Preliminary Feasibility Report

Biomass Heating Analysis for Colrain Central School

Colrain, MA

September, 2012
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EXECUTIVE SUMMARY

The Colrain Central Elementary School serves approximately 120 students in the Mohawk School District. The 30,000 square foot school was built in 1952 (with renovations in 1998) and is currently heated with a fuel oil hot water distribution system, which was installed in 1998.

The School currently uses more than 14,000 gallons of fuel oil on average each year and is locked in at a price of $3.16 per gallon of fuel oil for the upcoming year. At that price, the District will spend more than $45,000 on fuel oil for the Colrain Central Elementary School this coming year. This report analyzes the installation of a containerized pellet boiler to provide heat and hot water at the Colrain Central Elementary School.

Table 1: Summary Findings of Biomass Analysis for the Colrain Central Elementary School

<table>
<thead>
<tr>
<th></th>
<th>Current Annual fuel oil (gal)</th>
<th>Projected Annual Fuel Bill*</th>
<th>Total Estimated Project Costs</th>
<th>Annual Tons of Wood Pellets</th>
<th>Tons of Carbon Offset by Wood Pellets</th>
<th>Return on Investment</th>
<th>Net 1st Year Fuel Savings</th>
<th>Total 30 Year NPV Cumulative Savings</th>
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</thead>
<tbody>
<tr>
<td>No Reimbursement</td>
<td>14,384</td>
<td>$45,453</td>
<td>$294,683</td>
<td>102</td>
<td>145</td>
<td>6.3%</td>
<td>$18,697</td>
<td>$1.2 million</td>
</tr>
<tr>
<td>With MSBA Reimbursement</td>
<td>14,384</td>
<td>$45,453</td>
<td>$108,296</td>
<td>102</td>
<td>145</td>
<td>17.2%</td>
<td>$18,697</td>
<td>$1.4 million</td>
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</table>

*based on $3.16 per gallon of fuel oil

The analysis provided in this report indicates that the District could save nearly $1.2 million in operating costs (increasing to $1.4 million if the project receives MSBA reimbursement) over 30 years in today’s dollars even when the cost of financing is included. The analysis shows more than $18,000 in fuel savings in the first year alone.

The Colrain Central Elementary School appears to be a good candidate for a wood pellet heating system. We recommend the District take the following steps to further investigate the feasibility of a biomass heating system:

1. 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. Biomass heating systems, especially pellet boiler systems, operate significantly more efficiently and effectively (improving cost savings) if thermal storage is designed into the overall system. With thermal storage, a biomass boiler can quickly ramp up to high fire and will shut down when the thermal storage has reached its optimum temperature, this type of system can supply a greater
portion of the annual heating load and will therefore provide greater savings. We strongly recommend that any pellet boiler system that is specified for this project include thermal storage as a component of the overall design.

2. 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.

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. This would consider 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. The analysis in this report assumes a 4% interest rate for the entire cost of the project. It is possible that the District could receive 63.25% reimbursement from the MA School Building Authority for the entire cost of the project. (See the sensitivity analysis at the end of this report.) How the project is financed can make a big difference on the potential savings. Yellow Wood can provide alternative analysis based on different financial assumptions upon request.

5. 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 measuring fuel consumption regularly. There are many tools that could help the District track fuel use electronically which would make the data easier to analyze and allow the district to set energy conservation goals. 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.

6. If the School decides to move forward with a biomass system, they should work with Gordon Boyce, Marketing and Utilization Forester with the Massachusetts Department of Conservation & Recreation, to identify potential biomass fuel suppliers concurrent with the design of the biomass system. If the District moves forward with multiple biomass 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 Colrain Central Elementary 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 48 Vermont schools and several in Massachusetts. 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 Massachusetts to achieve targets for renewable energy use. This analysis indicates that the Colrain Central Elementary School would offset 145 tons of CO₂ annually by installing a biomass system.

This report is a pre-feasibility assessment specifically tailored to the Colrain Central Elementary School outlining whether or not a wood pellet heating system makes sense for this facility from a practical perspective. In May of 2012 staff from Yellow Wood Associates traveled to Colrain to tour the School. This assessment includes site specific fuel savings projections based on historic fuel consumption, and provides facility decision-makers suggestions and recommendations on next steps.

The study was funded by the U.S. Department of Agriculture Wood Education and Resource Center.

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

EXISTING HEATING SYSTEM AND FUEL USAGE

The Colrain Central Elementary School is currently heated by two Burnham hot water boilers totaling 1.7 mmBtu. The boilers, installed in 1998, appear to be oversized but are in good condition and can be used to provide back-up and shoulder season heat for the pellet system.

Over the past three years, the Colrain Central Elementary School used an average of 14,384 gallons of fuel oil for heat and hot water, this is equivalent to 0.48 gallons of fuel oil per square foot.

Figure 1: Average Fuel Oil Usage 2008-2011

Advances in biomass boiler technology have made biomass systems more flexible. When combined with a thermal storage system, the pellet boiler may be able to capture nearly 100% of the system heating load.

The existing fossil fuel boilers can be used to back-up the pellet system during maintenance or if heating demand (due to colder than normal weather) exceeds the capacity of the pellet 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 scenario envisions installing a new pellet boiler and thermal storage system that would serve the Colrain Central Elementary School. The scenario includes all ancillary equipment and interconnection costs. Under the biomass scenario, the existing heating equipment would still be used to provide supplemental heat during the coldest days of the year if necessary and potentially for the warmer shoulder season months when buildings only require minimal heating during chilly weather.

The analysis projects current and future annual 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 School 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 Colrain Central Elementary School used an estimated 14,384 gallons of fuel oil. This is the amount of fuel oil used for the base case in the analysis. The District has locked in at $3.16 per gallon for the 2012-2013 school year – this is the price used in the base case of the analysis. At that price, the District will spend more than $45,000 to heat the Colrain Central Elementary School next year.

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 Massachusetts Marketing and Utilization Forester for the Department of Conservation and Recreation, we are projecting a first year cost of $219 per delivered ton of pellets, which is equivalent to about $1.85 per gallon of fuel oil). The costs for pellets are adjusted for inflation each year over the thirty-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>
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<tr>
<td>Wood Pellet (ton)</td>
<td>15.5*</td>
<td>$219</td>
<td>85%</td>
<td>13.175</td>
<td>$16.62</td>
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<tr>
<td>Fuel Oil (gallon)</td>
<td>0.138</td>
<td>$3.16</td>
<td>75%</td>
<td>0.104</td>
<td>$29.66</td>
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*Assumes 6% moisture content  
**Average seasonal efficiency

The biomass scenario assumes the facility will meet 90% of its winter heating needs with pellets and therefore consume 102 tons of pellets per year at $219 per ton in the first year. The remaining 10% of the heating needs were then assumed to be provided by fuel oil, consuming about 1,438 gallons of fuel oil per year. The costs for supplemental fuel oil and pellets are then adjusted for inflation each year over the 30-year horizon. This estimate of fossil fuel use is for planning purposes only. Once a pellet system is installed and District personnel become familiar with operational procedures, the pellet system when combined with thermal storage may eliminate the use of fossil fuels entirely or require fossil fuel use only during required boiler maintenance periods or in extreme peak heat demand situations.

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 Massachusetts was 7.23% per year. The analysis projects this inflation rate for fuel oil forward over the 30-year analysis period. The Colrain Central Elementary School’s fuel rate of $3.16 per gallon was used for the first year of the analysis and then inflated each year at 7.23%.

Pellet fuel pricing tends to somewhat track that of fossil fuels for two reasons. First, it takes a considerable amount of energy to produce pellets. Secondly, wood pellet fuel is used almost exclusively as a heating fuel and therefore 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.

*Figure 2: VT Biomass and MA Fossil Fuel Inflation*

*VT Biomass pricing is used because it has the most complete historical woodchip price history. 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

This analysis assumes 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 pellet boiler 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.

An additional operations and maintenance cost is the 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 biomass scenario included $10,000 of scheduled maintenance anticipated in years 10, 20 and 30 and then annualized at $1,000 per year to simulate a sinking fund for major repairs. The $1,000 annual payments were inflated at the general annual inflation rate.

Under any biomass scenario, a case could be made that the existing heating units will require less maintenance and may last longer since they will only be used for a small portion of the heating season. However, all heating equipment should be serviced at least annually no matter how much it is used. Additionally, it is very difficult to estimate how long the replacement of the existing units might be delayed. For these reasons, no additional annual maintenance, scheduled repair or planned replacement costs for the existing hot water 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 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 (including the MSBA reimbursement). If the District would like to see other cash flows using different financing schemes, Yellow Wood can provide additional analysis.
BIOMASS SCENARIO

DESCRIPTION OF THE PROPOSED BIOMASS SYSTEM

The biomass scenario envisions the addition of a containerized pellet system (see site plan below for location) that will meet 90% of the annual heating needs currently met with fuel oil at the School. The scenario analyzes the installation of a 750,000 Btu pellet boiler and 1,000 gallons of thermal storage. Hot water from the boiler would be tied to the existing heating system via approximately 50 feet of underground insulated piping. Costs for a 42-ton pellet storage silo and an allowance for interconnecting to the existing heating distribution systems are included in the proposed capital costs. A healthy construction contingency, standard general contractor mark-up and professional design fees were also included.

Figure 3: Site Plan
BIOMASS SCENARIO ANALYSIS

The analysis of the biomass scenario shows that the School could save nearly than $1.2 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 at the School. Annual fuel savings alone are projected to be $18,651 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 6.3% and this project would have a positive annual cash flow in the fourth year.

Table 3: Biomass Scenario Analysis Assumptions

<table>
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<tr>
<th>Colrain Central Elementary School Pellet Scenario</th>
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</thead>
<tbody>
<tr>
<td><strong>Capital Cost Assumptions</strong></td>
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<tr>
<td>One 750,000 Btu containerized pellet hot water pellet boiler system including installation</td>
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<td>42 ton pellet storage silo</td>
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<tr>
<td>Underground insulated hot water piping from biomass boiler house to existing boiler room</td>
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<tr>
<td>Thermal Storage 1,000 gallon</td>
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<tr>
<td>Interconnect to existing boiler system</td>
</tr>
<tr>
<td>GC markup at 10%</td>
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<tr>
<td>Construction contingency at 10%</td>
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<tr>
<td>Design at 8%</td>
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<td><strong>Total estimated project costs</strong></td>
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<td><strong>Financing Costs</strong></td>
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<tr>
<td>Financing, annual interest rate</td>
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<td>Finance term (years)</td>
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<td>1st full year debt service</td>
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<tr>
<td><strong>Fuel Cost Assumptions</strong></td>
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<tr>
<td>Current annual fuel oil use (gal)</td>
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<td>Assumed fuel oil price in 1st year</td>
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<tr>
<td>Projected annual fuel oil bill</td>
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<tr>
<td>Percent pellet fuel utilization</td>
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<tr>
<td>Assumed pellet price in 1st year (per ton)</td>
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<tr>
<td>Projected 1st year pellet fuel bill</td>
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<tr>
<td>Projected 1st year supplemental fuel oil bill</td>
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<td><strong>Inflation Assumptions</strong></td>
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<tr>
<td>General inflation rate (twenty year average CPI)</td>
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<td>Fuel oil inflation rate (twenty year ELA average for Massachusetts)</td>
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<td>Pellet inflation rate (estimate from Biomass Energy Resource Center)</td>
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<tr>
<td><strong>O&amp;M Assumptions</strong></td>
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<tr>
<td>Annual pellet O&amp;M cost, including electricity for additional pumps and motors and staff time for daily and yearly maintenance</td>
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<td>Major repairs (annualized)</td>
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<td><strong>Savings</strong></td>
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<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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Figure 4: Annual Cash Flow Graph for Biomass Scenario

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.
<table>
<thead>
<tr>
<th>Yr</th>
<th>Current Fuel Oil</th>
<th>Finance Cost</th>
<th>Pellet Cost</th>
<th>Partial Fuel Oil Cost</th>
<th>O&amp;M</th>
<th>Scheduled Repairs</th>
<th>Total Costs</th>
<th>Annual Fuel Savings</th>
<th>Cashflow</th>
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**Notes:**
- **Annual Fuel Costs:** Calculated using 2013 energy costs and the average Massachusetts fuel oil price index increase.
- **Annual Maintenance Costs:** Estimated from Biomass Energy Resource Center.
- **Annual PM Costs:** Estimated of additional electricity for feed system motors and additional maintenance staff time.
- **Contingency for major repair:** At Years 10, 20 and 30, annualized.
ADDITIONAL ISSUES TO CONSIDER

THERMAL STORAGE

A thermal storage system is included in the capital cost estimate for this study. In this case, the thermal storage system includes a large, insulated hot water tank and ancillary piping and pumps that connect the insulated storage tank to the wood fired boiler and to the 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.

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.

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 Colrain Central Elementary 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. CO$_2$ avoidance is based on the emissions profile (Lbs. CO$_2$ /Btu) of the displaced fuel.

1 Graphic courtesy of Joe Kohler, Kohler and Lewis Mechanical Engineers.
The US EPA calculates that 22.37 lbs. of CO₂ is produced from each gallon of fuel oil consumed. It is projected that the Colrain Central Elementary School can offset approximately 12,946 gallons of fuel oil per year by replacing that heat using biomass. This is equivalent to about 145 tons of CO₂ annually.

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:


ENERGY EFFICIENCY

Whether the Colrain Central Elementary School converts to biomass or stays with fuel oil, the facility should use its heating fuel efficiently. There are several energy efficiency resources available in Massachusetts, including MassSave (www.masssave.com) and Massachusetts State Energy Program Grant (funding whole-building deep energy efficiency improvements). If the School decides to move forward with a biomass energy project, it should work with one or more of these resources to identify other efficiency projects that could be completed at the same time.

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

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2 Illustration taken from a handout produced by the Biomass Energy Resource Center
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 Colrain Central Elementary 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.

EMISSIONS & PERMITTING

There is little emissions data available for pellet boiler systems in North America. Since the EPA regulations are geared toward much bigger systems than what is proposed in this report, permitting should not be difficult. A report released in 2010 (and included in the Biomass and Green Building Resources binder), Emission Controls for Small Wood-Fired Boilers provides a series of Best Management Practices (BMPs) for maximizing energy efficiency and minimizing emissions from wood-fired boilers.
PROJECT FUNDING POSSIBILITIES

MASSACHUSETTS SCHOOL BUILDING AUTHORITY (MSBA) REIMBURSEMENT

The analysis in this report does not take the MSBA reimbursement into consideration. However it is possible that this project will be eligible to receive reimbursement (63.25% is Colrain's MSBA reimbursement rate) for a biomass heating system. Yellow Wood recommends that the District contact the MSBA to discuss the potential for reimbursement if a biomass project moves forward.

MSBA GREEN REPAIR PROGRAM

The Green Repair Program is for the repair or replacement of roofs, windows and/or boilers in public school facilities that are structurally, functionally and educationally sound except for the condition of the roof, windows and/or boilers. The green repair program may provide another option to receive reimbursement for the biomass boiler system if the existing boilers are in need of replacement.

MA BIOMASS THERMAL PILOT PROGRAM

The Massachusetts Biomass Thermal Pilot Program will be launched in the Fall of 2012 by the Massachusetts Clean Energy Center and Massachusetts Department of Energy Resources. One component of this program will provide grants for commercial-scale pellet boiler systems with a focus on Public Schools and Municipal Buildings. It is estimated that 4-8 grants will be awarded for a total of $1.5 million in grants for commercial scale pellet systems. A webinar on the Biomass Thermal Pilot Program is available at: http://www.youtube.com/watch?v=Y9jX-4D0joI&feature=plcp

Detailed information about this grant opportunity has not yet been released, but the District should contact Robert Rizzo, Bioenergy Program Manager, to learn more about this opportunity.

Robert Rizzo
Bioenergy Program Manager
Massachusetts Department of Energy Resources
Robert.Rizzo@state.ma.us
617.626.7379

MASSDEVELOPMENT GREEN LOAN PROGRAM

The Green Loan Program is designed to bridge the gap between energy efficiency project costs and the rebates or subsidies provided by utility companies and state/federal incentive programs. Eligible institutions must be a Massachusetts non-profit or for-profit business that has been in existence for a minimum of five years. Loans are available from $50,000 - $500,000 for:
HVAC replacements or improvements
Windows, insulation, and other building improvements
Lighting
Energy control systems
Chillers and Boilers
Hot water heaters
Photovoltaic panels

For more information, and to download an application, go to:
http://www.massdevelopment.com/financing/loans-guarantees/green-loan-program/

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.

Southern New England
State Office
451 West Street, Suite 2
Amherst, MA 01002
Phone: 413-253-4300
Fax: 413-253-4347

MUNICIPAL LEASE PURCHASE

As a municipal entity, the Colrain Central Elementary 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 lmccreery@fs.fed.us (304) 285–1538
CONCLUSIONS AND RECOMMENDATIONS

1. 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. Biomass heating systems, especially pellet boiler systems, operate significantly more efficiently and effectively (improving cost savings) if thermal storage is designed into the overall system. With thermal storage, a biomass boiler can quickly ramp up to high fire and will shut down when the thermal storage has reached its optimum temperature, this type of system can supply a greater portion of the annual heating load and will therefore provide greater savings. We strongly recommend that any pellet boiler system that is specified for this project include thermal storage as a component of the overall design.

2. 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.

3. A complete mechanical analysis that provides an independent assessment of how to improve efficiencies and the operations and maintenance of boiler equipment, ventilation equipment and controls should be performed before investing in any boiler system. Upgrades could include outdoor temperature reset, DDC controls for unit ventilators and improved boiler controls. A mechanical evaluation will more than likely pay for itself many times over regardless of whether or not the District moves forward with a biomass system.

4. The analysis in this report assumes a 4% interest rate for the entire cost of the project. It is possible that the District could receive 63.25% reimbursement from the MA School Building Authority for the entire cost of the project. (See the sensitivity analysis at the end of this report.) How the project is financed can make a big difference on the potential savings. Yellow Wood can provide alternative analysis based on different financial assumptions upon request.

5. The District 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.

6. 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 measuring fuel consumption regularly. There are many tools that could help the District track fuel use electronically which would make the data easier to analyze and allow the district to set energy conservation goals. 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_portfolio_manager. Another tool (designed specifically for schools) is the CHPS Operations Report Card – available at http://www.chps.net/dev/Drupal/orc.

7. If the School decides to move forward with a biomass system, they should work with Gordon Boyce, Marketing and Utilization Forester with the Massachusetts Department of Conservation & Recreation, to cultivate potential biomass fuel suppliers concurrent with the design of the biomass system. If the District moves forward with multiple biomass 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 show life-cycle costs of the biomass system under varying finance scenarios. Table 5 is a sensitivity analysis comparing annual fuel savings from the installation of a pellet boiler based on varying prices for wood and fuel oil (all of the additional assumptions stated in Table 3 remain the same). For example, if the price for fuel oil goes up to $3.50 per gallon and the District is able to purchase pellets for $200 per ton, the annual fuel savings will increase to $24,983.

Table 5: Annual Fuel Savings When Pellet and Fuel Oil Prices Vary

<table>
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<th>Pellet Cost per ton</th>
<th># 2 Fuel Oil per Gallon</th>
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Table 6 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a pellet system at the Colrain Central School based on the receipt of MSBA reimbursement (63.25%) or varying grant funding. In this analysis all of the assumptions presented in Table 3 are held constant with a reduction in the capital cost based on reimbursement or grant funding. For example, if the District was able to obtain MSBA reimbursement, the first year cash flow would increase to $6,059 and the 30-Year NPV for the system would be over $1.4 million.

Table 6: 1st Year Cash Flow and 30-Year Net Present Value (NPV) when Grant Funding Is Available

<table>
<thead>
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<th>Project Costs (Capital – Grant/Tax Credit)</th>
<th>1st Year Cash Flow</th>
<th>30-Year NPV</th>
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<td>No grant funding</td>
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<td>$186,387 MSBA Reimbursement</td>
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<td>$50,000 Grant</td>
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<td>$100,000 Grant</td>
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THE COLRAIN CENTRAL ELEMENTARY SCHOOL FUEL HISTORY

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

Table 7: Fuel Oil Deliveries 2008 – 2012

<table>
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<tr>
<th></th>
<th>2008-09 Gallons</th>
<th>2009-10 Gallons</th>
<th>2010-11 Gallons</th>
<th>2011-12 Gallons</th>
<th>Average Gallons</th>
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<td>Aug</td>
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<td>2,318</td>
<td>2,500</td>
<td>2,409</td>
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<td>Jun</td>
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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).

Figure 7: Outdoor Pellet Storage and Delivery\(^3\)

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 Gordon Boyce to gather this information.

Gordon Boyce
Marketing & Utilization Forester
Phone 413-253-1798 X 206
Gordon.Boyce@state.ma.us

\(^3\) Photo taken from the *Wood Pellet Heating Guidebook* published by Massachusetts Division of Energy Resources.
The average price paid per ton of pellets in Massachusetts during the 2011-2012 heating season was $219, 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.
BIOMASS AND GREEN BUILDING RESOURCES BINDER

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  o MassDevelopment Green Loan Program
  o USDOE Guide to Financing EnergySmart Schools (ON ENCLOSED CD)

➤ Efficiency Resources
  o The National Grid Small and Midsize Business Direct Install Program - BUSINESS ONLY
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  o Reference Guide for EPA Portfolio Manager software
  o NE-CHPS Operation and Maintenance Guide Info Sheet
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  o Mass Energy Insight
  o US Department of Energy Reduce Operating Costs with an EnergySmart School Project
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  o Collaborative for High Performance Schools and Green Schools Resources (ON ENCLOSED CD)
  o EPA Indoor Air Quality Tools for Schools Reference Guide (ON ENCLOSED CD)

➤ Pellet Boiler Manufacturers
  ACT Bioenergy
  New Horizon Corporation
  Okofen
  Solagen
  SWEBO
  TARM Biomass
  Viessman / KOB
  WoodMaster
  Woodpecker

➤ Biomass Energy Resources
  o Carbon Dioxide and Biomass Energy
  o North America’s Wood Pellet Sector - USDA
  o Pellet Fuel – Pellet Fuels Institute
  o The Wider World of Pellet Fuel – Pellet Fuels Institute
  o Pellet Fuel Standards – Pellet Fuels Institute
  o Demonstration and Public Education at the W!ld Center – NYSERDA
  o Commercial-Scale Biomass Boilers Market Growing in the Northeast – David Dungate, Northeast Sun
  o Massachusetts Renewable Heating and Cooling: Opportunities and Impacts Study (ON ENCLOSED CD)
  o Massachusetts Department of Energy Resources Wood Pellet Heating Guide Book (ON ENCLOSED CD)
### Facility Information:

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility name and mailing address</td>
<td>Colrain Central</td>
</tr>
<tr>
<td></td>
<td>39 Jacksonville Rd</td>
</tr>
<tr>
<td></td>
<td>Colrain, MA</td>
</tr>
<tr>
<td>Year of Building Construction</td>
<td>1952</td>
</tr>
<tr>
<td>Years of major renovation(s)</td>
<td>1999</td>
</tr>
<tr>
<td>First renovation</td>
<td></td>
</tr>
<tr>
<td>Second renovation</td>
<td></td>
</tr>
<tr>
<td>Public or Private</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contact person for questions regarding this form:</th>
<th>Type of facility (check one)</th>
<th>Number of Occupants:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Karen Pray</td>
<td>$\text{School}$</td>
<td></td>
</tr>
<tr>
<td>Title: Facilities Coordinator</td>
<td>College/University</td>
<td></td>
</tr>
<tr>
<td>Phone: (413) 635-0192 x21</td>
<td>Hospital</td>
<td></td>
</tr>
<tr>
<td>Fax: 413-635-0192</td>
<td>Industrial</td>
<td></td>
</tr>
<tr>
<td>E-mail address: <a href="mailto:Info@ColrainSchools.org">Info@ColrainSchools.org</a></td>
<td>Prison</td>
<td></td>
</tr>
<tr>
<td>Date form was completed: 3/14/13</td>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

### Buildings

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>Name of building</th>
<th>Size in square feet</th>
<th>Central boiler?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colrain Central</td>
<td>30,000</td>
<td></td>
</tr>
</tbody>
</table>

### Expansion Plans

An opportune 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  
- [x] No  

If so please describe below, including project timing.

### Heating System

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you have a central heating system?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have more than one heating system?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have one heating plant in one location?</td>
<td>[ ] Yes</td>
<td>[ ] No</td>
</tr>
<tr>
<td>Do you have heating plants in multiple locations?</td>
<td>[ ] Yes</td>
<td>[ ] No</td>
</tr>
</tbody>
</table>

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 20% or more of the building(s))

- Hot water boiler  
- Steam boiler  
- Hot air furnace  
- Electric baseboard  
- Roof top packaged units  
- Heat pumps
### Heating equipment

List each piece of heating equipment separately below. Include size in boiler horsepower or BTU, state type of equipment, what fuel it uses, when it was installed and its condition (Poor, Fair, Good, Excellent).

<table>
<thead>
<tr>
<th>Size</th>
<th>Type of Heater</th>
<th>Fuel Type, year installed, and condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 MBH or 200 BHP</td>
<td>Hot water boiler</td>
<td>32 fuel oil, installed in 1998, fair</td>
</tr>
<tr>
<td>9 x 100 (2)</td>
<td>Hot water boiler</td>
<td>No fuel Oil, 1998, 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

### Fuel Usage

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>Fuel Oil</td>
<td>2009</td>
<td>19.463</td>
<td>Gallons</td>
<td>47,259</td>
<td>100</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>2010</td>
<td>19.627</td>
<td>Gallons</td>
<td>36,155</td>
<td>100</td>
</tr>
</tbody>
</table>

### Domestic Hot Water

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 are hot water.

### Other Information

Has your facility recently undergone an energy audit? □ Yes □ No If so when? 2009

### Community/Institution Intentions

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

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

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.

### 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.

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

Yellow Wood Associates, Inc.
228 North Main Street, St. Albans, VT 05478
Fax 802-524-6643; Phone 802-524-6141

1/12/2012
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