeping records of fuel consumption and test results and making periodic submittals to regulatory agencies.

# CONCLUSIONS AND RECOMMENDATIONS

The Colton-Pierrepont Central School appears to be an excellent candidate for a woodchip heating system. The school is well sited for a biomass boiler house. The existing boiler systems could work well to provide back-up and supplemental heat in combination with a wood fired boiler. The school has ready access to low cost woodchip fuel. We recommend the district 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. 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.
3. Regardless of whether Colton-Pierrepont moves forward with a biomass project, the district should consider upgrading the existing steam distribution system to a hot water distribution system. Costs for a heating distribution system were not included in this analysis because a project of that nature will require a careful engineering study to determine the best equipment alternatives and to estimate costs. Such an engineering study was beyond the scope for this project. However, hot water distribution is typically easier to maintain, is more energy efficient and provides a more comfortable heat than steam. It is likely that the fuel cost savings from a biomass project will more than offset the costs of converting to a hot water distribution system.
4. Emission regulations for commercial boilers will be changing in the near future. The EPA is undergoing a public review process for draft rules that could affect the type of equipment specified for a site like this. The engineers hired by the district for a biomass project should carefully review the new rules and evaluate the best available technology options for pollution control devices when they are designing this project.
5. The biomass scenario analyzed in this report assumes one of the existing boilers will be replaced with a biomass boiler. If an existing boiler is replaced, the district should be able to sell it, as both existing boilers have been well maintained.
6. Regardless of whether Colton-Pierrepont moves forward with a biomass energy system, the district 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 Resource 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, Colton-Pierrepont 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, LLC

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 fuel oil. While fuel oil 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, facility managers should also be cultivating potential biomass fuel suppliers.

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

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

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

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

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

It is best to try to locate several potential suppliers. By doing so, the district 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 facility managers 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 facility managers 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