Preliminary Feasibility Report

Biomass Heating Analysis for the West Rutland School

West Rutland, Vermont

November, 2012

Prepared by:

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EXECUTIVE SUMMARY

The West Rutland School serves over 400 students in the Rutland Central Supervisory Union District. The 90,000 square foot school was built in 1926 (with renovations in 1976 and 1996). Half of the school is heated with steam and the other half with hot water.

The School currently uses over 40,000 gallons of fuel oil on average each year and pays $3.18 per gallon of fuel oil. At that price the District will spend more than $128,000 on fuel oil for the West Rutland School this coming year. This report analyzes two scenarios, 1) the installation of a steam pellet boiler and 2) the installation of a steam woodchip boiler to cover the hot water and steam heat loads. We also evaluated a third option, a hot water pellet boiler to replace the heat and hot water that serves the half of the school with hot water distribution. (This third option would have a much smaller capital cost but would replace less than 50% of the current fuel oil use.)

Table 1: Summary Findings of Biomass Analysis for the West Rutland School

<table>
<thead>
<tr>
<th></th>
<th>Current Annual fuel oil (gallons)</th>
<th>Projected Annual Fuel Bill*</th>
<th>Total Estimated Project Costs</th>
<th>Annual Tons of Pellets/ Woodchips</th>
<th>Tons of Carbon Offset</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>Pellet</td>
<td>40,385</td>
<td>$128,424</td>
<td>$636,085</td>
<td>285</td>
<td>407</td>
<td>8.0%</td>
<td>$51,094</td>
<td>$2,214,977</td>
</tr>
<tr>
<td>Woodchip</td>
<td>40,385</td>
<td>$128,424</td>
<td>$1,452,000</td>
<td>498</td>
<td>384</td>
<td>5.2%</td>
<td>$81,756</td>
<td>$2,143,532</td>
</tr>
</tbody>
</table>

*based on $3.18 per gallon of fuel oil

The analysis provided in this report indicates that the District could save over $2.2 million in operating costs over 30 years, in today’s dollars, even when the cost of financing is included, by installing a biomass boiler. The analysis shows more than $51,000 in fuel savings in the first year with a pellet system and $81,000 in fuel savings in the first year with a woodchip system.

Figure 1 compares the pellet scenario and the woodchip scenario to the fuel oil only scenario (the baseline) taking into account projected heating fuel savings (cost of pellets or woodchips versus the cost of fuel oil), projected revenue and projected debt service.
The West Rutland School appears to be a good candidate for a biomass heating system. We recommend the District take the following steps to further investigate the feasibility of either a pellet or woodchip system:

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. Hire an engineering firm to help refine the project concept and to obtain firm local estimates on project costs. An important issue for the project engineers to consider is thermal storage. Hot water biomass heating systems operate significantly more efficiently and effectively (improving cost savings) if thermal storage is designed into the overall system. With thermal storage, biomass systems can operate more effectively over low-load situations helping to cover a greater portion of the annual heating load and will therefore provide greater savings. With either biomass alternative, thermal storage for the hot water portion of the heat load should be included in the design.
3. The District should consider energy efficiency improvements simultaneously with boiler upgrades. As part of the design process for boiler system upgrades, a detailed audit of energy efficiency improvements should be conducted. An audit should evaluate whether building envelope and ventilation equipment upgrades would be beneficial. Upgrades might include added insulation, outdoor temperature reset, an improved mechanical system controls. 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. 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). Another tool (designed specifically for schools) is the CHPS Operations Report Card – available at [http://www.chps.net/dev/Drupal/orc](http://www.chps.net/dev/Drupal/orc).

5. If the School decides to move forward with a biomass system, they should work with Paul Frederick, Wood Utilization Forester with the Vermont Department of Forest and Parks, to cultivate potential biomass fuel suppliers concurrent with the design of the biomass system. If the Supervisory Union moves forward with multiple pellet boiler projects it should be able to negotiate a more favorable pellet price.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates for the West Rutland 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 (including woodchips and pellets) are being used quite successfully in 47 Vermont schools. 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 dollars 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 Vermont to achieve targets for renewable energy use. This analysis indicates that the West Rutland School could offset up to 407 tons of CO₂ annually by installing a pellet biomass system.

This report is a pre-feasibility assessment specifically tailored to the West Rutland School outlining whether or not a wood pellet heating system makes sense for this facility from a practical perspective. In April of 2012 staff from Yellow Wood Associates traveled to West Rutland to tour the West Rutland 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 SYSTEM AND FUEL USAGE

The West Rutland School is currently heated by two 2.7 mmBtu H.P. Smith sectional steam boilers, which were installed in 2006. The boilers are in very good condition and can be used to provide back-up and shoulder season heat. According to facilities staff, about half of the school is served by a hot water distribution system and half of the school is served by steam distribution.

Over the past three years, the West Rutland School used an average of 40,385 gallons of fuel oil for heat and hot water. The school will pay $3.18 in the 2012-2013 heating season for a total expected heating bill of more than $128,000.

Figure 2: Fuel Oil Usage 2009-2012

![Fuel Oil Usage Graph]

Even with a biomass system, 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 more than 47 schools that heat with wood, the average annual wood utilization with woodchips ranges from 77%-85%. Advances in biomass boiler technology have made biomass systems more flexible. When combined with a thermal storage system, a pellet boiler may be able to capture nearly 100% of the school’s heating load. The existing fossil fuel boilers can be used to back-up the biomass system during maintenance or if heating demand (due to colder than normal weather) exceeds the capacity of the biomass system.
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 envision installing a new boiler system. The 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 analysis projects current and future annual heating bills and compares that cost against the cost of operating a biomass system. Savings are presented in today’s dollars using a net present value calculation. Net present value (NPV) is defined as the present dollar value of net cash flows over time. This is a standard method for using the time value of money to compare the cost effectiveness of long-term projects.

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

During the past three years the West Rutland School used an estimated 40,385 gallons of fuel oil each year, this is the amount of fuel oil used for the base case in the analyses. The District has locked in a fuel oil price of $3.18 per gallon for the upcoming school year – this is the price used in the base case of both analyses.

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 and fluctuate more than other biomass fuel (such as woodchips). However, pellets are still a relatively local product so they will not likely have the same geopolitical pressures as fossil fuels. After consulting with the Vermont Department of Forests, Parks and Recreation, we are projecting a first year cost of $226 per ton of pellets, which is equivalent to about $1.87 per gallon of fuel oil. In the pellet scenario we assume that the biomass system will meet 90% of the school’s heating needs. The remaining 10% of the heating needs currently met with hot water were then assumed to be provided by the existing fuel oil system.

WOODCHIP FUEL COST ASSUMPTIONS

After consulting with the Vermont Department of Forests, Parks and Recreation, we are projecting a first year cost of $55 per ton for woodchips, which is equivalent to about $0.85 per gallon of fuel oil. In the woodchip scenario, it is assumed that 85% of the heating needs of the school will be covered by woodchips (this is the typical usage reported by Vermont Schools), the remaining 15% of the heating needs were then assumed to be provided by the existing fuel oil system, using approximately 6,058 gallons of fuel oil each year. The cost for supplemental fuel oil is then adjusted for inflation each year over the 30-year horizon.
Table 2: Fuel Pricing and Cost per mmBtu

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Input mmBtu/Unit</th>
<th>Cost/Unit</th>
<th>Assumed Efficiency***</th>
<th>Output mmBtu/Unit</th>
<th>Cost/mmBtu Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodchips (ton)*</td>
<td>10.0</td>
<td>$55</td>
<td>75%</td>
<td>7.5</td>
<td>$7.33</td>
</tr>
<tr>
<td>Wood Pellet (ton)**</td>
<td>15.5</td>
<td>$226</td>
<td>85%</td>
<td>13.18</td>
<td>$17.15</td>
</tr>
<tr>
<td>Fuel Oil (gallon)</td>
<td>0.138</td>
<td>$3.18</td>
<td>75%</td>
<td>0.104</td>
<td>$30.72</td>
</tr>
</tbody>
</table>

* Assumes 40% moisture content  
** Assumes 6% moisture content  
*** Average seasonal efficiency

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 (1991 – 2011) using US Energy Information Agency data and found that the average rate of increase for fuel oil in Vermont was 6.56% per year. The analysis projects this inflation rate for fuel oil forward over the 30-year analysis period. The West Rutland School’s fuel rate of $3.18 per gallon was used for the first year of the analysis and then inflated each year at 6.56%.

Pellet fuel pricing tends to track that of fossil fuels for two reasons. First it takes a considerable amount of energy to produce pellets. 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 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

\(^1\) 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.
geopolitical pressures that fossil fuels have. Over the past twenty years, woodchip fuel costs have been far less volatile than fossil fuels.

**Figure 3: VT Biomass and Fossil Fuel Inflation**

![Graph showing biomass and fossil fuel inflation](image)

*Wood pellet pricing based on 2010-2011 average price paid and projected back five years assuming a 4.25% inflation rate.

The overall Consumer Price Index for the period between 1991 and 2011, 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 fully automated woodchip heating systems of the size analyzed in Scenario 2 to spend 15-30 minutes per day to clean ashes² 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

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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.
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 $25/hr this equals $1,250 annually. An additional $750 in annual operational costs is assumed for electricity to run pumps and motors.

Another operations and maintenance cost that is included in all of the 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. Analyses for the woodchip scenario include $15,000 of scheduled maintenance anticipated in years 10, 20 and 30 and then annualized at $1,500 per year to simulate a sinking fund for major repairs. The $1,500 annual payments were inflated at the general annual inflation rate. Pellet boiler systems have fewer moving parts and should not require as much scheduled maintenance as a woodchip system. An annualized scheduled maintenance cost of $1,000 per year was included in the pellet scenario analysis for each boiler system 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 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 loan at a 4% interest rate. A typical loan repayment schedule was used where the principal and interest payment remains fixed over the life of the loan. At this time the analysis does not take into account any potential grants, lease arrangements or the impact of financing only a portion of the project cost. Other financing plans 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.
Sensitivity analyses are included in the appendices that show the relative life cycle cost savings under various financing and fuel price 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 biomass scenarios to provide heat and hot water to the school: 1) the installation of a pellet boiler to provide heat and hot water to the portion of the school with hot water distribution; 2) the installation of a woodchip boiler.

In this analysis the pellet boiler and pellet storage silo would be located outside, next to the existing boiler room while the woodchip boiler house and chip storage would be located at the far end of the parking lot where the buses are currently parked.

Figure 4: Site Plan
PELLET SCENARIO

The first biomass scenario envisions the addition of a containerized hot water pellet boiler system, located outside, adjacent to the existing boiler room. Since this is right next to the entrance of the school, the school may want to consider construction of a small boiler house that showcases the pellet system (see figure 5 below). The scenario assumes that the pellet boiler will meet 90% of the annual heating needs currently met with fuel oil at the School. The scenario analyzes the installation of a 3.0 mmBtu pellet boiler and 1,500 gallons of thermal storage. An alternative the District may want to consider is to specify two smaller pellet boilers, one for steam and one for hot water. The cost difference would likely be minor and a two-boiler system might provide more flexibility. If one steam boiler is installed, steam from the boiler will be tied into the existing steam distribution system and be converted to hot water and tied into the existing hot water distribution system. Steam and hot water would be tied to the existing heating system via approximately 25 feet of insulated piping. Costs for a 42-ton pellet storage silo, a 70 foot stack to get the outlet above the roof, and an allowance for interconnecting to the existing heating distribution system are included in the proposed capital costs. A healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

Figure 5: Wild Center Pellet Storage Bin3 and Energy Cabin4

The analysis of the pellet scenario shows that the School could save over $2.2 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 wood pellet boiler. Annual fuel savings alone are projected to be $51,094 per year in the first year and should increase over time as fossil fuel prices continue to climb. The return on investment from fuel

4http://www.tupos.eu/building.html
savings is estimated at 8.0% and this project would have a positive annual cash flow in the first year of operation.

Table 3: Pellet Scenario Analysis Assumptions

<table>
<thead>
<tr>
<th>West Rutland School Pellet Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital Cost Assumptions</strong></td>
</tr>
<tr>
<td>One 3.0 millionton containerized pellet steam boiler system including installation</td>
</tr>
<tr>
<td>50 % of plant’s capacity</td>
</tr>
<tr>
<td>Pellet boilerhouse</td>
</tr>
<tr>
<td>Underground insulated hot water piping from boiler house to school</td>
</tr>
<tr>
<td>Thermal Storage 1,500 gallon for the portion of the school that is heated with hot water</td>
</tr>
<tr>
<td>Interconnect to existing boiler system</td>
</tr>
<tr>
<td>GC markup at 10%</td>
</tr>
<tr>
<td>Construction contingency at 10%</td>
</tr>
<tr>
<td>Design at 8%</td>
</tr>
<tr>
<td><strong>Total estimated project costs</strong></td>
</tr>
<tr>
<td><strong>Financing Costs</strong></td>
</tr>
<tr>
<td>Financing, annual interest rate</td>
</tr>
<tr>
<td>Finance term (years)</td>
</tr>
<tr>
<td>Total full year debt service</td>
</tr>
<tr>
<td><strong>Fuel Cost Assumptions</strong></td>
</tr>
<tr>
<td>Total current annual fuel use</td>
</tr>
<tr>
<td>Assumed fuel oil price in 1st year</td>
</tr>
<tr>
<td>Projected annual fuel oil bill if annual heating is entirely from fuel oil</td>
</tr>
<tr>
<td>Percent pellet fuel utilization of hot water boiler</td>
</tr>
<tr>
<td>Assumed pellet price in 1st year (per ton)</td>
</tr>
<tr>
<td>Projected 1st year supplemental fuel oil bill</td>
</tr>
<tr>
<td>Projected 1st year supplemental fuel oil bill</td>
</tr>
<tr>
<td><strong>Inflation Assumptions</strong></td>
</tr>
<tr>
<td>General inflation rate (twenty year average CPI)</td>
</tr>
<tr>
<td>Fuel oil inflation rate (twenty year EIA average for Vermont)</td>
</tr>
<tr>
<td>Pellet inflation rate (estimate from Biomass Energy Resource Center)</td>
</tr>
<tr>
<td><strong>O&amp;M Assumptions</strong></td>
</tr>
<tr>
<td>Annual pellet O&amp;M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance</td>
</tr>
<tr>
<td>Major repairs (annualized)</td>
</tr>
<tr>
<td><strong>Savings</strong></td>
</tr>
<tr>
<td>Return on Investment</td>
</tr>
<tr>
<td>Net 1st year fuel savings</td>
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<tr>
<td>Total 30 year NPV cumulative savings</td>
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Table 4: 30-Year Life Cycle Analysis Spreadsheet for Pellet Scenario

<table>
<thead>
<tr>
<th>West Rutland School</th>
<th>Preliminary Life Cycle Cost Estimate</th>
<th>Pellets - Heat Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total estimated construction costs</td>
<td>$535,985</td>
<td></td>
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<tr>
<td>Financing:</td>
<td>4.9% Bond Interest rate</td>
<td></td>
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<tr>
<td>Oil heat consumption</td>
<td>40.363 MMBtu</td>
<td>(includes pellet BTUs)</td>
</tr>
<tr>
<td>Oil heat price</td>
<td>$3.18</td>
<td></td>
</tr>
<tr>
<td>Oil heat cost</td>
<td>$128,424</td>
<td>$177,735 (includes pellets for 317 tons)</td>
</tr>
<tr>
<td>Estimated pellet utilization</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>Projected pellet consumption</td>
<td>285 tons</td>
<td></td>
</tr>
<tr>
<td>Estimated 1st year pellet price</td>
<td>$228/ton Year 1</td>
<td></td>
</tr>
<tr>
<td>Projected 1st year pellet cost</td>
<td>$66,480</td>
<td>$127,728</td>
</tr>
<tr>
<td>Projected 1st year partial fuel oil cost</td>
<td>$12,642</td>
<td>$21,881</td>
</tr>
<tr>
<td>General inflation:</td>
<td>2.6% annually</td>
<td></td>
</tr>
<tr>
<td>Oil Inflation:</td>
<td>6.96%</td>
<td></td>
</tr>
<tr>
<td>Pellet Inflation:</td>
<td>4.25% annually</td>
<td></td>
</tr>
<tr>
<td>D &amp; M:</td>
<td>$2,800 in Year 1</td>
<td>$3,741</td>
</tr>
<tr>
<td>Major Repairs:</td>
<td>$1,000</td>
<td></td>
</tr>
</tbody>
</table>
WOODCHIP SCENARIO

The second biomass scenario envisions building a 2,500 square foot stand-alone boiler house and chip storage facility which would house a 3.0 mmBtu woodchip steam boiler and below-grade woodchip storage. In this scenario steam from the boiler would be tied into the existing heating system via 500 feet of underground, insulated piping. An allowance for interconnecting to the existing heating distribution systems and costs for a tall stack, to ensure good emissions dispersal, were included. 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. A healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

Table 5: Woodchip Scenario Analysis Assumptions

<table>
<thead>
<tr>
<th>West Rutland School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodchip Scenario</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capital Cost Assumptions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 mmBtu woodchip steam boiler including installation</td>
<td>$350,000</td>
</tr>
<tr>
<td>70 ft stack</td>
<td>$35,000</td>
</tr>
<tr>
<td>Pollution control equipment</td>
<td>$25,000</td>
</tr>
<tr>
<td>Woodchip boilerhouse and chip storage building</td>
<td>2,500 SF $150 /SF $375,000</td>
</tr>
<tr>
<td>Underground insulated hot water piping from boiler house to school</td>
<td>500 LF $450 /LF $225,000</td>
</tr>
<tr>
<td>Interconnection to existing boiler rooms</td>
<td>$50,000</td>
</tr>
<tr>
<td>GC markup at 10%</td>
<td>$106,000</td>
</tr>
<tr>
<td>Construction contingency at 15%</td>
<td>$159,000</td>
</tr>
<tr>
<td>Design at 12%</td>
<td>$127,200</td>
</tr>
<tr>
<td>Total estimated project costs</td>
<td>$1,452,200</td>
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<table>
<thead>
<tr>
<th>Financing Costs</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Financing, annual interest rate</td>
<td>4.0%</td>
</tr>
<tr>
<td>Finance term (years)</td>
<td>20</td>
</tr>
<tr>
<td>1st full year debt service</td>
<td>$106,855</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fuel Cost Assumptions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current projected annual fuel oil use in gallons</td>
<td>40,385</td>
</tr>
<tr>
<td>Assumed fuel oil price in 1st year</td>
<td>$3.18</td>
</tr>
<tr>
<td>Projected annual fuel oil bill</td>
<td>$128,424</td>
</tr>
<tr>
<td>Percentage of wood utilization</td>
<td>85%</td>
</tr>
<tr>
<td>Fuel oil (gai/ton ratio)</td>
<td>72</td>
</tr>
<tr>
<td>Assumed wood price in 1st year (per ton)</td>
<td>$55</td>
</tr>
<tr>
<td>Projected 1st year wood fuel bill</td>
<td>$27,405</td>
</tr>
<tr>
<td>Projected 1st year supplemental fuel oil bill</td>
<td>$19,264</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inflation Assumptions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>General inflation rate (twenty year average CPI)</td>
<td>2.6%</td>
</tr>
<tr>
<td>Fuel oil inflation rate (twenty year average EIA)</td>
<td>6.5%</td>
</tr>
<tr>
<td>Wood inflation rate (twenty year average extrapolated from Vermont Superintendents Assoc. data)</td>
<td>3.6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>O&amp;M Assumptions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Wood O&amp;M cost</td>
<td>$8,375</td>
</tr>
<tr>
<td>Major repairs (annualized)</td>
<td>$1,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Savings</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Return on Investment from fuel savings</td>
<td>5.6%</td>
</tr>
<tr>
<td>Net 1st year fuel savings</td>
<td>$81,756</td>
</tr>
<tr>
<td>Total 30 year NPV cumulative savings</td>
<td>$2,143,532</td>
</tr>
</tbody>
</table>
The analysis of the woodchip scenario shows that the School could save more than $2.14 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 boiler at the West Rutland School to meet 85% of the heating needs currently met with fuel oil. Annual fuel savings alone are projected to be $81,756 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 5.2% and this project would have a positive annual cash flow in the seventh year.

Table 6: 30-Year Life Cycle Analysis Spreadsheet for Woodchip Scenario

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel Oil Cost</th>
<th>Finance Cost</th>
<th>Woodchips Cost</th>
<th>Partial Fuel Oil Cost</th>
<th>Total Costs</th>
<th>Annual Fuel Savings</th>
<th>Annual Cashflow</th>
<th>Cumulative Cashflow</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>$120,424</td>
<td>$106,855</td>
<td>$27,405</td>
<td>$19,204</td>
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<td>$81,756</td>
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<tr>
<td>2</td>
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<td>$106,855</td>
<td>$23,252</td>
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<td>$88,694</td>
<td>$1,339</td>
<td>$87,355</td>
<td>$169,111</td>
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<tr>
<td>3</td>
<td>$143,629</td>
<td>$106,855</td>
<td>$21,874</td>
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<td>$90,782</td>
<td>$1,189</td>
<td>$94,903</td>
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<td>$106,855</td>
<td>$23,309</td>
<td>$27,899</td>
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<td>$1,041</td>
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<td>5</td>
<td>$155,856</td>
<td>$106,855</td>
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<td>$29,839</td>
<td>$90,980</td>
<td>$1,361</td>
<td>$104,641</td>
<td>$360,619</td>
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<td>6</td>
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<td>9</td>
<td>$213,501</td>
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<td>$38,732</td>
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<td>10</td>
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<td>$106,855</td>
<td>$37,676</td>
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<td>$1,210</td>
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<td>11</td>
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<td>$128,594</td>
<td>$438,960</td>
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<td>$49,814</td>
<td>$57,025</td>
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<td>$451,649</td>
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<td>$138,754</td>
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<tr>
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<td>$312,984</td>
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<td>$1,037</td>
<td>$143,891</td>
<td>$477,294</td>
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<tr>
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<td>$106,855</td>
<td>$64,560</td>
<td>$71,993</td>
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<td>$69,820</td>
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<tr>
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<tr>
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<td>$96,076</td>
<td>$270,336</td>
<td>$1,000</td>
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<td>$542,829</td>
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<tr>
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<td>$106,855</td>
<td>$93,363</td>
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</tr>
<tr>
<td>22</td>
<td>$487,670</td>
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<td>$100,139</td>
<td>$108,849</td>
<td>$309,968</td>
<td>$1,000</td>
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<td>$569,049</td>
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<tr>
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<td>$1,000</td>
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<tr>
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<td>$123,511</td>
<td>$130,567</td>
<td>$377,638</td>
<td>$1,000</td>
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<td>$608,396</td>
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<tr>
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<td>$628,785</td>
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<td>$131,848</td>
<td>$138,633</td>
<td>$393,481</td>
<td>$1,000</td>
<td>$199,105</td>
<td>$621,512</td>
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<tr>
<td>27</td>
<td>$660,034</td>
<td>$106,855</td>
<td>$140,576</td>
<td>$147,030</td>
<td>$409,506</td>
<td>$1,000</td>
<td>$204,105</td>
<td>$634,628</td>
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<tr>
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<tr>
<td>30</td>
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<td>$106,855</td>
<td>$168,711</td>
<td>$173,446</td>
<td>$458,141</td>
<td>$1,000</td>
<td>$219,105</td>
<td>$673,976</td>
</tr>
</tbody>
</table>

| Total 30-Yr. NPIV Savings | $621,965 | $551,790 | $5,512,784 |

| Total Annual Heating Costs | $1,217,252 | $1,438,233 | $1,161,774 | $571,743 | $4,599,041 | $5,001,818 | $5,512,784 | $5,512,784 |

The West Rutland School Biomass Pre-Feasibility Report

17


ADDITIONAL ISSUES TO CONSIDER

THERMAL STORAGE

A thermal storage system is included in the capital cost estimate for the pellet scenario. 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 warmer spring and fall periods, and in some cases, to address summer domestic hot water needs. Additionally, solar thermal energy systems can be connected to the storage tank. In fact, such combination systems are often used in Europe to meet summer domestic hot water needs and increase overall system efficiency.

We strongly recommend that any pellet system that is specified for this project include thermal storage as a component of the overall design.
SYSTEM SIZING

It is common for mechanical engineers to size boilers to exceed peak design loads. However, with biomass projects it is better to size a biomass boiler to smaller than peak demand. This is because all boilers and especially biomass boilers operate more efficiently when they operate on high fire. With a smaller boiler there is greater potential for operating on high fire more of the time. A biomass boiler sized to 60% of the peak demand will cover approximately 90% of the annual heat load. Because we always recommend a fully redundant, back-up, fossil fuel boiler system, it is not necessary to size the biomass boilers to meet peak demand during the year. On particularly cold nights, if the biomass boiler is insufficient to meet peak demand, then the fossil fuel boilers can be used to provide additional supplemental heat if needed.

The graphic at left shows the percent of the annual heat load (heat requirements) met by different sized boilers (as a percentage of the building’s peak load). This graphic shows that a boiler sized at 60% of the peak load will cover 90% of the annual heat load.

If the School decides to move forward with a biomass project, the US Forest Service may be able to provide additional technical assistance from engineers with biomass experience to help with conceptual design.

CARBON REDuctions

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.

5 Graphic courtesy of Joe Kohler, Kohler and Lewis Mechanical Engineers.
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 West Rutland School could undertake that would reduce its carbon footprint more than switching their heating fuel use from fuel oil and electricity to a biomass fuel.

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 22.37 lbs. of CO₂ is produced from each gallon of fuel oil consumed. It is projected that the West Rutland School can offset approximately 36,347 gallons of fuel oil per year in the pellet scenario, and 34,327 gallons per year in the woodchip scenario, by replacing that heat using biomass. This is equivalent to about 407 tons of CO₂ annually for the pellet scenario and 384 tons of for the woodchip scenario.

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 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. 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 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: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager.

Figure 7: Carbon Cycle Illustration

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6 Illustration taken from a handout produced by the Biomass Energy Resource Center
ENERGY EFFICIENCY

Whether the West Rutland School converts to biomass or stays with fuel oil, the facility should use its heating fuel efficiently. The Vermont Superintendents Association offers expert energy efficiency consultation through the School Energy Management Program (SEMP). SEMP offers core services to maximize efficiency, reduce energy budgets and improve the learning environment. For more information on SEMP, contact Norm Etkind, Program Director at semp@vtvsa.org. Additional efficiency resources are available through Efficiency Vermont (www.efficiencyvermont.com). If the District 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.

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 West Rutland School work with an independent, third-party, commissioning agent during the design and construction of a biomass heating system. See the Biomass and Green Building Resources binder for more information on commissioning.

HOT WATER VS. STEAM HEATING DISTRIBUTION

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

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

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

If the School were to convert to hot water, it may be able to save considerably on the cost of a biomass system. The scenario in this study assumed the School was going to stay with steam and therefore the capital costs for a biomass system include a steam boiler and underground insulated steam piping from the remote boiler house (in the woodchip scenario). Steam piping is much more expensive than hot water piping. Typical underground hot water piping might be about $150/linear foot and we assumed $450/linear foot for steam piping in this study.

Pellet fuel is about half the cost per Btu of fuel oil and woodchip fuel is only about 25% the cost of fuel oil per Btu. With these kinds of fuel savings, the school may be able to offset the cost of converting to hot water distribution in conjunction with a biomass option depending on the cost of conversion.

**EMISSIONS & 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 7: Comparison of Boiler Emissions Fired by Wood, Distillate Oil, Natural Gas and Propane

<table>
<thead>
<tr>
<th></th>
<th>Woodchips</th>
<th>Distillate Oil</th>
<th>Natural Gas</th>
<th>Propane</th>
</tr>
</thead>
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<tr>
<td>PM&lt;sub&gt;10&lt;/sub&gt;</td>
<td>0.1000</td>
<td>0.0140</td>
<td>0.007</td>
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<td>CO</td>
<td>0.7300</td>
<td>0.0350</td>
<td>0.08</td>
<td>0.021</td>
</tr>
<tr>
<td>SO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>0.0082</td>
<td>0.5000</td>
<td>0.0005</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>CO&lt;sub&gt;2&lt;/sub&gt; 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 (PM<sub>10</sub>). 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. Appropriate emission control equipment technologies should be identified in consultation with local air quality regulators.

The emissions from a modern woodchip boiler are much less than most people think. One of the most common misconceptions about institutional/commercial biomass energy systems comes from the experience people have with residential wood stoves and outdoor wood boilers. In general, an institutional/commercial-scale wood energy system emits only one fifteenth (seven percent) the PM<sub>10</sub> 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.

The boilers analyzed in this report is smaller than 10 million Btu – under the new EPA regulations the West Rutland School would be required to perform a boiler tune-up every two years on the biomass boilers. Up-to-date information on EPA emission requirements is available at: [www.epa.gov/airquality/combustion/](http://www.epa.gov/airquality/combustion/)

While there is little emissions data available for pellet boiler systems in North America, emissions testing in Europe on pellet boiler installations suggest that pellet boiler perform even better than woodchip systems. Since the EPA regulations are geared toward much bigger systems than what is proposed in this report, permitting should not be difficult.

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PROJECT FUNDING POSSIBILITIES

EFFICIENCY VERMONT

There are a number of programs available through Efficiency Vermont, an organization created by the legislature and the Vermont Public Service Board to help all Vermon ters save energy and reduce energy costs, such as the HVAC Rebate Program, which provides rebates for a variety of HVAC equipment and controls, including pellet boilers. The HVAC Rebate Form can be accessed online at http://www.efficiencyvermont.org/docs/for_my_business/rebate_forms/HVACRebateForm.pdf, and is included in the Biomass and Green Building Resources Binder accompanying this report.

USDA COMMUNITY FACILITY GRANTS AND LOANS

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.

Brattleboro (Serving Bennington, Rutland, Windham and Windsor Counties):
Andrea Ansevin-Allen
Andrea.ansevinallen@vt.usda.gov
(802)257-7878 x111

MUNICIPAL LEASE PURCHASE

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

• In a municipal lease, the intent of the lessee is to purchase and take title to the equipment. The financing is a full payout contract with no significant residual or balloon payments at the end of the lease term.
• The lease payments include the return of principal and interest, with the interest being exempt from Federal income taxation to the recipient. Because the interest is exempt from federal tax, a tax-exempt lease offers the lessee a significant cost savings when compared to conventional leasing.
There are a number of companies that provide municipal leases. Information about municipal leases is included in the Biomass and Green Building Resources Binder accompanying this report.

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.

Applications for 2012 funding were due on April 1st 2012. A new announcement, for a 2013 round of funding has not yet been announced. For more information on the grant program, contact:

Lew McCreery, Northeastern Area—S&PF, 11 Campus Blvd., Suite 200
Newtown Square, PA 19073–3200
lmcreery@fs.fed.us
(304) 285–1538
CONCLUSIONS AND RECOMMENDATIONS

The West Rutland School appears to be a good candidate for a biomass heating system. We recommend the District take the following steps to further investigate the feasibility of either a pellet or woodchip system:

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. Hire an engineering firm to help refine the project concept and to obtain firm local estimates on project costs. An important issue for the project engineers to consider is thermal storage. Hot water biomass heating systems operate significantly more efficiently and effectively (improving cost savings) if thermal storage is designed into the overall system. With thermal storage, biomass systems can operate more effectively over low-load situations helping to cover a greater portion of the annual heating load and will therefore provide greater savings. With either biomass alternative, thermal storage for the hot water portion of the heat load should be included in the design.

3. The District should consider energy efficiency improvements simultaneously with boiler upgrades. As part of the design process for boiler system upgrades, a detailed audit of energy efficiency improvements should be conducted. An audit should evaluate whether building envelope and ventilation equipment upgrades would be beneficial. Upgrades might include added insulation, outdoor temperature reset, an improved mechanical system controls. 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. 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. Another tool (designed specifically for schools) is the CHPS Operations Report Card – available at http://www.chps.net/dev/Drupal/orc.
5. If the School decides to move forward with a biomass system, they should work with Paul Frederick, Wood Utilization Forester with the Vermont Department of Forest and Parks, to cultivate potential biomass fuel suppliers concurrent with the design of the biomass system. If the Supervisory Union moves forward with multiple pellet boiler projects it should be able to negotiate a more favorable pellet price.
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 analyses compare annual fuel savings from the installation of a biomass boiler based on varying prices for fuel oil and pellets (Table 8) and woodchips (Table 9). In these analyses the other assumptions laid out in tables 3 and 5 remain the same. For example, if the price of fuel oil goes up to $4.00 per gallon and the District is able to purchase pellets for $220 per ton, the annual fuel savings (under scenario 1) will be $82,610. With fuel oil at $4.00 per gallon and woodchips at $55 per ton, the annual fuel savings (under scenario 2) will be $109,904.

Table 8: Annual Fuel Savings When Pellet and Fuel Oil Prices Vary

<table>
<thead>
<tr>
<th>Pellet Cost per ton</th>
<th>$2.50</th>
<th>$3.00</th>
<th>$3.50</th>
<th>$4.00</th>
<th>$4.50</th>
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<tr>
<td>$180</td>
<td>$39,504</td>
<td>$57,677</td>
<td>$75,850</td>
<td>$94,024</td>
<td>$112,197</td>
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<tr>
<td>$200</td>
<td>$33,797</td>
<td>$51,970</td>
<td>$70,143</td>
<td>$88,317</td>
<td>$106,490</td>
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<td>$220</td>
<td>$28,090</td>
<td>$46,263</td>
<td>$64,437</td>
<td>$82,610</td>
<td>$100,783</td>
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<tr>
<td>$240</td>
<td>$22,383</td>
<td>$40,556</td>
<td>$58,730</td>
<td>$76,903</td>
<td>$95,076</td>
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<tr>
<td>$260</td>
<td>$16,676</td>
<td>$34,849</td>
<td>$53,023</td>
<td>$71,196</td>
<td>$89,369</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Woodchip $/ton</th>
<th>$2.50</th>
<th>$3.00</th>
<th>$3.50</th>
<th>$4.00</th>
<th>$4.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$45</td>
<td>$63,396</td>
<td>$80,559</td>
<td>$97,723</td>
<td>$114,887</td>
<td>$132,050</td>
</tr>
<tr>
<td>$50</td>
<td>$60,904</td>
<td>$78,068</td>
<td>$95,232</td>
<td>$112,395</td>
<td>$129,559</td>
</tr>
<tr>
<td>$55</td>
<td>$58,413</td>
<td>$75,577</td>
<td>$92,740</td>
<td>$109,904</td>
<td>$127,068</td>
</tr>
<tr>
<td>$60</td>
<td>$55,922</td>
<td>$73,085</td>
<td>$90,249</td>
<td>$107,413</td>
<td>$124,576</td>
</tr>
<tr>
<td>$65</td>
<td>$53,430</td>
<td>$70,594</td>
<td>$87,758</td>
<td>$104,921</td>
<td>$122,085</td>
</tr>
</tbody>
</table>
Table 10 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a pellet system or a woodchip system at the West Rutland School based on grant funding. In this analysis all of the assumptions presented in Tables 3 and 5 are held constant with a reduction in the capital cost based on grant funding. This shows that if the District were able to obtain a $100,000 grant for a biomass project, the Return on Investment (ROI) for the pellet project (scenario 1) would increase to 9.5% and the ROI of the woodchip project (scenario 2) would rise to 6.0%.

Table 10: 1st Year Cash Flow and 30-Year Net Present Value (NPV) with $100,000 Grant

<table>
<thead>
<tr>
<th></th>
<th>Project Costs (Capital – Grant/Tax Credit)</th>
<th>1st Year Cash Flow</th>
<th>Return on Investment</th>
<th>30-Year NPV</th>
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<td>Pellet Scenario</td>
<td>$536,085</td>
<td>$8,648</td>
<td>9.5%</td>
<td>$2,314,977</td>
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<tr>
<td>Woodchip Scenario</td>
<td>$1,352,200</td>
<td>($27,617)</td>
<td>6.0%</td>
<td>$2,243,532</td>
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THE WEST RUTLAND SCHOOL FUEL HISTORY

Fuel oil is the primary heat source for the West Rutland School. The table below summarizes fuel history provided by the West Rutland School as part of the application for a biomass pre-feasibility study.

Table 11: Fuel Oil Usage (gallons delivered) 2009 - 2012

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2011</th>
<th>2010</th>
<th>2009</th>
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<tr>
<td>July</td>
<td>4,250</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>5,512</td>
<td>649</td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>4,161</td>
<td>3,101</td>
<td>6,000</td>
<td>7,502</td>
</tr>
<tr>
<td>November</td>
<td>4,695</td>
<td>11,839</td>
<td>7,502</td>
<td>7,508</td>
</tr>
<tr>
<td>December</td>
<td>9,750</td>
<td>9,590</td>
<td>7,500</td>
<td>7,006</td>
</tr>
<tr>
<td>January</td>
<td>8,621</td>
<td>9,495</td>
<td>7,498</td>
<td>7,499</td>
</tr>
<tr>
<td>February</td>
<td>2,262</td>
<td>1,533</td>
<td>6,001</td>
<td>7,505</td>
</tr>
<tr>
<td>March</td>
<td>2,758</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td></td>
<td></td>
<td>3,759</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td></td>
<td></td>
<td>2,661</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>35,000</td>
<td>45,875</td>
<td>38,260</td>
<td>37,020</td>
</tr>
</tbody>
</table>
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. Bulk pellets are typically unloaded into an outdoor pellet silo (see Figure 8 below) but there are also interior pellet storage options (Figure 9).

Figure 8: Outdoor Pellet Storage and Delivery8

Figure 9: Indoor Pellet Storage9

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. 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 Paul Frederick to gather this information.

Paul E. Frederick
Wood Utilization Forester
VT Department of Forests, Parks & Recreation
5 Perry Street, Suite 20, Barre, VT 05641-4265
(802) 479-7436 FAX: (802) 476-0129
paul.frederick@state.vt.us

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8 Photo taken from the Wood Pellet Heating Guidebook published by Massachusetts Division of Energy Resources.
9 Photo courtesy of A.B.S. Flexible Silos.
The average price paid per ton of pellets in Vermont during the 2011-2012 heating season was $226, however pellet fuel may be available at a lower cost, and the District should check with multiple providers to find the lowest price fuel available.
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 Paul Frederick for a list of local suppliers.

Paul E. Frederick  
Wood Utilization Forester  
VT Department of Forests, Parks & Recreation  
5 Perry Street, Suite 20, Barre, VT 05641-4265  
(802) 479-7436 FAX: (802) 476-0129  
paul.frederick@state.vt.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.
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    - Moss
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  - Air Emissions from Modern Wood Energy Systems
  - EPA Institutional Boilers Fact Sheet
  - Particulate Matter Emissions-Control Options for Wood Boiler Systems
  - North America’s Wood Pellet Sector - USDA
  - Pellet Fuel – Pellet Fuels Institute
  - The Wider World of Pellet Fuel – Pellet Fuels Institute
  - Pellet Fuel Standards – Pellet Fuels Institute
  - Demonstration and Public Education at the Wild Center – NYSERDA
  - *Commercial-Scale Biomass Boilers Market Growing in the Northeast – David Dungate, Northeast Sun*
  - Wood Pellet Heating Guide Book (ON ENCLOSED CD)
  - Emission Controls for Small Wood Fired Boilers (ON ENCLOSED CD)
  - Biomass Boiler and Furnace Emissions and Safety Regulations in the Northeast States (ON ENCLOSED CD)
## APPLICATION FOR BIOMASS PRE-FEASIBILITY STUDY

### US Forest Service Wood Education and Resource Center

**Wood Energy Utilization Support Program**

**Application for Biomass Pre-Feasibility Study**

This application is available electronically at: [www.fs.fed.us/forestry/woodenergy/](http://www.fs.fed.us/forestry/woodenergy/)

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### Facility name and mailing address

West Rutland School  
713 Main Street  
West Rutland, VT 05777

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### Year of Building Construction

Year of Building Construction: 1988

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### Years of major renovation

- First renovation: 1995
- Second renovation: 1996

---

### Public or Private

- Public [ ]  
- Private [ ]

---

### Officer

- Name: 
- Title: Principal
- Phone: 802-468-2299
- Fax: 802-468-2121
- Email: principal@rutland.k12.vt.us
- Date form was completed: 07/01/12

---

### 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 or not.

<table>
<thead>
<tr>
<th>Name of building</th>
<th>Size in square feet</th>
<th>Central boiler?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Notes on gas or electric systems, including heating systems.

- An optimum 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 perfect timing.

---

### 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 apply:
  - Hot water [ ]
  - Steam [ ]
  - Ducted air [ ]
  - Electric resistance [ ]

---

### How is heat generated?

- Check all that apply, and state any equipment:
  - Hot water boiler [ ]
  - Steam boiler [ ]
  - Hot air furnace [ ]
  - Electric heat pump [ ]
  - Electric heat exchanger [ ]
  - Roof/air package unit [ ]
  - Heat pumps [ ]

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The West Rutland School Biomass Pre-Feasibility Report  
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**The West Rutland School Biomass Pre-Feasibility Report**

<table>
<thead>
<tr>
<th>Size</th>
<th>Type of Heater</th>
<th>Fuel Type, year installed, condition</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,500 sq ft or 200,000 BTU</td>
<td>Hot water boiler</td>
<td>02 fuel oil, installed in 1994, fair</td>
<td></td>
</tr>
<tr>
<td>3,500 sq ft</td>
<td>Steam boiler</td>
<td>34 ton, installed in 2008, very good</td>
<td></td>
</tr>
<tr>
<td>5,500 sq ft</td>
<td>Steam boiler</td>
<td>27 ton, installed in 2008, very good</td>
<td></td>
</tr>
</tbody>
</table>

**If heated 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 the past year. (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>No. 1</td>
<td>2009</td>
<td>20,999</td>
<td>Gallons</td>
<td>$10,000</td>
<td>100%</td>
</tr>
<tr>
<td>No. 2</td>
<td>2010-2011</td>
<td>40,875</td>
<td>Gallons</td>
<td>$20,000</td>
<td>100%</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 type, volume used and the total dollars spent in 2009 on that water.

**Fuel Type | Year | Volume | Units | Cost**
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Has your facility recently undergone an energy audit? □ Yes □ No**

<table>
<thead>
<tr>
<th>Year</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2010</td>
<td></td>
</tr>
</tbody>
</table>

**Community/Institution Intentions**

Is there an identified community champion for this work? □ Yes □ No

Mary Ann Goulette, Town Manager

Is there a community or institutional policy that supports the use of biomass or its benefits? □ Yes □ No

If yes, please attach.

Are there other institutions/buildings in the vicinity that have expressed interest in participating? □ Yes □ No

If yes, please provide contact information.

**Fire Department**

**Fire Chief (Rural Crew)**

**Town Board (Road Crew)**

**Biomass Initiative**

**Recommended Attachments**

1. If the facility has multiple heating plants in various locations please draw a 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.

**Email, Mail or fax completed application form to:** ginger@yellowwood.org

Yellow Wood Associates, Inc.  
228 North Main Street, St. Albans, VT 05478  
Fax 802-524-8643; Phone 802-524-6141

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