Preliminary Feasibility Report

Biomass Heating Analysis for Fannett-Metal School District
Willow Hill, Pennsylvania
April, 2012
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EXECUTIVE SUMMARY

The Fannett-Metal School District serves 600 students in a 46,000 square foot Elementary School and a 47,000 square foot High School. The Elementary School is served by a hot water distribution system and the High School is served by a steam distribution system; both schools are heated with fuel oil. The two schools are approximately 250 feet apart on the same site, and there is a suitable site between them for a biomass boiler house and a woodchip storage bin.

The Fannett-Metal School District currently uses approximately 13,930 gallons of fuel oil to heat the Elementary School and 19,596 gallons of fuel oil to heat the High School on average each year. The District is currently paying $3.29 per gallon of fuel oil. At that price, the Elementary School will spend approximately $45,829 on fuel oil and the High School will spend approximately $64,471 on fuel oil for a combined bill of $110,301 this coming year.

This report analyzes two different biomass scenarios for the Fannett-Metal School District. One scenario analyzes the installation of a pellet boiler to serve the Elementary School only, while the second scenario analyzes the installation of a woodchip system that would serve both the Elementary and High Schools. The pellet scenario has a significantly lower capital cost, but the woodchip scenario has much greater fuel cost savings. If the District decides to move forward with a biomass project, it will need to weigh the costs and benefits of each scenario.

Table 1: Summary Findings of Biomass Analyses for Fannett-Metal School District

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total Estimated Project Costs</th>
<th>Annual Tons Woodchips / Pellets</th>
<th>Tons of Carbon Offset by Biomass</th>
<th>Return on Investment</th>
<th>Net 1st Year Fuel Savings</th>
<th>Total 30 Year NPV Cumulative Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Pellet system serving Elementary School</td>
<td>$396,000</td>
<td>99</td>
<td>131</td>
<td>4.8%</td>
<td>$19,202</td>
<td>$723,000</td>
</tr>
<tr>
<td>2) Woodchip system serving both schools</td>
<td>$1.35 million</td>
<td>455</td>
<td>316</td>
<td>5.6%</td>
<td>$75,573</td>
<td>$2.19 million</td>
</tr>
</tbody>
</table>

The analysis shows that Fannett-Metal would need to spend approximately $396,000 for a pellet system and the required infrastructure, versus $1.35 million for a woodchip system, and the District would save approximately $19,000 on fuel in the first year with a pellet system, versus $75,000 with a woodchip system. The chart on the following page compares annual heating costs over the next 30 years for Fannett-Metal with the existing heating systems, a wood pellet system serving the Elementary School and woodchip system serving both schools. As you can see, the analysis predicts that both biomass scenarios will provide savings of the existing fuel oil systems.

Fannett-Metal School District Biomass Pre-Feasibility Report
The Fannett-Metal School District appears to be a good candidate for a biomass system. Both scenarios that were analyzed have a good return on investment. The pellet scenario (Scenario 1) requires a significantly smaller investment than the woodchip scenario (Scenario 2) but it also has a smaller return on investment. Conversely, the woodchip scenario has a significantly higher installation cost, but a much better short term and long term return on investment. We recommend the District take the following steps to investigate this opportunity further.

1. The US Forest Service may be able to provide a phase II engineering analysis that refines the project concept. If the District decides to move forward with a biomass project, decision-makers should contact Lew McCreery, the US Forest Service Biomass Coordinator for the Northeastern Area, to see what assistance can be provided. Contact Lew at (304)285-1538 or lmccreery@fs.fed.us.

2. From the original site visit, it was obvious that the buildings at this facility are very well run. In order to continue this level of maintenance, it is recommended that the District develop a facilities operation and maintenance manual that describes current practices and includes recommendations for future improvements. For example, the facility manager does an excellent job of controlling
the boiler inputs and outputs. It may be worth considering automating some of those controls in the future to make sure that the efficiency of the system is not reliant on any particular individual.

3. The District recently received a walk through energy audit and should consider energy efficiency improvements simultaneously with boiler upgrades. The efficiency of the building envelope and ventilation equipment need to be considered when sizing new boiler equipment. This should be done regardless of whether or not the District moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives is included in the *Biomass and Green Building Resources* binder accompanying this report.

4. In order to effectively measure progress toward energy efficiency goals historical energy consumption data should be collected and updated frequently. The facility manager for this school does an excellent job of not only tracking fuel deliveries, but also measuring fuel consumption on a regular basis. There are many tools that could help the District accomplish this electronically. 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 and provides useful reports and graphs. This software can be downloaded at: [http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager](http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager).

5. The District should also work with Mike Palko, Biomass Energy Specialist with the Pennsylvania Department of Conservation & Natural Resources, Bureau of Forestry, to cultivate potential biomass fuel suppliers concurrent with the design of the biomass system.

*This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates for the Fannett-Metal School District. 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 45 public schools in Vermont and ten in Pennsylvania. 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.

In addition to the potential financial benefits of installing a biomass energy system, a biomass system would utilize locally grown and harvested wood (keeping energy dollar in the local economy); reduce the District’s carbon footprint (by replacing fossil fuel with a renewable fuel source); and reduce dependence on fossil fuel, helping Pennsylvania to achieve targets for renewable energy use. This analysis indicates that Fannett-Metal School District could offset up to 316 tons of CO$_2$ annually by installing a woodchip system to serve the Elementary and High School (approximately 131 tons of CO$_2$ would be offset each year with a pellet system at the Elementary School).

This report is a pre-feasibility assessment specifically tailored to Fannett-Metal School District outlining whether or not a biomass system makes sense for this facility from a practical perspective. In December 2011, staff from Yellow Wood Associates traveled to Franklin County, Pennsylvania to tour the Fannett-Metal Elementary School and High 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

EXISTING HEATING SYSTEMS AND FUEL USAGE

The Fannett-Metal Elementary School is heated with a 3278.3 MBH hot water boiler that was installed in 1974 and is in good condition. The school is served by a hot water distribution system. The Elementary School uses an average of 13,930 gallons of fuel oil each year. The High School is heated with a 3385.1 MBH fuel oil boiler that was installed in 1983 and is in good condition. The High School is served by a steam distribution system and uses an average of 19,596 gallons of fuel oil each year.

Figure 2: Average Annual Fuel Oil Usage (2008-2011)
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 scenarios include all ancillary equipment and interconnection costs. Under the biomass scenarios, the existing heating equipment would still be used to provide supplemental heat during the coldest days of the year if necessary and potentially for the warmer shoulder season months when buildings only require minimal heating during chilly weather.

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

It is not the intent of this project, nor was it in the scope of work, to develop detailed cost estimates for a biomass system. It is recommended that for a project of this scale, the 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.
FUEL OIL COST ASSUMPTIONS

Based on school records, during the past three years, the District used an estimated 13,930 gallons of fuel oil to heat the Elementary School and 19,596 gallons of fuel oil to heat the High School. These totals were the assumed annual fuel consumption used for the base cases of the biomass analyses. The most recent price paid for fuel oil, in October 2011, was $3.29 per gallon according to the District. At that price, the District will spend more than $45,800 to heat the Elementary School and $64,000 to heat the High School in the coming 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 well over 40 schools that heat with wood, the average annual wood utilization is about 85%. This analysis assumes that the woodchip boiler will cover 85% of the heat load at the Elementary and High School.

After consulting with other woodchip users in the region, we are projecting a first year cost of $40 per ton for woodchips which is equivalent to about $0.60 per gallon of fuel oil. The remaining 15% of the heating needs were then assumed to be provided by the existing fuel oil systems at each of the schools. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.

WOOD PELLET FUEL COST ASSUMPTIONS

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

The biomass scenario utilizing pellets assume the Elementary School will meet 85% of its winter heating needs with pellets. The remaining 15% of the heating needs were then assumed to be provided by fuel oil. The costs for supplemental fuel oil and pellets are 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 30-year analysis, some rate of inflation needs to be applied to future fuel costs.

We looked retrospectively over the last 20 years (1990 – 2010) using US Energy Information Agency data and found that the average annual increase for fuel oil in Pennsylvania was 7.1% per year. The analysis projects this average inflation rate for fuel oil forward over the 30-year analysis period. The District’s fuel rate of $3.29 per gallon was used for the first year of the analysis and then inflated each year at 7.1%.

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

Figure 3: Woodchip and Pennsylvania Fossil Fuel Inflation

\(^1\) Extrapolated from Vermont Superintendent Association School Energy Management Program data. Woodchip price history is taken from Vermont because this State has the longest and best recorded, woodchip pricing history.
Pellet fuel pricing tends to track that of fossil fuels more closely than woodchips for two reasons. First, it takes a considerable amount of energy to produce pellets. Woodchip and sawdust feedstock need to be dried, which requires energy, and then it also takes energy to compress the feedstock into pellets. Second, wood pellet fuel is used almost exclusively as a heating fuel. It competes directly with fossil fuels used for heat. While it is true that wood pellet fuel tends to be produced relatively locally and therefore has less geopolitical volatility than fossil fuels, there does appear to be a link between pellet fuel prices and fuel oil prices. The Biomass Energy Resource Center uses 4.25% as an inflation factor for pellet fuel. This is more than the average rate of inflation for woodchip fuel over the past twenty years but less than the rate of inflation over the same period for fuel oil. For this analysis it was assumed that wood pellet fuel would inflate at 4.25% per year.

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

OPERATION AND MAINTENANCE ASSUMPTIONS

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

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

Another operations and maintenance cost that is included in both analyses is periodic repair or replacement of major items on the boilers such as the furnace refractory. It is reasonable to anticipate these types of costs on a 10-15 year cycle. Analysis for the woodchip scenario included $15,000 of scheduled maintenance anticipated in years 10, 20 and 30 and then annualized at $1,500 per year to simulate a sinking fund for major repairs. The $1,500 annual payments were inflated at the general annual

\(^2\) Wood ash is generally not considered a hazardous material in most states and can be landfilled or land applied as a soil amendment by farmers or on-site maintenance staff.
inflation rate. Pellet boiler systems have fewer moving parts and should not require as much scheduled maintenance as a woodchip system. An annualized maintenance cost of $1,000 per year was included in the pellet scenario analysis and then inflated at the general inflation rate.

Under any biomass scenario, a case could be made that the existing heating units will require less maintenance and may last longer since they will only be used for a small portion of the heating season. However, all heating equipment should be serviced at least annually no matter how much it is used. Additionally, it is very difficult to estimate how long the replacement of the existing units might be delayed. For these reasons, no additional annual maintenance, scheduled repair or planned replacement costs for the existing boilers were taken into consideration as these are considered costs that the Fannett-Metal School District 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 District will finance the entire cost of the biomass project with a low interest 4% 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 District would like to see other cash flows using different financing schemes, Yellow Wood can provide additional analysis.
BIOMASS SCENARIOS

This report analyzes two different scenarios for the Fannett-Metal School District. The first scenario envisions adding a pellet boiler, located in a small boiler house at the Northwest corner of the school, to the existing heating system at the Elementary School. The second scenario envisions building a woodchip boiler house between the Elementary School and the High School (See site plan below). In this scenario, hot water would be piped from the boiler house to the Elementary School and steam would be piped from the boiler house to the High School.

Figure 4: Site Plan

THERMAL STORAGE

A thermal storage system is also included in the capital costs of both scenarios. In this case the thermal storage system includes a large, insulated hot water tank and ancillary piping and pumps that connect the insulated storage tank to the wood fired boiler and to the building heating system. Heat from the wood boiler is stored in the water in the insulated tank until needed by the building system. This allows the
boiler to operate in a high fire state at peak efficiency and then be turned off or to go into a stand-by mode where a minimal amount of fuel is being burned.

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

Additional benefits of the thermal storage system include the ability to extend the operation of the wood combustion system during shoulder seasons. It is also possible to include solar thermal energy systems to be connected to the storage tank. Such combination systems are often used in Europe to meet summer domestic hot water needs and to increase overall system efficiency.

**BIOMASS SCENARIO 1 – PELLET SYSTEM SERVING THE ELEMENTARY SCHOOL**

Biomass Scenario 1 envisions a pellet boiler system located in a small boiler house outside of the existing boiler room. For the stand-alone pellet scenario we are assuming that the pellet boiler will meet 85% of the annual heating needs currently met with fuel oil at the Elementary School. The scenario analyzes the construction of a boiler house, containing a 1.7 mmBtu wood pellet boiler and 1,700 gallons of thermal storage. Hot water from the boiler would be tied into the exiting HVAC systems in the Elementary School via approximately 50 feet of underground insulated piping. Costs for a 40-ton pellet storage silo and an allowance for interconnecting to the existing heating distribution systems are included in the proposed capital costs.

**BIOMASS SCENARIO 1 - ANALYSIS**

The analysis of Biomass Scenario 1 shows that Fannett-Metal could save more than $723,000 in today’s dollars in operating costs over the next 30 years -even including debt service on the cost of the system- by installing a wood pellet system to provide heat and hot water for the Elementary School. Annual fuel savings are projected to be $19,202 per year in the first year and should increase over time as fossil fuel prices continue to climb. The return on investment from fuel savings is estimated at 4.8% and this project would have a positive annual cash flow in the eighth year.
# Table 2: Biomass Scenario 1 Analysis Assumptions

## Fannett-Metal School District

### Pellet Scenario

<table>
<thead>
<tr>
<th>Capital Cost Assumptions</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>One 1.7 mmBio containerized pellet hot water boiler system including installation</td>
<td>$200,000</td>
</tr>
<tr>
<td>40 ton pellet storage silo</td>
<td>$30,000</td>
</tr>
<tr>
<td>Underground insulated hot water piping from boiler house to school</td>
<td>$7,500</td>
</tr>
<tr>
<td>Thermal Storage 1,700 gallon</td>
<td>$17,000</td>
</tr>
<tr>
<td>Interconnect to existing boiler system</td>
<td>$25,000</td>
</tr>
<tr>
<td>GC markup at 10%</td>
<td>$27,950</td>
</tr>
<tr>
<td>Construction contingency at 15%</td>
<td>$46,118</td>
</tr>
<tr>
<td>Design at 12%</td>
<td>$42,428</td>
</tr>
<tr>
<td><strong>Total estimated project costs</strong></td>
<td><strong>$395,996</strong></td>
</tr>
</tbody>
</table>

### Financing Costs

- Financing, annual interest rate: 4.0%
- Finance term (years): 20
- 1st full year debt service: $35,244

### Fuel Cost Assumptions

- Current annual fuel oil use (gal): 13,930
- Assumed fuel oil price in 1st year: $3.29
- Projected annual fuel oil bill: $45,830
- Percent pellet fuel utilization: 85%
- Fuel oil (gal)/ton ratio: 120
- Assumed pellet price in 1st year (per ton): $200
- Projected 1st year pellet fuel bill: $19,753
- Projected 1st year supplemental fuel oil bill: $6,974

### Inflation Assumptions

- General inflation rate (twenty year average CPI): 2.7%
- Fuel oil inflation rate (twenty year EIA average for Pennsylvania): 7.1%
- Pellet inflation rate (estimate from Biomass Energy Resource Center): 4.25%

### O&M Assumptions

- Annual pellet O&M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance: $2,000
- Major repairs (annualized): $1,000

### Savings

- Return on Investment: 4.68%
- Net 1st year fuel savings: $19,202
- Total 30 year NPV cumulative savings: $723,218
Figure 5: Annual Cash Flow Graph for Biomass Scenario 1

This graph shows the projected cash flow over the 30 year life-cycle of the biomass boiler. The graph takes into account projected heating fuel savings (cost of pellets versus the cost of fuel oil), projected revenue and projected debt service.
### Fannett-Metal School District Biomass Pre-Feasibility Report

#### Preliminary Life Cycle Cost Estimate

<table>
<thead>
<tr>
<th>Total estimated construction costs</th>
<th>$395,996</th>
<th>Conceptual project cost, pellet system, building and associated costs.</th>
</tr>
</thead>
</table>
| Financing:                         |          | 4.0% Bond interest  
| 20 Term of bond                    |          |                                                   |
| Oil heat consumption               | 13,930   | 15% Load covered by Fuel oil = 2,090 gallons  
| Oil heat price                     | $3.39    | 120 gal. / ton of pellets                      |
| Oil heat cost                      | $45,830  | 116 tons if 100% pellets for oil               |
| Estimated pellet utilization       | 85%      |                                                    |
| Projected pellet consumption       | 99 tons  |                                                    |
| Estimated 1st year pellet price    | $200 / ton Year 1 | Estimate of additional electricity for feed system motors and additional maintenance staff time |
| Projected 1st year pellet cost     | $19,753  | Contingency for major repair (e.g. refractory replacement) at Years 10, 20 and 30 annualized |
| Projected 1st year partial fuel oil cost | $6,874 | $2,000 in Year 1 $ |
| **General inflation:**             | 7.1% annually | Twenty year average annual US Labor Dept. Consumer Price Index increases |
| **Oil inflation:**                 | 2.5% annually | Average increase for Pennsylvania Commercial Fuel Oil from 1990 - 2010 (US EIA) |
| **Pellet Inflation:**              | 2.5% annually | Estimate from Biomass Energy Resource Center |
| **O & M:**                         | $1,000 |                                                   |

#### Table 3: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario 1

<table>
<thead>
<tr>
<th>Total Yr. Fuel Costs</th>
<th>Finance Cost</th>
<th>Pellet Partial</th>
<th>Total O&amp;M</th>
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### 30 Year NPV at 4.0% Discount Rate

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<tr>
<th>Total Annual Heating Costs</th>
<th>Pellet Fuel First Year</th>
<th>Partial Fossil Fuel First Year</th>
<th>Pellet System O&amp;M /yr</th>
<th>Scheduled Repairs Allowance / Year</th>
<th>Pellet + Fossil Fuel + O&amp;M + Shoudled Repair</th>
<th>Annual Fuel Cost Savings</th>
<th>Total Project Cost</th>
<th>Simple Payback (yrs)</th>
<th>30 Year NPV Savings</th>
<th>Return on Investment</th>
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<td>$1,000</td>
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Table 3: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario 1
BIOMASS SCENARIO 2 – WOODCHIP SYSTEM SERVING BOTH SCHOOLS

Biomass Scenario 2 analyzes the installation of a woodchip boiler to serve the Elementary School and High School. The woodchip biomass scenarios envision building a 2,500 square foot stand-alone boiler house and chip storage facility which would house a 4.2 mmBtu woodchip steam boiler and below ground woodchip fuel storage. Steam from the woodchip boiler house would be tied into the exiting steam distribution system at the High School via 150 linear feet of insulated piping and hot water would be tied into the HVAC system at the Elementary School via approximately 100 feet of underground insulated piping. Costs for a tall stack were included to ensure good emissions dispersal. An allowance for pollution control equipment was also included. The District should direct its design engineers to investigate the costs and benefits of different types of pollution control equipment before making a decision on which technology will work best in this situation.

Figure 6: Underground Insulated Piping

BIOMASS SCENARIO 2 - ANALYSIS

The analysis of Biomass Scenario 2 shows that Fannett-Metal could save more than $2.19 million in today’s dollars in operating costs over the next 30 years -even including debt service on the cost of the system- by installing a woodchip system to provide heat and hot water for the Elementary School and High School. Annual fuel savings are projected to be $75,573 per year in the first year and should increase over time as fossil fuel prices continue to climb. The return on investment from fuel savings is estimated at 5.6% and this project would have a positive annual cash flow in the seventh year.
Table 4: Biomass Scenario 2 Analysis Assumptions

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<tr>
<th>Capital Cost Assumptions</th>
<th>Cost</th>
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<td>4.2 mmBtu woodchip steam boiler including installation</td>
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<td>70 ft stack</td>
<td>$35,000</td>
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<tr>
<td>Pollution control equipment</td>
<td>$100,000</td>
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<tr>
<td>Woodchip boilerhouse and chip storage building</td>
<td>2,500 SF</td>
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<tr>
<td>Underground insulated steam water piping from boiler house to high school</td>
<td>150 LF</td>
</tr>
<tr>
<td>Underground insulated hot water piping from boiler house to elementary school</td>
<td>100 LF</td>
</tr>
<tr>
<td>Thermal storage 1,700 gallon</td>
<td></td>
</tr>
<tr>
<td>Interconnection to existing boiler room</td>
<td></td>
</tr>
<tr>
<td>GC markup at 10%</td>
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<tr>
<td>Construction contingency at 15%</td>
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<tr>
<td>Design at 12%</td>
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</tr>
<tr>
<td>Total estimated project costs</td>
<td></td>
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</tbody>
</table>

| Financing Costs                                                                         |         |
| Financing, annual interest rate                                                         | 4.0%    |
| Finance term (years)                                                                    | 20      |
| 1st full year debt service                                                             |         | $121,444 |

| Fuel Cost Assumptions                                                                  |         |
| Current annual fuel oil use (gal)                                                      | 33,526  |
| Assumed fuel oil price in 1st year                                                     | $3.29   |
| Projected annual fuel oil bill                                                        | $110,301|
| Percentage of wood utilization                                                        | 85%     |
| Fuel oil (gal)/ton ratio                                                               | 63      |
| Assumed wood price in 1st year (per ton)                                               | $40     |
| Projected 1st year wood fuel bill                                                     | $18,182 |
| Projected 1st year supplemental fuel oil bill                                         | $16,545 |

| Inflation Assumptions                                                                  |         |
| General inflation rate (twenty year average CPI)                                       | 2.7%    |
| Fuel oil inflation rate (twenty year average EIA)                                      | 7.1%    |
| Wood inflation rate (twenty year average extrapolated from Vermont Superintendents Assoc. data) | 3.6%    |

| O&M Assumptions                                                                       |         |
| Annual Wood O&M cost                                                                  | $8,375  |
| Major repairs (annualized)                                                            | $1,500  |

| Savings                                                                                |         |
| Return on Investment from fuel savings                                                | 5.6%    |
| Net 1st year fuel savings                                                             | $75,573 |
| Total 30 year NPV cumulative savings                                                 | $2,191,153|

The graph below shows the projected cash flow over the 30 year life-cycle of the biomass boiler. The graph takes into account projected heating fuel savings (cost of woodchips versus the cost of fuel oil) projected revenue and projected debt service.
Figure 7: Annual Cash Flow Graph for Biomass Scenario 2
<table>
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<tr>
<th>Yr</th>
<th>Total Costs</th>
<th>Finance Cost</th>
<th>Woodchips Cost</th>
<th>Partial Fuel Cost</th>
<th>O&amp;M</th>
<th>Scheduled Repairs</th>
<th>Total Costs</th>
<th>Annual Cashflow</th>
<th>Cumulative Cashflow</th>
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<td>$98,445</td>
<td>$16,742</td>
<td>$2,999</td>
<td>$222,376</td>
<td>$402,512</td>
<td>$5,658,995</td>
</tr>
<tr>
<td>28</td>
<td>$702,060</td>
<td>$67,426</td>
<td>$44,946</td>
<td>$105,435</td>
<td>$17,194</td>
<td>$3,080</td>
<td>$229,946</td>
<td>$429,512</td>
<td>$6,168,507</td>
</tr>
<tr>
<td>29</td>
<td>$722,866</td>
<td>$68,946</td>
<td>$45,946</td>
<td>$112,921</td>
<td>$17,659</td>
<td>$3,163</td>
<td>$237,605</td>
<td>$457,439</td>
<td>$6,686,146</td>
</tr>
<tr>
<td>30</td>
<td>$808,255</td>
<td>$70,709</td>
<td>$47,938</td>
<td>$120,938</td>
<td>$18,153</td>
<td>$3,248</td>
<td>$245,383</td>
<td>$507,117</td>
<td>$7,193,263</td>
</tr>
<tr>
<td>Totals $4,571,508</td>
<td>$1,916,113</td>
<td>$519,505</td>
<td>$685,726</td>
<td>$2,189,286</td>
<td>$399,098</td>
<td>$3,378,738</td>
<td>$1,102,770</td>
<td>$2,191,153</td>
<td>$2,911,353</td>
</tr>
</tbody>
</table>

Discount Rate 4% 
30 Yr. NPV $2,378,738

Table 5: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario 2
ADDITIONAL 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 facility manager at these schools does an excellent job of tracking both fuel deliveries and fuel consumption on a regular basis. The Environmental Protection Agency has developed a public domain software program called Portfolio Manager that can track and assess energy and water consumption across an entire portfolio of buildings and might be a helpful addition to current practice. 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 Fannett-Metal School District 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:


ENERGY EFFICIENCY

Whether the District converts to biomass or stays with fuel oil, the District should use its heating fuel efficiently. The Pennsylvania Energy Partnership (PEP) is an initiative of the Local Development District Network of Pennsylvania, delivering energy education, training and technical assistance to 52 counties in Pennsylvania. The goal of the program is to reduce energy costs and consumption through efficiency and demand reduction. PEP has a range of programs and services available at no cost. For more information, go to: www.paenergypartnership.psu.edu. Additional funding for energy efficiency projects may be available through the Pennsylvania Green Energy Loan Fund (GELF) -see Project Funding Possibilities to learn more about GELF.

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

COMMISSIONING

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

**HOT WATER VS. STEAM HEATING DISTRIBUTION**

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

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

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

COMMONWEALTH FINANCE AUTHORITY

The Commonwealth Finance Authority (CFA) is an independent agency of the Commonwealth established to administer the State’s economic stimulus packages. Several schools and hospitals have used Commonwealth Finance Authority funding to fund their biomass projects. For more information on the CFA and programs available, go to: http://www.newpa.com/find-incentives-apply-for-funding/commonwealth-financing-authority.

PENNSYLVANIA GREEN ENERGY LOAN FUND (GELF)

The GELF energy loans provide low interest financing (3.5%) for building energy efficiency retrofits and high-performance energy systems that result in a 25% reduction in energy consumption. The GELF accepts loan applications on a rolling basis. For more information about the program and to download an application, go to: http://www.trfund.com/financing/energy/pagelf.html.

PENNSYLVANIA ENERGY DEVELOPMENT AUTHORITY (PEDA) GRANTS

PEDA grants provide financial assistance for alternative energy projects including biomass and energy efficiency. Funding can be used for capital costs such as construction and equipment purchase. Funding requires the project to have a research component and have a measureable environmental benefit for the commonwealth. You can access more information on PEDA grants and sign up to be notified when the next PEDA round opens at: http://www.portal.state.pa.us/portal/server.pt/community/peda-move_to_grants/10496.

WEST PENN POWER SUSTAINABLE ENERGY FUND

The West Penn Power Sustainable Energy Fund provides grants for renewable energy projects. While the fund is not currently accepting new proposals, they are in the process of developing a program that would provide funding for school biomass, and other demonstration, projects. For more information, contact:

Joel L. Morrison WPPSEF Program Administrator
814-865-4802
wppsef@ems.psu.edu
http://www.wppsef.org
WOODY BIOMASS UTILIZATION GRANT PROGRAM

The woody biomass utilization grant program, administered by the Department of Agriculture, provides grant funding for wood energy projects requiring engineering services. The woody biomass shall be used in a bioenergy facility that uses commercially proven technologies to produce thermal, electrical, or liquid/gaseous bioenergy. The funds from the Woody Biomass Utilization Grant program (WBU) must be used to further the planning of such facilities by funding the engineering services necessary for final design and cost analysis. This program is aimed at helping applicants complete the necessary design work needed to secure public and/or private investment for construction. In particular, USDA Rural Development has established grants and loan programs that might help fund construction of such facilities. For more information on the grant program, contact:

Lew R. McCrery
Biomass Coordinator, USFS Northeastern Area
180 Canfield St., Morgantown, WV 26505
(304) 285-1538
lmccreery@fs.fed.us

To see this year’s request for proposals go to:

APPALACHIAN REGIONAL COMMISSION

The Appalachian Regional Commission (ARC) is a federal-state partnership providing community and economic development resources. ARC awards project grants through their state offices. For more information on ARC grant opportunities, contact:

Neil Fowler
Community Affairs & Development
Pennsylvania Department of Community & Economic Development
Commonwealth Keystone Building
400 North Street, Fourth Floor
Harrisburg, PA 17120-0225
(717)214-5395
nfowler@state.pa.us
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 the local USDA office to express interest and to get program updates.

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*.

MUNICIPAL LEASE PURCHASE

As a municipal entity, the 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 about municipal leases is included in the *Biomass and Green Building Resources Binder* accompanying this report.

CARBON OFFSETS

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

Figure 8: Carbon Cycle Illustration

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 CO₂ 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. CO₂ avoidance is based on the emissions profile (Lbs. CO₂ /Btu) of the displaced fuel. The US EPA calculates that 22.2 lbs. of CO₂ is produced from each gallon of fuel oil consumed. It is projected that the Fannett-Metal School District can offset approximately 28,500 gallons of fuel oil per year by replacing that heat at the Elementary School and High School using biomass. This is equivalent to about 316 tons of CO₂ 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 $950 - $1,580 or a lump sum up front payment of as much as $15,800.

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3 Illustration taken from a handout produced by the Biomass Energy Resource Center

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Fannett-Metal School District Biomass Pre-Feasibility Report
25
There are a number of companies that are interested in contributing to the construction of new sources of clean and renewable energy through carbon offsets. Information about carbon offsets is included in the *Biomass and Green Building Resources Binder* accompanying this report.
PERMITTING

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

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

Table 6: Comparison of Boiler Emissions Fired by Wood, Distillate Oil, Natural Gas and Propane

<table>
<thead>
<tr>
<th></th>
<th>Wood (Pounds per million Btu output)</th>
<th>Distillate Oil</th>
<th>Natural Gas</th>
<th>Propane</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM10</td>
<td>0.1000</td>
<td>0.0140</td>
<td>0.007</td>
<td>0.004</td>
</tr>
<tr>
<td>NOX</td>
<td>0.1650</td>
<td>0.1430</td>
<td>0.09</td>
<td>0.154</td>
</tr>
<tr>
<td>CO</td>
<td>0.7300</td>
<td>0.0350</td>
<td>0.08</td>
<td>0.021</td>
</tr>
<tr>
<td>SO2</td>
<td>0.0082</td>
<td>0.5000</td>
<td>0.005</td>
<td>0.016</td>
</tr>
<tr>
<td>TOC</td>
<td>0.0242</td>
<td>0.0039</td>
<td>0.01</td>
<td>0.005</td>
</tr>
<tr>
<td>CO2 gross 220 (net 0)</td>
<td>159</td>
<td>118</td>
<td>137</td>
<td></td>
</tr>
</tbody>
</table>

The pollutant of greatest concern with biomass is particulates (PM10). 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

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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 9: Particulate Emissions

New EPA Regulations

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

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

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CONCLUSIONS AND RECOMMENDATIONS

The Fannett-Metal School District appears to be a good candidate for a biomass system. Both scenarios that were analyzed have a good return on investment. The pellet scenario (Scenario 1) requires a significantly smaller investment than the woodchip scenario (Scenario 2) but it also has a smaller return on investment. Conversely, the woodchip scenario has a significantly higher installation cost, but a much better short term and long term return on investment. We recommend the District take the following steps to investigate this opportunity further.

1. The US Forest Service may be able to provide a phase II engineering analysis that refines the project concept. If the District decides to move forward with a biomass project, decision-makers should contact Lew McCcreery, the US Forest Service Biomass Coordinator for the Northeastern Area, to see what assistance can be provided. Contact Lew at (304)285-1538 or lmccreery@fs.fed.us.

2. From the original site visit, it was obvious that the buildings at this facility are very well run. In order to continue this level of maintenance, it is recommended that the District develop a facilities operation and maintenance manual that describes current practices and includes recommendations for future improvements. For example, the facility manager does an excellent job of controlling the boiler inputs and outputs. It may be worth considering automating some of those controls in the future to make sure that the efficiency of the system is not reliant on any particular individual.

3. The District recently received a walk through energy audit and should consider energy efficiency improvements simultaneously with boiler upgrades. The efficiency of the building envelope and ventilation equipment need to be considered when sizing new boiler equipment. This should be done regardless of whether or not the District moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives is included in the Biomass and Green Building Resources binder accompanying this report.

4. In order to effectively measure progress toward energy efficiency goals historical energy consumption data should be collected and updated frequently. The facility manager for this school does an excellent job of not only tracking fuel deliveries, but also measuring fuel consumption on a regular basis. There are many tools that could help the District accomplish this electronically. 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 and provides useful reports and graphs. This software can be downloaded at: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager.

5. The District should also work with Mike Palko, Biomass Energy Specialist with the Pennsylvania Department of Conservation & Natural Resources, Bureau of Forestry, to cultivate potential biomass fuel suppliers concurrent with the design of the biomass system.
WHO WE ARE

Yellow Wood Associates

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

Richmond Energy Associates

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

SENSITIVITY ANALYSIS

The following sensitivity analysis refers to Scenario 2 – a woodchip system that serves both the Elementary School and High School. Table 7 is a sensitivity analysis comparing annual fuel savings from the installation of a woodchip system based on varying prices for woodchips and fuel oil. In this analysis, the assumed loan interest rate of 4.0% and the inflation rates outlined in the Scenario 2 assumptions are held constant. For example, if woodchips cost $35 per ton and fuel oil climbed to $4.00 per gallon, the annual fuel savings would be $98,079.

Table 7: Annual Fuel Savings When Woodchip and Fuel Oil Prices Vary

<table>
<thead>
<tr>
<th>Woodchip $/ton</th>
<th>Fuel Oil $ / Gallon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$2.50</td>
</tr>
<tr>
<td>$35</td>
<td>$55,333</td>
</tr>
<tr>
<td>$40</td>
<td>$53,060</td>
</tr>
<tr>
<td>$45</td>
<td>$50,788</td>
</tr>
<tr>
<td>$50</td>
<td>$48,515</td>
</tr>
<tr>
<td>$55</td>
<td>$46,242</td>
</tr>
</tbody>
</table>

Table 8 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a woodchip system based on varying grant funding and tax credits. In this analysis all of the assumptions presented in Table 4 are held constant with a reduction in the capital cost based on grant funding. For example, if the District was able to obtain a grant for $250,000, the project capital costs would decrease to $1.1 million and the 30-Year NPV for the system would be over $2.4 million.

Table 8: 1st Year Cash Flow and 30-Year Net Present Value (NPV) when Grant Funding Is Available

<table>
<thead>
<tr>
<th></th>
<th>Project Costs (Capital – Grant/Tax Credit)</th>
<th>1st Year Cash Flow</th>
<th>30-Year NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>No grant funding</td>
<td>$1,349,375</td>
<td>$(55,746)</td>
<td>$2,191,153</td>
</tr>
<tr>
<td>$100,000 grant</td>
<td>$1,249,375</td>
<td>$(46,746)</td>
<td>$2,291,153</td>
</tr>
<tr>
<td>$250,000 Grant</td>
<td>$1,099,375</td>
<td>$(33,246)</td>
<td>$2,441,153</td>
</tr>
<tr>
<td>$500,000 Grant</td>
<td>$849,375</td>
<td>$(10,746)</td>
<td>$2,691,153</td>
</tr>
</tbody>
</table>
FANNETT-METAL FUEL HISTORY

Fuel oil is the primary heat source for both the Elementary School and the High School. The table below summarizes fuel history provided by the Fannett-Metal School District as part of the application for a biomass pre-feasibility study.

Table 9: Fuel Oil Usage 2008 - 2011

<table>
<thead>
<tr>
<th></th>
<th>2010-2011</th>
<th></th>
<th>2009-2010</th>
<th></th>
<th>2008-2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elementary School</td>
<td>High School</td>
<td>Elementary School</td>
<td>High School</td>
<td>Elementary School</td>
</tr>
<tr>
<td>Sep</td>
<td>294</td>
<td>0</td>
<td>294</td>
<td>0</td>
<td>99</td>
</tr>
<tr>
<td>Oct</td>
<td>776</td>
<td>606</td>
<td>872</td>
<td>944</td>
<td>888</td>
</tr>
<tr>
<td>Nov</td>
<td>1,495</td>
<td>2,098</td>
<td>1,299</td>
<td>1,679</td>
<td>1,435</td>
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<tr>
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<td>2,224</td>
<td>4,312</td>
<td>2,324</td>
<td>3,956</td>
<td>2,658</td>
</tr>
<tr>
<td>Jan</td>
<td>2,711</td>
<td>4,115</td>
<td>2,541</td>
<td>3,890</td>
<td>2,619</td>
</tr>
<tr>
<td>Feb</td>
<td>2,265</td>
<td>3,526</td>
<td>2,835</td>
<td>3,883</td>
<td>2,130</td>
</tr>
<tr>
<td>Mar</td>
<td>2,767</td>
<td>3,552</td>
<td>1,617</td>
<td>2,523</td>
<td>2,143</td>
</tr>
<tr>
<td>Apr</td>
<td>1,204</td>
<td>1,660</td>
<td>1,115</td>
<td>877</td>
<td>1,015</td>
</tr>
<tr>
<td>May</td>
<td>603</td>
<td>0</td>
<td>555</td>
<td>0</td>
<td>810</td>
</tr>
<tr>
<td>Jun</td>
<td>100</td>
<td>0</td>
<td>101</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td><strong>14,439</strong></td>
<td><strong>19,869</strong></td>
<td><strong>13,553</strong></td>
<td><strong>17,752</strong></td>
<td><strong>13,797</strong></td>
</tr>
</tbody>
</table>
WOODCHIP FUEL

Purchasing wood fuel is a different exercise than purchasing fossil fuels. While conventional fuels are delivered to the site with little interaction from facility managers, biomass fuel suppliers will need to be cultivated and educated about the type of fuel needed, its characteristics and the frequency of deliveries. Concurrently with designing a wood-energy system, the District 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 Mike Palko for a list of local suppliers.

Michael T. Palko, Biomass Energy Specialist
PA Department of Conservation & Natural Resources
Bureau of Forestry
330 Pine Street, Suite 200 | Williamsport, PA 17701
Phone: 570.326.6020 | Fax: 570.322.2914
mipalko@pa.gov
www.dcnr.state.pa.us

The bottom line is that both the District 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 the District should insist on the quality of the chip. A sample fuel specification is included in the Biomass and Green Building Resources Binder to give an idea of the types of characteristics to look for in woodchip fuel. Below is a description of the advantages and disadvantages of different types of biomass fuels in order of preference.

**Green Hardwood Chips**

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

**Mill Residues vs. Harvest Residues**

Woodchips can be produced at sawmills or other primary wood products industrial sites as part of their waste wood disposal process. Mill residues are typically the most desirable source of fuel woodchips. Mills can produce a bark-free chip with few long pieces or branches that can jam augers and fuel conveyors. A mill supplier can easily calculate trucking costs and can negotiate dependable delivery at a consistent price.
Another potential type of wood fuel is whole tree chips which are produced as part of tree harvesting. Whole tree chips tend to be a dirtier fuel than sawmill residues and may contain small branches, bark, twigs and leaves. The longer pieces can jam the relatively small augers of an institutional/commercial scale biomass system and can add to the daily maintenance because they produce more ash.

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

**Softwood Chips**

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

**Dry Chips vs. Green Chips**

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

**Bark**

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

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

**Ground or “Hog” Fuel**

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

**Figure 10: Williamstown, VT High School Woodchip Boiler Plant**

![Williamstown, VT High School Woodchip Boiler Plant](image)
WOOD PELLET FUEL

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

Much of the pellet fuel market is geared toward supplying 40 pound bags for residential scale pellet stoves and boilers. Commercial scale systems typically have bulk storage of pellet fuel that can then be fed into the boiler automatically. Therefore, pellet fuel suppliers for a commercial scale system need to have the ability to deliver in self unloading trucks. Commercial scale pellet consumers should identify several pellet fuel manufacturers within a 200 mile radius that have the capability to deliver pellet fuel in bulk.

**Figure 11: Typical Bulk Pellet Fuel Storage and Delivery**

![Typical Bulk Pellet Fuel Storage and Delivery](image)

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

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6 Photo taken from *Wood Pellet Heating Guidebook* published by Massachusetts Division of Energy Resources.
There are additional pellet manufacturers in neighboring states. If the District decides to move forward with a wood pellet project they should contact each manufacturer for pricing and delivery information or work with Mike Palko to gather this information.

Michael T. Palko, Biomass Energy Specialist
PA Department of Conservation & Natural Resources
Bureau of Forestry
330 Pine Street, Suite 200  |  Williamsport, PA 17701
Phone: 570.326.6020  |  Fax: 570.322.2914
E-mail: mipalko@pa.gov
www.dcnr.state.pa.us
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- The Wider World of Pellet Fuel – Pellet Fuels Institute
- Pellet Fuel Standards – Pellet Fuels Institute
- Demonstration and Public Education at the W!ld Center – NYSERDA
- Commercial-Scale Biomass Boilers Market Growing in the Northeast – David Dungate, Northeast Sun
- Wood Pellet Heating Guide Book (ON ENCLOSED CD)
- Biomass Boiler and Furnace Emissions and Safety Regulations in the Northeast States (ON ENCLOSED CD)
- Woodchip Heating Systems, A Guide for Institutional and Commercial Installations (ON ENCLOSED CD)
APPLICATION FOR BIOMASS PRE-FEASIBILITY STUDY

US Forest Service Wood Education and Resource Center
Wood Energy Utilization Support Program
Application for Biomass Pre-feasibility Grant

Facility name and mailing address:
Fannett-Metal School District
16273 Pain Valley Rd
Willow Hill, PA 17271

Year of Building Construction: 1951, 1974, etc.
Years of major renovation(s):
First renovation:
Second renovation:

Public or Private:

Name:
JAMES DUFFY
School:

Title:
Teacher/Principal
College/University:

Phone:
717-370-3299
Fax:
717-370-3299

E-mail address:

Date form was completed:

If the facility has multiple buildings, list each building below, give its size in square feet and state whether it is heated from a central boiler plant:

<table>
<thead>
<tr>
<th>Building Name</th>
<th>Size in square feet</th>
<th>Central boiler?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fannett-Metal High School</td>
<td>427,000</td>
<td>Yes</td>
</tr>
<tr>
<td>Fannett-Metal Elementary</td>
<td>54,800</td>
<td>Yes</td>
</tr>
</tbody>
</table>

An opportunity time for adding a boiler is when a facility is undergoing an expansion or major renovation. Do you have any plans for expansion or major renovation in the foreseeable future? (Yes / No)

If so, please describe below, including project timing:

Would like to within next 5 years but funding

Prohibiting

Do you have a central heating system? (Yes / No)
Do you have more than one heating system? (Yes / No)
Do you have one heating plant in one location? (Yes / No)
Do you have heating plants in multiple locations? (Yes / No)

How is heat delivered to rooms? (check all that are applicable)
- Hot water
- Steam
- Ducted air
- Electric resistance

How is heat generated? (check all major systems that are applicable (those that serve 30% or more of the building(s))
- Hot water boiler
- Steam boiler
- Hot air furnace
- Electric baseboard
- Rooftop packaged units
- Heat pumps

USDA Forest Service - Wood Education and Resource Center
Date Printed: 9/14/2010
List each piece of heating equipment separately below. Include size in boiler horse power or Btu, state type of equipment, what fuel it uses, when it was installed and its condition (Poor, Fair, Good, Excellent etc.).

<table>
<thead>
<tr>
<th>boiler</th>
<th>type of boiler</th>
<th>fuel type, year installed, condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 MMBtu or 200 HP</td>
<td>Hot water boiler</td>
<td>#2 fuel oil, installed in 1998, fair</td>
</tr>
<tr>
<td>3,278.5</td>
<td>Hot water boiler</td>
<td>#2 fuel oil, 1976, gas</td>
</tr>
<tr>
<td>3,285</td>
<td>Steam boiler</td>
<td>#2 fuel oil, 1973, good</td>
</tr>
</tbody>
</table>

If buried steam lines or hot water lines are used to connect multiple buildings to a central boiler plant, what condition are the lines? Check One: Poor = Fair = Good = Excellent

Please review your heating fuel bills from the past year and list each type of heating fuel used, the total volume and the total spent on each heating fuel in 2009. This information can be collected from your fuel bills or by contacting your fuel dealer(s). In the last column list what percentage of your building square footage is heated by each type of fuel used for heat.

<table>
<thead>
<tr>
<th>fuel type</th>
<th>year</th>
<th>volume</th>
<th>units</th>
<th>cost</th>
<th>% of total sf</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2 fuel oil</td>
<td>2010</td>
<td>30,000</td>
<td>gallon</td>
<td>$75,000</td>
<td>10%</td>
</tr>
</tbody>
</table>

Is your domestic hot water provided by a different boiler than your space heat? Yes No

Is your domestic hot water heated from a central boiler? Yes No

If your domestic hot water is provided by a different boiler than your space heat, please list the type of fuel used to heat your domestic hot water, the total volume used and the total dollars spent in 2009 for hot water.

<table>
<thead>
<tr>
<th>fuel type</th>
<th>year</th>
<th>volume</th>
<th>units</th>
<th>cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>propane</td>
<td>2010</td>
<td>1,000</td>
<td>gallon</td>
<td>$2,000</td>
</tr>
</tbody>
</table>

Has your facility undergone an energy audit? Yes No

If yes, who is it? Please provide contact information.

Required Attachments

1. If the facility has multiple heating plants in separate locations, please provide a rough sketch on a separate page of the campus and locate each heating system on the sketch. Feel free to use a pre-printed campus map or building floor plan if one is available.

2. Please provide a copy of your latest fuel bill and electric bill for all accounts on site that includes account number and cost of fuel.

Use Submit button below or Email, Mail, Fax completed application form to: ginger@yellowwood.org

Yellow Wood Associates, Inc.
228 North Main Street, St. Albans, VT 05478
Fax 802-224-6043; Phone 802-224-6141

USDA Forest Service - Wood Education and Resource Center

Fannett-Metal School District Biomass Pre-Feasibility Report

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